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Earn a living? What the Côte d'Ivoire–Ghana cocoa living income differential might deliver on its promise

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ABSTRACT

Despite the high value of the global chocolate market and the high profitability of the few multinational companies dominating it, the farmers growing cocoa beans remain poor. To change this, the two biggest cocoa producers, Côte d'Ivoire and Ghana, have jointly introduced the cocoa Living Income Differential (LID) policy. Charging higher prices for beans, the policy might help mitigate both poverty and the serious child labour and deforestation issues associated with cocoa farming, for which poverty is regarded as a root cause. Nevertheless, the design of the policy and the current lack of complementary measures raise doubts about the success and longevity of the policy and concerns about the implications for farmers in other countries. Accounting for the repercussions with international cocoa markets, this study quantifies the magnitude of the policy's effects in the LID countries and elsewhere under several alternative configurations of policies and market reactions with the support of model simulations and finds increases in farmer income ranging from zero to sizeable. Discussing the policy's potential impacts in the past and present context of the cocoa industry, it identifies a number of issues threatening its sustainability. Moreover, it underlines the strong dependence of the policy's success on chocolate manufacturers' support unless complemented by supply management measures. Such measures could limit the aggravation of, or even improve, the income situation for farmers elsewhere and the child labour and deforestation issues.

1. Introduction

Rarely is the contrast in living standards between farmers producing an essential ingredient and producers and consumers of the final product so obvious as in the global value chain for chocolate. At the one end, there are five to six million (WCF, 2012) predominantly and often extremely poor smallholder farmers (FAO and BASIC, 2020), primarily located in a few, poorer tropical countries, growing the cocoa beans. At the other end, largely located in distant, higher-income, western countries, there is a global, US $138 billion (henceforth, all prices will be in USD unless otherwise stated) chocolate market (in 2019, Business Wire, 2020), dominated by a few big western manufacturing companies (Hütz-Adams and Schneeweiß, 2018). On the way from its farm origin to the retail store shelf in the consumer country, a cocoa bean is transformed in many steps requiring additional labour, energy, sugar, often dairy, and other inputs before it becomes a chocolate consumer product. Of the value added generated along the chain, final manufacturers and retailers receive a share of 79.4% whereas cocoa farmers obtain 6.6% (Fountain and Hütz-Adams, 2015). Whether there is abuse of market power by the big players in the chocolate value chain that depresses the farmers' value-added share remains unsettled (see Hütz-Adams et al., 2016, for a review) but many of the large cocoa traders and processors and chocolate manufacturers publicly agree that cocoa farmers' incomes are too low and need to be increased. They have committed to this goal not only via their own sustainability programmes (van Vliet et al., 2021), but also through their support for the cocoa Living Income Differential (LID) (Aboa, 2022), a policy that has been introduced jointly by the governments of Côte d'Ivoire and Ghana to raise the cocoa farmers' share in the value added and thereby their incomes.

Côte d'Ivoire and Ghana are the two biggest cocoa producers, accounting for 44.4 and 16.3% of global cocoa bean production, respectively, in 2020 (ICCO, 2022b). At the same time, cocoa is important to their own economies, not only in terms of employment, but also foreign exchange earnings and government revenue. Little cocoa is

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consumed domestically. Most of the cocoa is exported, largely as beans or first-stage processed products, generating 38.9% of Côte d'Ivoire's and 16.2% of Ghana's total merchandise export earnings in 2019 (UN Comtrade, 2021).

Widespread poverty among cocoa farmers continues to be a challenge in the two countries. Around 54.9 and 26.9% of cocoa farmers in Côte d'Ivoire in 2014/2015 (World Bank, 2019) and Ghana in 2012/2013 (Vigneri and Kolavalli, 2018), respectively, were living below the national poverty line. Moreover, the incomes of 73 to 90% of cocoa farming households do not reach the level of a "living income"[1] (van Vliet et al., 2021). Cocoa farming households in Côte d'Ivoire and Ghana typically depend strongly on the income from cocoa sales, which accounts, on average, for 66 and 61% of the total household income, respectively (Bymolt et al., 2018). Correspondingly, these households' incomes are heavily influenced by the farmgate price for cocoa. However, since their farms are typically also characterised by small acreage and low productivity, their income base is low as well (Wessel and Quist-Wessel, 2015; Bymolt et al., 2018). This, in turn, limits input use and farm investment, leaving these farmers stuck in a trap of low productivity and low incomes (Hütz-Adams et al., 2016).

Low productivity and poverty are regarded as root causes for two other major sustainability issues associated with cocoa farming, the continued clearance of protected tropical forest areas and the high prevalence of child labour in the cocoa sector (Fountain and Hütz-Adams, 2020). The amounts of inputs and labour required to maintain cocoa yields increase with the age of the plantation (Ruf and Schroth, 2015). As Ruf and Schroth (2015) show, cocoa farmers clear tropical virgin forests to exploit the land's positive properties, including good soil fertility and moisture retention and little pressure from weeds, pests, and diseases. But these benefits are exhausted after 15 to 30 years. According to Amanor et al. (2021), old cocoa plantations become susceptible to weeds, diseases, and pests and suffer from low soil fertility. Correspondingly, maintaining yield levels requires increasing quantities of labour, pesticides, and fertilisers. Moreover, cocoa trees need at least three years to become productive and while they typically have an economic life of 30 to 40 years, their yields start to decline after about 15 years, with these numbers varying depending on the context (Somarriba et al., 2021). Consequently, the income from growing cocoa beans declines over time. As the cost for clearing and replanting an old cocoa plantation in terms of labour, fertiliser and pesticide inputs is much higher than that of a virgin forest area (Ruf and Schroth, 2015), extending into virgin forest area is a rational choice for a poor farmer. Besides, by expanding to new land, farmers retain the income from the old trees while the new trees mature (Bymolt et al., 2018). Under these conditions, the mere maintenance of the income level results in a cycle of deforestation.

Goldman et al. (2020) estimate that over the 2001–2015 period, cocoa farming caused 1.9% of global agriculture-linked deforestation. Even though this share is small compared to the shares attributed to cattle, oil palm and soy, it particularly affects rainforests in biodiversity hotspot areas (Kroeger et al., 2017). According to the WRI (2021), Côte d'Ivoire and Ghana accounted for 22 and 10% of the global cocoa-related deforested area, respectively. This corresponds to 25 and 33% of total tree cover loss in Côte d'Ivoire and Ghana over that period, respectively.

While poverty and labour costs are important determinants of child labour, many other factors have been found to be associated with the prevalence of child labour, such as the opportunity costs of children's time, limited access to childcare, missing schooling and training opportunities, desire to transfer skills, land and asset ownership, lack of access to credit, regulatory factors, household composition, and local norms, see, e.g. discussions in Sadhu et al. (2020) and Vigneri et al. (2016). These factors indicate that the impact channel from cocoa prices and household incomes to child labour is complex and that the outcome of an income increase is ambiguous *a priori*, as reviewed by Ravetti (2020). The review finds that an increase in income might decrease child labour in some situations but increase it in others. The latter is often linked to improved earnings opportunities that also raise the opportunity costs of children's time. Similarly, Vigneri et al. (2016) discuss whether theoretically the effects of higher cocoa yields on the occurrence of child labour could go both ways, but they did not find evidence of child labour-increasing effects from increasing yields in their empirical study covering the two countries. Finally, sacrificing children's formal education also decreases their capacity to become economically independent and escape poverty in the future (Luckstead et al., 2019).

The 2018/2019 survey data analysed by Sadhu et al. (2020) indicates that of the 5 to 17-year old children from agricultural households in cocoa farming areas, 45% (790,000 children in Côte d'Ivoire and 770,000 in Ghana) are engaged in child labour in cocoa production. Of these children, about 95% carry out tasks which are categorised as hazardous work according to the child labour definition by the International Labour Organization, which includes, for example, dangerous tasks, carrying heavy loads, and working long hours or at night.

As consumers, civil society and governments become increasingly sensitive to the human rights and sustainability issues in the chocolate supply chain (Barrientos, 2016; Fold and Neilson, 2016), the pressure on chocolate traders and manufacturers to eradicate the causative practices, including the issue of cocoa farmers' low incomes, is mounting. Moreover, under the seventh International Cocoa Agreement from 2010, a number of cocoa-producing and consuming member countries of the International Cocoa Organisation (ICCO), which also include Côte d'Ivoire, Ghana and the European Union (EU), have committed to improving the livelihoods of cocoa farmers and the environmental sustainability of the cocoa supply chain (UNCTAD, 2010). Finally, a group of organisations under the umbrella of the Living Income Community of Practice (2022) is advocating for the living income to be acknowledged as a necessary condition for establishing several human rights.

While a variety of programmes that include measures to improve cocoa farmers' livelihoods has been implemented over the past decades by cocoa producer governments, civil society, and chocolate traders and manufacturers (see Online Appendix D for an overview), these have so far failed to bring about substantial improvements for cocoa farmers. The LID policy is a novel, joint effort by the governments of Côte d'Ivoire and Ghana that builds on the support of the chocolate industry.

The LID's primary objective is higher farmgate prices. While it is clear that an increase in farmgate prices stimulates cocoa farmers to expand production, it is less clear how large their supply response might be. In light of the combined market share of the two countries, the magnitude of the feedback via the world market price and its ramifications for the goals to increase farmgate prices and farmer incomes need to be clarified as well as what additional measures could be necessary to reach those goals. Moreover, the extent to which these goals are reached varies with the details of the LID's implementation and accompanying policies as well as with the market actors' behavioural reactions, which all remain still unknown. Another question concerns the sustainability of the LID policy itself, e.g. as it might have substantial effects on the government budgets of Côte d'Ivoire and Ghana, and its effects on the sustainability of the cocoa sector.

The only two existing studies quantifying the effect of the LID premium on farmer incomes by van Vliet et al. (2021) and Waarts et al. (2021) both calculate the benefit from the LID premium for each farmer

[1] Similar to a poverty line, the "living income" is an absolute income threshold but it extends beyond the basic needs and provides for a "decent standard of living", which, according to the Living Income Community of Practice (2022), additionally includes "food, water, housing, education, healthcare, transport, clothing, and other essential needs including provision for unexpected events".

corresponding to farm survey data and determine that the LID gains are very low in terms of poverty and living income. However, both studies consider only cocoa farmers in Côte d'Ivoire and Ghana and neglect other stakeholders in the market and other cocoa-producing countries. Moreover, they ignore supply and demand reactions, which counteract the positive effect of the initial farmgate price increases, and thereby overestimate resulting farm incomes. Comprehensively accounting for these reactions requires a quantitative, model-based assessment.

To shed light on the potential outcomes following the introduction of the LID, the present study conducts a series of thought experiments on how the policy might play out under varying assumptions. Two sets of experiments have been designed to answer two central questions. What could be the impacts of the LID policy itself? And what magnitude of complementary supply management policies would be required in addition to the LID to reach the minimum farmgate price the LID implicitly aims to guarantee? Furthermore, we identify several threats to the sustainability of the LID policy and the sustainability of the cocoa sector by evaluating the results in light of past attempts to raise farmer welfare in the cocoa and other agricultural sectors by governments and other stakeholders. To the best of our knowledge, this is the first study providing a quantitative *ex-ante* assessment of the long-term impacts of the LID policy that fully accounts for market reactions.

The remainder of the article is organised as follows. Section 2 provides background on farmgate prices and the LID. Section 3 describes the model, data and simulation scenarios before Section 4 evaluates the simulation results and Section 5 enters a wider discussion. Section 6 presents conclusions and policy recommendations.

2. Background and policy context

2.1. The price determination process

The cocoa markets in Ghana and Côte d'Ivoire are both strongly regulated, albeit very differently, and their market programmes include measures to improve the livelihoods of the cocoa farmers, affecting productivity, quality and farmgate prices (Grumiller et al., 2018). With respect to farmgate prices, both countries adopt price-fixing mechanisms, which largely guarantee a minimum price for the farmers throughout the harvest season[2] (Grumiller et al., 2018), thereby reducing intra-seasonal price variability (Staritz et al., 2022) and the bargaining power of intermediaries in the supply chain between the farmgate and the exporter. They also adopt stabilisation funds to reduce volatility across seasons, e.g. caused by exchange rate fluctuations. Quality management measures in both countries have led to higher quality beans which achieve a premium at world market prices (Staritz et al., 2022). In both countries, the price farmers receive for their cocoa beans is much lower than the export price. The deducted difference pays not only the costs and margins of the operators providing trade and transport services between the farmgate and the point of export but also taxes and other sector-specific levies, which are partly returned by the marketing boards to the cocoa farmers in the form of inputs and services provision, thereby ultimately decreasing farmers' production costs (Staritz et al., 2022). It is important to keep these benefits in mind when comparing the farmgate prices of Côte d'Ivoire and Ghana to those of other countries, which do not provide such benefits to their farmers, or to the international market price. However, the extent of these benefits differs strongly across farms, as Bymolt et al. (2018) and Kolavalli and Vigneri (2017) find based on different data sets.

In Ghana, the state-owned Ghana Cocoa Marketing Board (COCOBOD) directly or indirectly controls all purchases, sales and exports of cocoa but also provides a range of services including quality control and transportation. COCOBOD sets cocoa farmgate prices once per year in a multi-stakeholder approach around the start of the harvesting season in October. All buyers of cocoa beans have to pay farmers the fixed price.

As described by Kolavalli and Vigneri (2017), the price determination process begins once 60 to 70% of the predicted main harvest of next year has been forward sold. First, the expected cocoa revenue is calculated from predictions for the year of the gross Free-on-Board (FOB) export price in USD, the Ghana cedi (GHS) to USD exchange rate, and the harvest. Then, an amount is deducted to cover the cost or subsidies for a number of goods and services, such as cocoa research, jute sacks, disease and pest control, fertilisers, scholarship funds, actions to reduce child labour and certification. This yields the net FOB price per tonne. The net FOB price is then divided between all agents involved in the cocoa production, transport and marketing, including COCOBOD and the government, where the farmers' share has typically amounted to around 60 to 70% in recent years. The detailed expenditure data analysed in Kolavalli et al. (2012) shows strong variation in the expenditure budgeted for specific items across years.

Consequently, measured against the gross FOB price,[3] cocoa farmers have frequently received a share of less than 70% in recent years (see Oomes et al., 2016). While Ghana does not levy explicit taxes on cocoa bean exports, the producer price-fixing mechanism causes a high implicit taxation of all cocoa bean sales, which also includes selling to domestic processing companies (WTO, 2014). On the other hand, the mechanism provides farmers with a degree of price stability while allowing for some transmission of international market price changes (Quarmine et al., 2014).

In Côte d'Ivoire, the cocoa board, Conseil du Café-Cacao (CCC), is responsible for the sector's regulations including the setting of guaranteed minimum farmgate prices, price stabilisation and the allocation of export licenses (Bymolt et al., 2018). After a decade of a liberalised cocoa market, the sector was re-regulated in 2011. Now, the cocoa bean price for the next season is fixed after export licences for 70 to 80% of the upcoming year's harvest have been sold in auctions and, in the past few years, a minimum of 60% of the Cost–Insurance–Freight (CIF) price has been guaranteed as the farmgate price (Oomes et al., 2016).

Côte d'Ivoire levies an export tax of 14.6% and a registration fee of 1.5% on raw cocoa beans.[4] Further levies are earmarked for cocoa- or agriculture-specific services, like CCC management, quality control and agricultural investment funds. For processed cocoa products, this tax rate decreases with increasing levels of processing (WTO, 2017), thereby encouraging domestic processing. For the 2018/2019 season, together with parafiscal levies, taxes on cocoa totalled 22% of the export price, whereas margins of private operators for trade and transport totalled about 18% (World Bank, 2019). In recent years, cocoa farmers have typically received well below 70% of the international market price (Oomes et al., 2016).

In the course of the LID introduction, the above-described processes for determining the farmgate prices might have been adjusted, but no information is available on this yet.

2.2. The Living Income Differential

After Côte d'Ivoire and Ghana dropped initial plans for a price floor of $2600 per tonne of cocoa bean exports, they jointly announced the LID policy (FCC, 2019) in 2019. This is a new attempt to raise the farmgate price by capitalising on their collective market power and thereby increasing the share their farmers receive of the value of the global chocolate market. It is also a first step towards enabling a living income. The LID itself is a mandatory $400 per tonne premium on

[2] In rare cases, farmgate prices are adjusted mid-season.

[3] In the literature, the FOB export price is typically approximated by the annual average of the daily international prices published by ICCO.

[4] https://pwic.gouv.ci/procedures-exportations/cafe-cacao/, accessed on 19 April 2022.

top of the FOB export price of cocoa beans, which is applied to all cocoa sales starting with the harvest season 2020/2021. The policy relies on the chocolate industry's declared support (Aboa, 2022) and its commitment to improving the living conditions of cocoa farmers and the associated willingness to pay prices above the international market level. This voluntary element is crucial as otherwise the LID would resemble an export tax or a levy and correspondingly result in lower rather than higher farmgate prices.

The LID also introduces a new price stabilisation fund to improve farmgate price stability across harvest seasons. According to FCC (2019), the price stabilisation fund pays the shortfall when the realised FOB export price including the LID falls below $2600. When it exceeds $2900, the excess is held back and transferred into the stabilisation fund. Accordingly, the minimum gross FOB export price as relevant to the farmers is $2600 per tonne including the $400 LID premium. Since FCC (2019) allocates 70% of the gross FOB export price to the farmers, they would be guaranteed a farmgate price of at least $1820 per tonne (henceforth called "target farmgate price"). This amounts to a roughly 20 to 30% rise in the government institution-controlled annually fixed farmgate prices compared to the 2019/2020 season (Fountain and Hütz-Adams, 2020).

In contrast to the price stabilisation mechanisms already existing in the two countries, this new mechanism has a clearly defined price band, thereby increasing its predictability, and its limits are specified in USD terms, which implies that to some extent the farmgate prices are protected against domestic inflation.

2.3. Unknowns around the LID

At the time of writing, the first season under the new policy has passed and Côte d'Ivoire and Ghana have collected the LID premium on sales for the 2020/2021 and 2021/2022 seasons. However, no official documents have surfaced to provide more details on the LID's implementation and accompanying policies. Correspondingly, several unknowns surrounding the LID remain: Is the LID premium subject to the same levies as the export price itself or is it paid to the farmers in full? Are the levies from the export price, i.e. the gap between the FOB export price and the farmgate price, reduced from present levels down to 30%? Are the governments ready to defend the lower price limit of the price stabilisation mechanism and thereby the minimum target of a farmgate price of $1820 per tonne, even if this exceeds the stabilisation fund? Will supply management measures be put in place to limit the expansion of cocoa production and if so, which ones? Will the governments directly intervene in the market with beans purchases or support stockholding to influence the market price, and to what extent?

Although some claims about LID premiums passed to farmers and FOB price levies have emerged in press reports, the facts are insufficient to clarify these unknowns without further insights into the governments' decision details, see Online Appendix E for a discussion on the farmgate prices announced since the LID's introduction.

In addition, the success and costs of the LID policy with respect to the objectives of the target farmgate price and farmers' incomes depend on how the market stakeholders – particularly chocolate manufacturers, and cocoa farmers and governments elsewhere – in the rather concentrated global cocoa market will react to it in the long run.

Buying cocoa beans from Ghana and Côte d'Ivoire and paying the LID might provide chocolate manufacturers with benefits in the form of an improved corporate image, conveying the image of responsible and sustainable chocolate production. In fact, Thorlakson (2018) found that the fear of negative impacts on company reputation with consumers has been a strong driver for engaging with sustainability issues in the supply chain. On the other hand, the higher costs of cocoa beans as inputs in chocolate manufacturing might prompt manufacturers to adapt their product assortment due to lower profits or require higher sales prices which could decrease sales. Correspondingly, when evaluating the outcomes of the LID, the extent to which chocolate manufacturers might adapt their sourcing of beans in response to the new prices and to what extent they might pass the higher cost of beans on to the consumers must be considered.

While several large chocolate traders and manufacturers have expressed their support for the LID initiative and cocoa bean sales have progressed at prices including the LID (Aboa and Angel, 2019b,a), there were also suspicions that some companies might have been increasing their purchases from non-LID countries or the commodity exchange to avoid the LID (Aboa, 2020; Almeida et al., 2020). This leaves room for speculation as to what degree manufacturers are willing and able to disregard competitive pressures in their sourcing decisions. If manufacturers shift the purchase of their beans from an LID to a non-LID country, the international price for beans, specific to that LID country, will decrease, counteracting the initial increase caused by the LID.

Regarding the LID's impact on consumer prices, calculations for France by FAO and BASIC (2020) indicate that, in 2018, roughly 90% of the margins generated over the cocoa supply chain accrue to the final chocolate manufacturers and retailers. For plain milk and dark chocolate bars in France, they calculate margins in the value chain downstream from the cocoa farmers of 149 and 180%, respectively, compared to the part of the bar's total costs that goes to the farmers. If companies pass the cost for the LID on to consumers, the authors simulate the same value chains and estimate an increase in the consumer prices of the chocolate bars by 1.5 and 2%, respectively. Together, this raises hope that the necessary increase of the consumer price and demand reactions could be very limited.

3. Methods

The experiments for assessing the potential effects of the LID are based on a comparative-static analysis that takes a long-run view of the market for cocoa beans. All annual figures presented refer to the year the crop season ends unless stated otherwise, e.g. 2020 denotes the season 2019/2020. The analysis investigates the long-run equilibrium the market of the crop year ending 2020 would settle on following the introduction of the LID. This assumes that everything else, i.e. population, preferences, production technology, weather and yields, policies in other countries, and so forth, all remained the same as in 2020 and all market participants had sufficient time to fully adapt to the new situation. Such an adaptation would probably take more than 10 years, allowing new land to be acquired and converted and newly planted cocoa trees to mature.

The approach chosen provides a clear picture of the long-term, persistent effects of a policy change in isolation, avoiding the confounding effects arising from other long-term developments. Note that although farmgate prices in Côte d'Ivoire and Ghana are government controlled, they are adapted each year, taking the achieved export price into account, and they thus follow the international price to a certain extent (Quarmine et al., 2014, for Ghana).

Given the dominant share of cocoa produced jointly by Côte d'Ivoire and Ghana, the LID policy will substantially affect the global cocoa market and result in feedback effects through export prices. To account for these effects, a global cocoa market model representing the rest of the world, in addition to Côte d'Ivoire and Ghana, has been developed.

3.1. The global cocoa bean partial equilibrium (PE) model

We have developed a single product, multi-region, PE model covering the global market for cocoa beans. Each region is represented by a set of iso-elastic supply and demand functions. These functions depend on a cocoa bean price that reflects the incentives relevant for producers and consumers, respectively, i.e. it accounts for taxes and subsidies, for example. All national markets are linked via the international market which requires exports and imports to balance globally.

Cocoa beans are treated as being homogeneous. However, export prices vary between producer countries owing not only to transaction costs but also to quality differences, such as national quality standards, fine cocoa or cocoa certified for sustainability or ethical trade. The corresponding price differential is introduced as a multiplication factor to the international price to arrive at the domestic price. Thus, all regions' domestic prices differ from the international price. The latter is calibrated to equal the annual average of the daily international price as published by the ICCO. The cocoa trade is represented non-spatially as net exports. To some extent, averaging across types of cocoa conforms with reality, where cocoa certified for sustainability, thus more expensive cocoa beans but with otherwise identical properties, are often physically mixed with non-certified ordinary ones ("mass balance approach", Stoop et al., 2021). This model simplification, which also averages across fine or special-origin cocoa, for example, is necessary as data that differentiates types of cocoa is not sufficiently available.

The model is implemented as a mixed complementarity problem in the General Algebraic Modelling System (GAMS) version 35.1.0 and solved numerically using the PATH solver version 5.0.02. See Online Appendix A for the mathematical model formulation.

3.2. Data

The data for the PE model has been compiled from various sources. Quantities of national production, exports, imports and changes in stocks of cocoa beans are taken from the Quarterly Bulletin of Cocoa Statistics (ICCO, 2022b). Demand is approximated by bean grindings. All data is aggregated to the three regions Côte d'Ivoire, Ghana and Rest of World (ROW). According to the data, in 2020, Côte d'Ivoire, Ghana and ROW accounted for 44.4, 16.3 and 39.3%, respectively, of global cocoa bean production and similar shares of exports while ROW accounted for virtually all imports.

The model is calibrated on three layers of cocoa beans prices: the domestic prices farmers receive at the farmgate, the FOB price at the location of export in the respective country, and the international reference price. Data on national farmgate prices for 2013 to 2020 (additional years for comparison) have been compiled for Côte d'Ivoire from price announcements on the government's website[5] and for Ghana from the 2013 to 2019 issues of the Ghana Cocoa Board Annual Report & Financial Statements,[6] amended with a press announcement for 2020. Data for seven of the next top eight producers have been compiled from national government websites (Brazil and Columbia), from FAOSTAT (2022) producer prices (Indonesia, Ecuador, Peru and Dominican Republic) and from ICCO[7] (Cameroon). These prices have been converted from local currencies to USD using the average of the monthly exchange rates (IMF, 2022) from October to September for a crop year or over an actual calendar year, corresponding to the type of farmgate price available.

The country-specific FOB export price is estimated by the unit value calculated from the country's export data retrieved from FAOSTAT (2022). This data is based on calendar years. The FOB export price data is reflective of the average price received for cocoa bean exports but neglects domestic sales. Therefore, the overall national sales price average might differ to some extent, especially if the quality of exported beans differs from beans sold domestically. In Ghana, for example, the mid-crop harvest lower-quality beans, accounting for about 10% of the annual harvest, are sold to domestic processors at a discount of 20% (Mulangu et al., 2017).

The international reference price is represented by the one-year average of the daily international prices as published by the ICCO (2022a). Only for comparison to the FOB export prices above, are these also calculated over calendar years. The international price serves as a reference price for the international market development but is not necessarily close to the FOB export price of any country.

The price-fixing processes in Côte d'Ivoire and Ghana are complex. They factor in a variety of aspects and are subject to prediction errors and human judgement. Correspondingly, there exists no statutory percentage levy that allows the domestic farmgate price to be calculated from the FOB price. Instead, the levy is approximated by the percentage deduction from the FOB export price yielding the farmgate price using the 2020 price data described above. For ROW, this is the simple average of the previously named next top producer countries. The levies (henceforth called "FOB price levies") are applied to the FOB export price and amount to 41.4, 40.8 and 26.4% for Côte d'Ivoire, Ghana and ROW, respectively. Over the 2013 to 2020 period, the calculated levy varied between 20.3 and 46.35% in Côte d'Ivoire and between 33.4 and 52.6% in Ghana. Note that the levy, besides actual government taxes and levies, includes the costs and margins for trade and transport from the farmgate to the point of export. In the global cocoa model, the FOB price levies are applied as producer taxes and thus affect both the export and domestic sales of the beans.

Estimates for the long-run price elasticities of cocoa demand and supply are taken from the literature. A search for estimations published after 2000 yielded studies by Burger (2008), Gilbert and Varangis (2004), Gilbert (2012, 2014), ICCO (2008) and Tothmihaly (2018). Therein, estimates for the price elasticities of world cocoa demand range from −0.19 to −0.96. For the price elasticity of cocoa supply, estimates range from 0.285 to 0.57 for world supply, from 0.43 to 0.58 for Côte d'Ivoire, and from 0.43 to 0.64 for Ghana. Here, the most recent estimations in the literature by Tothmihaly (2018) are adopted, who estimated long-run price elasticities of world supply of 0.57 and of demand of −0.34, respectively. These seem plausible considering the range of other estimates found. In general, the supply and demand elasticities are expected to be low (highly inelastic) because cocoa trees are a long-run investment and cocoa beans amount to only a small share of the final price of chocolate products, a product group with no close substitutes. The same elasticities are used for all countries.

Cocoa farmer welfare impacts are derived from the simulation results in terms of changes in producer surplus. This monetary metric is translated into impacts on the income of a hypothetical average cocoa farmer by leveraging the cocoa farm survey-based income data for average Ivorian and Ghanaian cocoa farms, respectively, reported in Bymolt et al. (2018) and updated to 2020 using national price and production statistics (ICCO, 2022b). This farm income accounts for cocoa revenue and costs plus non-cocoa income. By contrast, the change in producer surplus only accounts for the difference between the producer price of a product and its marginal costs, ignoring fixed costs. Hence, the farm household's share in the change in cocoa producer surplus according to its proportion in total cocoa production is added to its initial income. Correspondingly, our income measure assumes that all non-cocoa incomes and fixed costs remain constant. Income is converted to USD per day and adult equivalent (AE) and yields $2.08 per day and AE for Côte d'Ivoire and $1.50 for Ghana. As benchmarks for the income changes, we update the values from the living income benchmark studies for cocoa farmers by CIRES (2018) and Smith and Sarpong (2018) to 2020 and derive a living income per day and AE of $4.02 for Côte d'Ivoire and of $3.21 for Ghana. For the ROW aggregate, no such data exists and only the producer surplus change is reported. For data sources and calculation details, see Online Appendix B.

3.3. Scenarios

The year 2020 is taken as the reference point for the analysis. In 2020, the annual international cocoa bean price as published by ICCO was relatively low at $2398 per tonne. After two peaks in 2010 and

[5] https://www.gouv.ci, accessed on 19 April 2022.
[6] https://cocobod.gh/resources/annual-report, accessed on 3 May 2022.
[7] Personal communication.

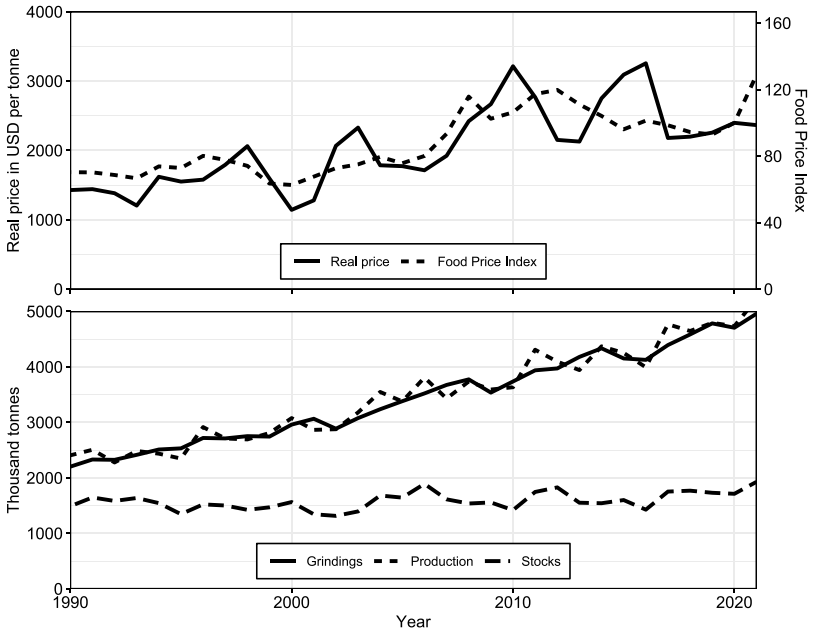

Fig. 1. Historic international cocoa bean prices and the general Food Price Index (FPI, base = 2020) and global production, grindings and stocks. The years for all data apart from the FPI refer to the harvest season from October of the previous year to September of the year shown. Real prices are shown in constant 2020 USD, deflated using the Manufactures Unit Value (MUV) index.
Source: Authors' elaboration; prices, production, grindings and stocks from ICCO (2022b); MUV and FPI from World Bank (2022).

2016, the real price dropped strongly in 2017, see Fig. 1, and has only recovered fractionally until now (September 2022).

All simulation scenarios examine the impacts of the LID policy change but differ in the assumptions they make about the unknowns around the LID. All scenarios assume that Côte d'Ivoire and Ghana introduce all policies in a synchronised manner.

3.3.1. The LID scenarios set

The first set of scenarios (the LID scenarios) examines the introduction of the LID of $400 per tonne and the reduction of the FOB price levy to 30%. The assumptions of the main *LID* scenario, which is used as a basis for the other scenarios, follows the policy details from the FCC (2019) document to the letter. At the time of writing, it remains unclear, however, whether the policy has indeed been implemented this way. The resulting *LID* scenario takes a rather optimistic view from the perspective of the first-order impact on farmgate prices in Côte d'Ivoire and Ghana. It assumes that the chocolate manufacturers are paying the LID without letting it influence their sourcing decisions and that the FOB price levies in Côte d'Ivoire and Ghana are reduced to 30% but are also applied to the LID premium. Governments are assumed to fully pass on the LID revenue (after the FOB price levy deduction) to the farmers. Moreover, it is assumed that the LID-related cost increase is small enough to avoid demand reactions from chocolate consumers.

Enumerating all combinations of possible assumptions regarding the unknowns would result in an excessive number of scenarios and would offer little information. To reduce this number in the absence of conclusive evidence regarding the unknowns, instead of choosing a set of arbitrary "likely" scenarios, here, we follow the strategy to show for each unknown in isolation what effect a change in the corresponding assumption has. Thereby, each scenario provides readers with a sense of the direction and magnitude of the effect of that change. Readers can then use the simulation results to form an approximate judgement of the total effect of a scenario combining a specific new set of assumptions for the unknowns although this scenario has not been simulated here.[8] This strategy also reveals which assumptions are more or less important with respect to effect sizes. To implement this, the subsequent scenarios are all modifications of the set of assumptions about the unknowns included in the main *LID* scenario, as shown in the overview in Fig. 2, and only the modifications are described. Each scenario changes a single assumption with respect to the main *LID* scenario, respectively, the *TPFG quota* scenario (see the following section).

Under competitive market conditions, the price for a specific country's beans is exclusively determined by supply and demand on the international market. Thus, after the introduction of the LID, the price including the LID must fall to sell all beans produced and is eventually driven down to the initial market equilibrium price where the market is cleared again. As the price the farmers would receive, including the LID and after deducting the levy, is identical to the price they initially received, the introduction of the LID itself has no effect at all. This situation is henceforth referred to as the competitive market (*CM*) assumption. Nevertheless, the second component of the LID agreement, the reduction of the FOB price levy, increases the farmgate price and thus creates a production incentive irrespective of the manufacturers' behaviour. This is simulated in the *LID CM* scenario.

In the *Pre-LID levy* scenario, the levy from the FOB price remains at around 41% in the two countries, identical to that before the introduction of the LID.

It is important to highlight the *Pre-LID levy CM* scenario which is indeed a realistic possibility: This is an LID scenario where both the manufacturers behave competitively and the FOB price levy is kept at the pre-LID level. As in effect everything remains identical to the pre-LID situation, the total effect of this scenario is zero.

In the *LID full* scenario, the LID premium is paid to the farmers without levy deduction. The consumer cost (*Cons.cost*) scenario implies that chocolate manufacturers do pass on the higher bean costs to the consumers, thereby causing a demand reaction. Finally, the *Quota*

[8] Due to non-linearities and trade-offs in the model, the total effect of a new scenario would differ from a pure summation of those simulated individual effects.

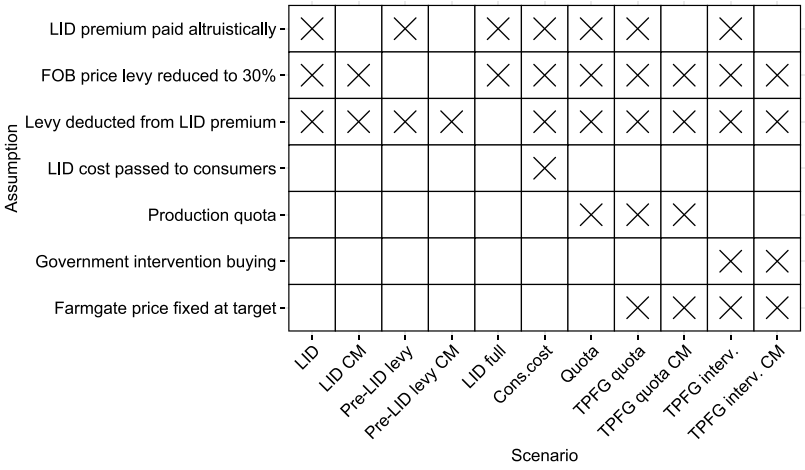

Fig. 2. Overview of the scenario assumptions.
Source: Authors' elaboration.

scenario assumes that Côte d'Ivoire and Ghana limit cocoa production to the pre-LID level by applying a production quota. Production quotas allocate quantified rights to specific producers and are a common policy instrument to control the output and prices of agricultural commodities and have been effectively applied, e.g. for dairy and sugar in the EU (Tangermann and von Cramon-Taubadel, 2013) or for tobacco and peanuts in the US (Schmitz et al., 2016). A similar effect can be achieved using planting rights which limit the acreage planted with the crop to the area specified but still allow for productivity increases. This has been implemented in the EU for vine (Deconinck and Swinnen, 2015), for example. Production quotas cause low direct budget costs for the government, mainly for the administration of the licenses, monitoring and enforcement. Here, and in the following scenarios involving a quota, it is assumed that quotas are administered such that the quota rent accrues to the cocoa farmers.

3.3.2. The target price at farmgate (TPFG) scenarios set

The TPFG scenario set investigates what magnitude of additional supply management measures is needed to increase the international market price such that the price at the farmgate reaches the targeted minimum of $1820 per tonne, corresponding to the lower limit of the LID's price stabilisation mechanism, and what impact this has. This is illustrated by two hypothetical policy measures, production quotas (*TPFG quota*) and governmental intervention buying (*TPFG interv.*). Intervention buying is another common policy instrument to control market prices and denotes a direct purchasing operation of the government in the domestic market. It has been intensively applied in the EU, for example, for a range of agricultural commodities. This instrument is included in the simulations solely for illustrative purposes to provide a benchmark for the quantity of beans that would need to be removed from the market to achieve the target price. The actual total cost of such an intervention would depend on the further use of these beans and future market opportunities. These beans could, for instance, be stored for a limited period and sold later at a different price, transferred to other uses, such as animal feed, or destroyed. Storage is furthermore conditional on the availability of appropriate storage facilities and entails storage costs, and the international price would be depressed the moment large quantities were released to the market.

The competitive market scenarios, *TPFG quota CM* and *TPFG interv. CM*, are identical to the previous two but assume that the chocolate manufacturers are not willing to ignore the LID premium in their sourcing decisions, thereby rendering the LID ineffective.

To reach at least the target farmgate price, the LID countries need to increase the international price by reducing their supply to the world market. Technically in the model, they achieve this by either limiting their production to a fraction of their pre-LID production or by buying up a fraction of their production and thereby taking this quantity off the market. To synchronise their efforts, both countries apply the same fraction relative to their respective pre-LID production level. This latter assumption is important as Côte d'Ivoire's production is much higher and its farmgate price is initially further below the target compared to Ghana's. Without it, Ghana could free ride and let Côte d'Ivoire bear the entire burden of market supply reduction required to move the world market sufficiently, as test simulations indicated.

3.3.3. Sensitivity analysis

Acknowledging the uncertainty around the estimates adopted for supply and demand elasticities and to check the sensitivity of the results with respect to these, all simulations are repeated with three alternative price elasticity sets. The elasticities are selected from the far end of the range the authors deem plausible, that is, the demand elasticity of −0.19 from Gilbert and Varangis (2004) and the supply elasticity of 0.285 from Gilbert (2016). The price elasticities of supply and demand are combined into three alternative sets as follows: set A: −0.19 and 0.57, set B: −0.34 and 0.285, and set C: −0.19 and 0.285.

4. Results

The results from the market model simulations of the LID and TPFG scenario sets are discussed in Sections 4.1 and 4.2, respectively. The results from the sensitivity analysis are presented in Section 4.3. All the results in this section are additionally summarised in an overview table in Online Appendix C.

4.1. Results from the LID scenarios

In the 2020 base data, farmers in Côte d'Ivoire and Ghana receive producer prices of $1407 and $1492 per tonne, respectively. The main *LID* scenario (1) introduces the LID premium on the FOB price of $400 per tonne minus the FOB price levy and (2) reduces the FOB price levies from 41.4% in Côte d'Ivoire and 40.8% in Ghana to 30%. Ignoring market reactions, this would mean a rise in the farmgate prices in Côte d'Ivoire and Ghana to $1961 and $2044 or by 39.4 and 37%, respectively.

These initial price shocks incentivise farmers in Côte d'Ivoire and Ghana to expand production, which, in the emerging equilibrium, rises by 13 and 11.9%, respectively. As a result, the international price drops by 12.9% and cocoa production in other countries falls by 7.5% (Fig. 3). On balance, global supply increases by 4.8% (see Fig. 4).

The farmgate price rises to $1744 (+23.9%) in Côte d'Ivoire and $1817 (+21.8%) in Ghana (see Fig. 3). Thus, the $1820 target is not

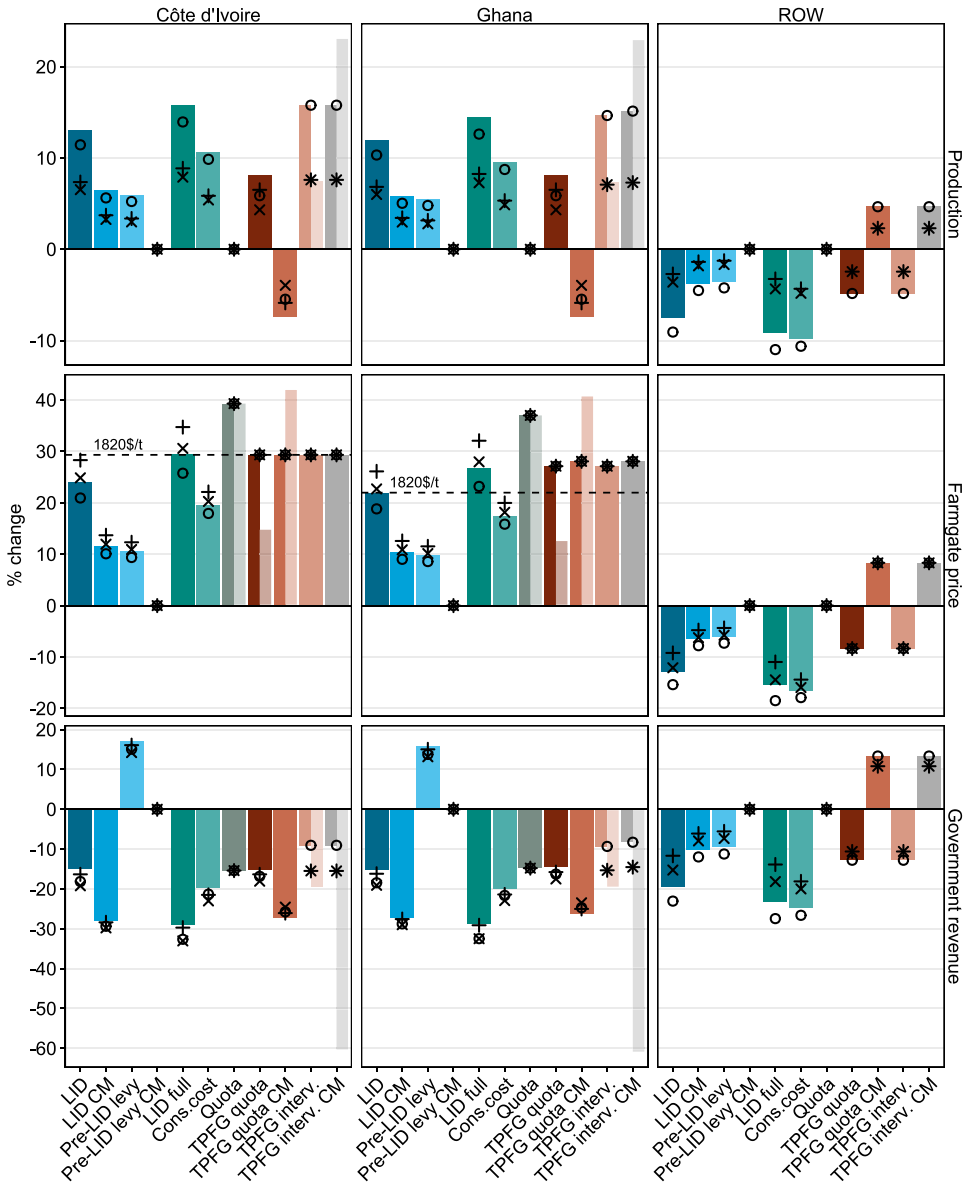

Fig. 3. Change in cocoa bean production, farmgate prices and government revenue from pre-LID levels by region. Production: Slim, light-coloured bars represent production bought via government intervention as a share of pre-LID production. Farmgate price: Dashed horizontal lines indicate the percentage increase required to reach the $1820 per tonne target farmgate price. Slim, light-coloured bars represent the magnitude of the quota rent as a share of the pre-LID farmgate price. Government revenue: Slim, light-coloured bars represent the cost of government intervention buying as a negative percentage of pre-LID government revenue. ○, + and × indicate results using alternative elasticity parameter sets A, B and C, respectively. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)
Source: Authors' elaboration.

reached in Côte d'Ivoire but is almost achieved in Ghana. The price for farmers elsewhere drops by 12.9%.

The impact on government cocoa revenue is approximated by that on the revenue from the FOB price levy. This relationship is correct if the revenue from the levy continues to be shared in identical proportions among the cocoa value chain stakeholders between the farmgate and the point of export. At least for Ghana, this assumption might not be far from reality: Kolavalli and Vigneri (2017) describe that the price determination process is governed by the expectation that the levy revenue will be shared among the stakeholders.

Government revenue in the LID countries decreases by about 15% (Fig. 3) as the increase in the FOB price (including the LID) and the increase in sales are not sufficient to offset the cut in the rate of the levy to 30%. The revenue for ROW governments decreases by 19.4% due to lower sales and lower prices.

With production and prices increasing, the income of cocoa farmers in Côte d'Ivoire and Ghana increases by 18.3 and 17.4%, respectively (Fig. 5). By contrast, for cocoa producers elsewhere, producer surplus drops alongside production and prices.

The *LID CM* and *pre-LID levy* scenarios provide an indication of the magnitude of the effect of the *LID* scenario attributable to either of the two components of the LID, the LID premium and the reduction in the FOB price levy.

The *LID CM* scenario illustrates that if the chocolate manufacturers act competitively, almost half of the *LID* scenario's farmgate price effect is lost (Fig. 3). Under these conditions, the target farmgate price is missed by a large margin in both countries. However, due to lower production incentives, there is a lower production increase and negative effects for other producing countries are also strongly reduced.

Equivalently, the *pre-LID levy* scenario leaves the FOB price levies in the LID countries at the initial level of around 41%, providing less incentive for output expansion. The increase in farmgate prices in both countries is less than half of that in the *LID* scenario (Fig. 3), failing to get even near the target. This is the only scenario where the LID

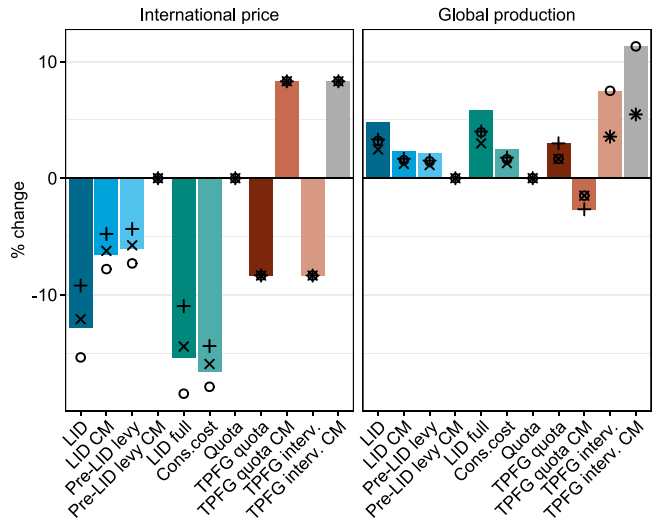

Fig. 4. Change in international price and global production from pre-LID levels. ○, + and × indicate results using alternative elasticity parameter sets A, B and C, respectively.
Source: Authors' elaboration.

governments' revenues increase due to the larger volume sold and the levy from the LID premium itself.

As explained earlier, the *Pre-LID levy CM* scenario assumptions imply that effectively there is no change to the market and correspondingly, no impact at all.

The *LID full* scenario amplifies the effects of the *LID* scenario and results in greater increases in farmgate prices. The price exceeds the target in Côte d'Ivoire by $1 and in Ghana by $72 (Fig. 3). The two governments lose around 29% of revenue compared to their initial cocoa revenue. Analogous to the increased supply from the two countries, prices in the ROW fall even further.

The higher consumer price of chocolate in the *cons.cost* scenario provokes a decrease in demand. This exerts downward pressure on the international price which emerges below the level of the previous scenarios (Fig. 4). The resulting farmgate price, the cocoa farmer income, respectively, producer surplus and government revenue in all three regions are lower than in the *LID* scenario (Fig. 3). For farmers elsewhere, this scenario yields the worst outcome.

In the *quota* scenario, farmgate prices in Côte d'Ivoire and Ghana ($1960 and $2044) exceed the target (Fig. 3) because the supply limits avoid the countervailing decrease in the international price (Fig. 4). Correspondingly, cocoa farmers elsewhere are not negatively affected. However, government revenues from cocoa in both LID countries decrease to a similar extent as in the *LID* scenario (Fig. 3) due to the lower FOB price levy. The gain in cocoa farmer income of about 28% including the quota rent (indicated as slim, light-coloured bars in the farmgate price panel of Fig. 3) is the largest of all scenarios (Fig. 5).

4.2. Results from the TPFG scenarios

This scenario set investigates what it takes for the LID countries to enforce the farmgate price target of $1820, requiring an increase of 27.9% in Côte d'Ivoire and 20.6% in Ghana, respectively.

Because the farmgate price in Côte d'Ivoire in 2020 is much further below the target than that in Ghana, and both countries apply the policies in sync, Côte d'Ivoire reaches the target price precisely in all four scenarios while Ghana exceeds it by a large margin. The quota limit necessary in both countries is 8.1% above the 2020 production level under the "altruism" assumption but 7.4% below the 2020 production level under the competitive market assumption (Fig. 3). Accordingly, in the *TPFG quota* scenario, LID country production increases by 8.1%, causing an international market price drop (Fig. 4) and a negative effect on cocoa producers elsewhere, albeit less than in most scenarios of the LID scenario set. The LID country farmer income increases by about 22%. By contrast, in *TPFG quota CM* the production of the two countries contracts so that the international price rises by 8.3% and cocoa production in ROW increases by 4.7%, resulting in an increase in producer surplus in ROW while the LID country farmer income still rises by 19%.

In the intervention buying scenarios, farmers can benefit from additional production, but at an excessive expense of government resources. In the *TPFG interv.* and *TPFG interv. CM* scenarios, the governments purchase cocoa beans corresponding to about 7 and 23% of 2020 production (indicated by slim, light-coloured bars in the production panel of Fig. 3), respectively. In the earlier case, this indeed amounts to a substantial part of or, in the latter, even substantially more than the production increase resulting from the farmgate price rise. The government interventions require large monetary outlays, corresponding to around 19 and 60% of pre-LID 2020 FOB price levy revenue in the LID countries, respectively (Fig. 3). Because the opportunities for the further utilisation of the beans is uncertain, this potentially large cost item is shown separately from the government revenue effect in Fig. 3. As the resulting supply to the market after the government buying intervention is precisely the same as in the corresponding TPFG quota scenarios, the impacts on the international market and farmers elsewhere are also identical to those (Fig. 4).

Farmer income in Côte d'Ivoire and Ghana increases somewhat more than in the TPFG quota scenarios due to larger production (Fig. 5). This represents a large transfer from the government to the farmers. Farmers in the ROW gain welfare only in the CM scenarios, where the LID country producers receive the same prices as producers elsewhere so that the LID governments can raise their export price only if they reduce market supply. Increasing their production with the rising prices, ROW farmers then benefit from price and quantity effects (Fig. 3).

4.3. Sensitivity of the results with respect to alternative elasticity assumptions

The alternative price elasticity estimates of supply and demand presented in Section 3.2 are about half (50 and 56%) of those in the main elasticity set. Overall, the simulations of the scenarios adopting alternative elasticity estimate sets, indicated by symbols ○, + and × in Figs. 3 to 5, yield results that are similar in order of magnitude and have the same ordering with regard to the effects on the farmgate price, farmer income and government revenue. Nevertheless, the influence on production is large, where the effects are about half the size of those obtained with the main elasticity set.

With supply elasticities halved (elasticity sets + and ×), production in Côte d'Ivoire and Ghana increases only half as much after the introduction of the LID, leading to a somewhat stronger rise in the farmgate price and farmer income than with the main elasticity set (Fig. 3). Correspondingly, the international price for cocoa decreases less (Fig. 4), thereby reducing the negative effect on non-LID country producers.

If only the demand elasticity is roughly halved (set ○), then international prices need to decrease more to create the demand for absorbing the additional output compared to the main elasticity set. This implies larger decreases in the farmgate prices and producer surplus in the non-LID countries, see Fig. 3.

Under quota and government intervention scenarios, all elasticity sets lead to international prices identical to those in the main results (Fig. 4).

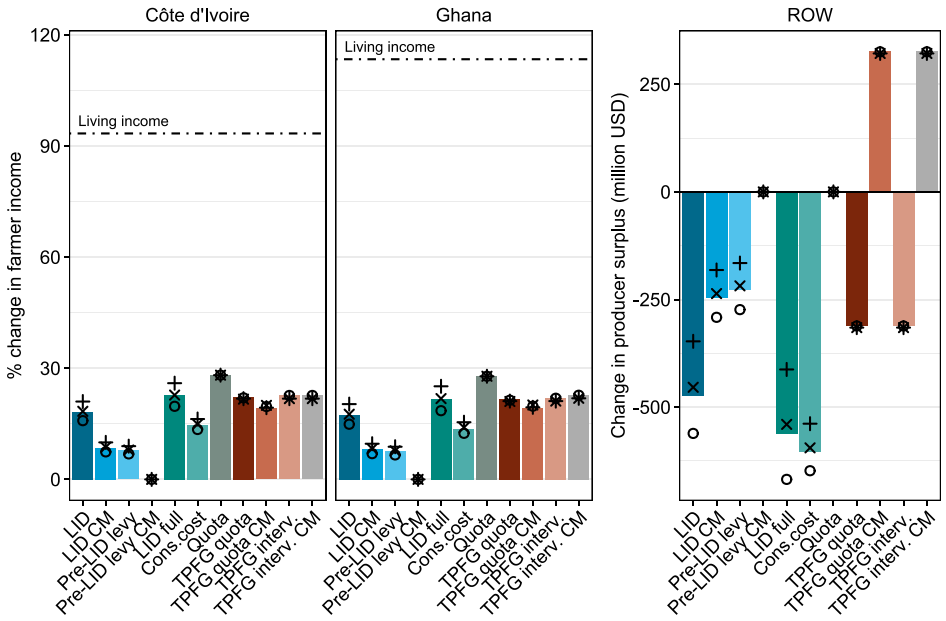

Fig. 5. Change from pre-LID levels in income of cocoa farmers in Côte d'Ivoire and Ghana and in producer surplus in ROW. ○, + and × indicate results using alternative elasticity parameter sets A, B and C, respectively.
Source: Authors' elaboration.

5. Discussion

Based on a global multi-regional PE model of the cocoa market, this study presents a quantitative long-run analysis of the LID policy for cocoa in Côte d'Ivoire and Ghana and its impacts on both the domestic and global cocoa markets and cocoa farmers in these countries and elsewhere. To date, many details surrounding the policy itself and how market participants might react to it remain unknown, so assumptions about these unknowns are varied in a series of scenario simulations to assess the range of possible outcomes of the LID and the achievement of its goals. Note that the model simulations are a vehicle for structuring the thinking around the impacts of the LID and do not represent predictions of future market outcomes.

At the 2020 international price level of $2398, which is 0.2% below the 2021 price, Côte d'Ivoire and Ghana would need an increase in the farmgate price of about 29 and 22%, respectively, to reach the minimum farmgate price targeted by the LID. The LID causes farmgate prices to rise by between 0 and 39% in Côte d'Ivoire and 37% in Ghana, depending on the assumptions. However, while in Ghana the LID under our default assumptions is nearly sufficient to reach the target price, in Côte d'Ivoire the target is only reached under the most optimistic assumption from a farmer's perspective or if a complementary supply management measure is introduced. Government revenues from cocoa drop markedly by up to 29% compared to 2020 whenever the FOB price levies are reduced to 30%. Not reducing these levies shrinks the gain in the farmgate price to less than a half. Hence, the cut in the FOB price levy as defined in the LID agreement (FCC, 2019) is a crucial element for the positive effects of the LID policy on farmer welfare. However, due to a lack of data, both the size of the levies and the extent of the reduction potential for the levies are uncertain. Reducing the FOB price levies would likely require a reduction of all: the cocoa-related government levies and taxes and trade and transport costs and margins for the stakeholders between the farmgate and the point of export. Similarly, if the manufacturers shirk the LID by acting competitively, almost half the farmgate price increase is lost. If both occur, that is, the levy is not reduced and manufacturers act competitively, the total effect of the policy is zero. This latter result is conditional on the LID governments passing on the full premium after a deduction of the agreed FOB price levy. If further shares of the premium were diverted, cocoa farmers' welfare could even be negatively affected in this scenario.

Moreover, only if market supply is controlled to remain at the pre-LID level do farmgate prices in both countries reach and even greatly exceed the target level. This case also yields the highest income gains for cocoa farmers of all scenarios. The result is conditional on the government ensuring that quota rents accrue to the farmers and are not captured by the government or other stakeholders. The magnitude of government revenue losses associated with this scenario of around 15% of pre-LID revenue combined with the importance of cocoa-related revenue for the governments, might hint at a potential conflict of interest between governments and cocoa farmers. That loss could be mitigated by reducing the quantity or quality of services provided by the cocoa boards, such as free or subsidised seedlings, fertilisers, or spraying. But though these provisions may be inefficient and may not reach all farmers (Bymolt et al., 2018), farmers nevertheless currently benefit from these to varying extents as they lower input costs or raise yields or quality and thereby increase incomes.

The welfare gains for farmers in the LID countries are partially at the expense of the welfare of cocoa farmers in other countries, which account for 39.3% of global cocoa output. For them, the LID means a drop in farmgate prices of up to 16.6%, inducing a drop in production. These negative income effects are avoided if the LID countries restrict market supply to the initial output level.

The second set of scenarios explores the magnitude and the impacts of two supply management interventions needed by Côte d'Ivoire and Ghana to reach at least the target farmgate price. In these scenarios, the prices in Côte d'Ivoire meet the target, whereas in Ghana, the target is far exceeded since the initial shortfall from the target price is far smaller. With altruistic manufacturers, the quota could even be set to allow an 8.1% expansion of production compared to 2020. However, the magnitude of the quota rents shown highlights that, if the quota rent is captured by some stakeholder other than the farmers, the farmers' gain could be drastically diminished or even turn into a loss. The *TPFG quota CM* scenario stands out as an option for reaching the target farmgate price and raising farmer welfare by a sizeable amount without being reliant on chocolate manufacturer behaviour, and even creating benefits for cocoa farmers elsewhere.

The government intervention buying scenarios are somewhat more beneficial for farmers in terms of producer welfare than the quota

scenarios. This gain, however, is due to a large transfer from the government to the cocoa farmers. These scenarios illustrate the excessive level of direct government outlays required for intervening with bean purchases. However, the actual cost of the measure could be higher or lower, depending on the further use of the beans purchased and market developments, as discussed in Section 3.3.2. Note that, as this study conducts a long-run analysis, the purchase needs to be interpreted as the average annual purchase and indicates a permanent surplus at the LID's targeted minimum price under the 2020 market conditions, including the low international price. Under these circumstances, this intervention would be clearly unsustainable.

As illustrated by the failure of the international buffer stock scheme under the International Cocoa Agreement in the 1980s – see Online Appendix D – stocks are only suitable for temporary price stabilisation around the (unknown) long-run market equilibrium price. The EU's experience with providing sectoral support and maintaining domestic prices above international prices using intervention buying and stocks, production quotas, and coupled and decoupled direct payments has shown that it is possible but also very costly, and it might create claims for vested interests and major inefficiencies in the economy (see Tangermann and von Cramon-Taubadel, 2013, for an overview). Most remembered is the EU situation in the 1980s, when agricultural surpluses were bought up to maintain prices above world market levels and overflowing warehouses were cleared with great losses.

Moreover, traders directly price stock levels in the international bean price: The stocks-to-grinding ratio and the international cocoa price are strongly negatively related (Bymolt et al., 2018; Irfan-ul-Haque, 2004), so that an increase in global stock levels is associated with a lower international price.

Lastly, the analyses assumed that Côte d'Ivoire and Ghana implement all policies in a synchronised manner, especially regarding supply management. This is necessary to avoid free-riding. But a cartel-like organisation creates corresponding problems, like the incentives for members to increase production beyond the agreed for additional gains, and thus poses a potential for conflict and break up, or opposition via international institutions, such as the WTO (Grumiller et al., 2018).

Three auxiliary scenarios (not presented) are simulated to assess what change in global demand compared to 2020, everything else equal, would be necessary to sustain a long-run international equilibrium price that corresponds to a farmgate target price of at least $1820 in the two LID countries. The scenarios suggest that global demand would need to increase by 4.4% in the case of the main *LID* scenario assumptions, by 14.4% if instead manufacturers behave purely competitively (*LID CM*), and by 26.5% if both manufacturers behave competitively and the FOB price levies are not cut (*pre-LID levy CM*). Growth in global supply and demand over the past 30 years averaged 2.5% annually, while the long-run international real cocoa price moved roughly in line with the general Food Price Index (Fig. 1) on a low upward trend. This is an indication that cocoa supply and demand grew roughly in balance and that limiting supply growth is important to avoid it outstripping demand growth and depressing the price.

For cocoa farmers in other countries, the policies in the second scenario set have smaller negative effects than the actual LID policies and even quite positive impacts if chocolate manufacturers behave competitively.

The effect of the LID depends on the chocolate manufacturers' response. It is hardly conceivable that manufacturers would pay an LID premium in the long run if they did not get marketable benefits in return. Given the increasing awareness of consumers regarding human rights and sustainability issues in the chocolate supply chain, these could come in the forms of child labour-free, deforestation-free, or living income-paid guarantees or in improved institutional infrastructure and regulation which, in turn, support the manufacturers' efforts towards the traceability and monitoring of such issues and reduce their costs of their own sustainability programmes. For this, the board-governed market structures in Côte d'Ivoire and Ghana could represent a valuable advantage compared to other cocoa-producing countries. Manufacturers face mounting pressure to implement these types of programmes as governments, e.g. of France, Germany and the EU, continue to enact human rights and sustainability due diligence regulations. While lifting farmers out of poverty might reduce the risk of child labour and deforestation, the magnitude of production increases caused by the LID in Côte d'Ivoire and Ghana, as suggested by the simulation results, might increase the risk of additional child labour and deforestation if production expansion is not controlled. The simulations indicate that this risk might increase further if the target farmgate price is being enforced using intervention buying. Effective prevention of additional deforestation, possibly in combination with the enforcement of sustainable production practices as discussed, e.g. by Koning and Jongeneel (2006), might hold production expansion in check.

Sensitivity analysis showed the results in terms of cocoa price and farmer welfare and income impacts remain robust even under alternative price elasticity assumptions, but cocoa output effects might be substantially smaller.

Furthermore, as examined in the competitive market scenarios, market forces could prompt manufacturers to gradually shift to other, cheaper producing countries, possibly only partially to expand their bulk chocolate production. Post-LID introduction press reports (Almeida et al., 2020) about unusually large purchases of cocoa beans from the commodities futures exchange allegedly linked to chocolate manufacturers trying to avoid the LID point in that direction. In the long run, it also seems impossible to credibly distinguish LID premium-induced changes in the sourcing decisions of the manufacturers from other business operation-induced changes, rendering the monitoring of LID commitment impossible. Accordingly, the effect of the LID could be partially eroded over time. At the time of writing, both LID countries have sold beans with a reduced or even negative country quality premium (or country differential) which is usually paid on top of the international price, thereby (partially) cancelling out the LID (Reuters, 2021a). However, the low prices including the LID also need to be seen in context with globally weak demand and strong supply due to the COVID-19 pandemic and record harvests (Reuters, 2021b).

Regardless of whether the chocolate manufacturers continue paying the LID premium in the future or behave competitively, the simulation results illustrate that supply management helps to attain a substantial increase in farmgate prices and farmer income in Côte d'Ivoire and Ghana and is key to limiting negative impacts on the welfare of cocoa farmers elsewhere. But the manner in which supply management can be implemented in an efficient and sustainable way remains an open question.

With a market share of over 60%, the two countries have the market power to influence international prices by adjusting their supply or setting a minimum price. Nevertheless, although their cooperation has sometimes been nicknamed COPEC, in reference to the Organization of the Petroleum Exporting Countries (OPEC), cocoa is a very different product than crude oil. Cocoa output cannot easily be adjusted as it is the outcome of millions of individual farmers' decisions, and being perishable, it requires good storage facilities to keep the beans for a limited time without deteriorating (Beckett et al., 2017). Correspondingly, holding cocoa in stocks has limits and can turn out to be very costly.

In any case, the LID policy has created momentum with regard to a living income for cocoa farmers. But even if the LID's minimum farmgate price target of $1820 per tonne is reached under favourable assumptions about its implementation details and manufacturer responses, the incomes are still far away from a living income. According to the results shown in Fig. 5, the LID could raise the incomes of Ivorian and Ghanaian cocoa farmers by 28% in the best case, which is a fraction of the necessary increase of 93 and 113%, respectively.

6. Policy implications and conclusions

In summary, the results presented indicate that the LID policy could benefit cocoa farmer prices and welfare in Côte d'Ivoire and Ghana but the magnitude of the benefits ranges from zero to sizeable, depending on the details of how precisely the policy is implemented and the actual behavioural response of chocolate manufacturers. Without complementary policies to narrowly limit the expansion of market supply, the only chance the LID has to achieve the target farmgate price is if both components of the LID policy written in the agreement document (FCC, 2019) are implemented, i.e. the LID premium and the reduction in the FOB price levies. Government revenues from cocoa might drop substantially. However, as the study illustrates, overfocusing on higher prices and ignoring market reactions leads to grossly exaggerated expectations for increasing incomes, which should be the ultimate goal of the policy. By introducing flanking supply management measures, the targeted minimum farmgate price could be guaranteed and farmer incomes further increased irrespective of whether chocolate manufacturers fulfil their pledges for the LID. Importantly, potentially substantial damage to the welfare of cocoa farmers elsewhere could be mitigated or even turned into a benefit with such measures.

Over the course of the study, a number of potential threats to the sustainability of the LID policy itself, varying with the policy's details, have been identified, which might need to be managed actively. First, the LID could incentivise a large expansion of cocoa production, causing an international price- and cocoa income-decreasing countereffect and implying a risk of additional child labour and deforestation. This could be mitigated by adopting supply management measures, such as cocoa planting rights or production quotas, possibly in combination with a prescription of sustainable farming practices.

Second, the reduction of the FOB price levy to 30% constitutes a correction of a market bias and is a crucial factor for the LID's positive welfare effects but also a transfer of resources from governments and other actors between the farmgate and the point of export to farmers. This creates a conflict of interests and could induce governments to revert this measure. However, such tendencies could be disciplined by a commitment to transparency of the cocoa-related budget and the price-setting process.

Third, the commercial interests of chocolate manufacturers might lead to a leakage of sourcing towards non-LID countries over time and thus the erosion of the LID's benefit for farmgate prices in Côte d'Ivoire and Ghana. This points at creating either a level playing field by involving other producer countries or valuable returns for producers, e.g. in the form of improved institutions and infrastructure, which reduce the chocolate manufacturers' costs of complying with sustainability demands and new due diligence laws in cocoa consumer countries. In any case, to raise the incentive for manufacturers to comply with the LID, governments should build trust by making the farmgate price-setting mechanism fully transparent and rule-based. This would allow manufacturers and farmers to monitor the use of the premium and avoid governments being suspected of "creative" price setting. If further parts of the LID premium were diverted for other uses, the total income of cocoa farmers could even be negatively affected.

Fourth, negative welfare effects for farmers in non-LID countries could result in potential disputes but could be avoided through effective supply management in the LID countries. Fifth, synchronising the LID-related policies between the two countries has been deemed necessary in order to prevent free-riding and the break-up of the LID due to typical cartel problems. Thus, close coordination of all cocoa-related policies and a transparent monitoring mechanism are needed to discipline deviations. The joint body *The Côte d'Ivoire–Ghana Cocoa Initiative*, founded by the governments of Côte d'Ivoire and Ghana in 2020, could serve this purpose. Finally, if supply management measures are introduced, it is crucial to ensure that the arising rents accrue to the farmers by appropriate administration, otherwise the LID might even cause them to lose out.

The outcomes of the study emphasise that Côte d'Ivoire and Ghana could best leverage their collective market power by producing less rather than more, by keeping future production expansion below that of demand. Without the need to rely on chocolate manufacturers' behaviour, they could create large benefits not only for their own farmers but also for farmers elsewhere. Producing less might imply less labour and land requirements which, in turn, could mitigate the child labour and deforestation issues beyond that resulting from the indirect link to poverty reduction. Hence, this suggests coordinated, cartel-type price making by limiting market supply either directly or indirectly, e.g. by employing production quotas or restricted cocoa planting rights. However, whether the benefit for the farmers eventually materialises crucially hinges on the rents accruing to the farmers, that is, through the appropriate administration of quota licences or cocoa planting rights. Ultimately, the effectiveness of the cartel over time would be vulnerable to other countries ramping up cocoa production, requiring an extension of the membership group.

If the clearing of protected forest areas for cocoa growing is effectively prevented in the future, increases in cocoa prices will capitalise in the price of suitable land as the limiting factor. This highlights the need for formal land property rights and the need to consider the cocoa sector as an integral part of the agricultural sector. Indeed, Bymolt et al. (2018) find that poverty in Côte d'Ivoire and Ghana is not a problem specific to cocoa but more general to rural smallholder farmers and that, despite low cocoa incomes, cocoa growing is perceived as the "best option" among smallholder farmers. Similarly, for Ghana's cocoa growing regions, Vigneri and Kolavalli (2018) report significantly lower poverty incidence among cocoa than non-cocoa households in 2012/2013.

It should be noted that this study assesses the impacts on the cocoa sector in isolation by taking a partial equilibrium perspective. However, as cocoa is a sector of major importance for agriculture and the economy in terms of value-added creation and employment in both countries, the LID might have substantial impacts also on non-cocoa farmers. Moreover, their cocoa sectors are important sources of foreign exchange and government revenue. Future research should address the impacts of the LID on the wider agricultural sector and the economies of Côte d'Ivoire and Ghana and should also investigate the impacts on the distribution of income across the diversity of cocoa and other farm households. Ultimately, the LID initiative and current attention for the cocoa sector provides an opportunity to build a model that exemplifies how the sustainability of the entire agricultural sector might be improved.

CRediT authorship contribution statement

Ole Boysen: Conceptualization, Methodology, Formal analysis, Visualization, Writing – original draft, Writing – review & editing. **Emanuele Ferrari:** Conceptualization, Writing – review & editing. **Victor Nechifor:** Conceptualization, Writing – review & editing. **Pascal Tillie:** Conceptualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.foodpol.2022.102389. It contains the online appendices A to E.

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