A Quantitative Look at the Economics of Cocoa Certification[1]

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The following quantitative analysis consists of modeling the impact of cocoa certification programs under a variety of assumptions about underlying technology, behavior and external conditions.

The focus is on the cost of certification to Mars and the industry, including impacts on cocoa prices and farm revenue. Data and assumptions provided by Mars were used, as well as authoritative sources in the industry and research literature.

The key constraint to this study is the high degree of uncertainty regarding future market conditions and a variety of behavioral and technology characteristics. The future is uncertain by definition, but in this case there is the added randomness of the large degree of uncertainty regarding the impacts of certification on productivity, the impacts of other activities on productivity, how these may vary across nations, etc. This is addressed using a scenario framework, which permits a better understanding of the nature of the variables as they affect the outcomes being considered, and of the order of magnitude of certification and how different actions may affect it. The analysis consists of two grand scenarios, and within each are sub-scenarios to illustrate how factors will affect key performance variables.

The first section presents a general overview of the two conceptual models developed for this study, both of which are described in detail in appendices. This is followed by a discussion of quantitative data reviewed and used, followed by results and discussion of the simulations. The simulation results cover results of the overall impact of certification on cocoa under stylized conditions in order to elucidate some of basic mechanisms at work, and then country-by-country estimates. The report closes with a section on conclusions and opportunities to extend this work.

Quantitative models

The complexities of today's global economy are such that decision makers relying on intuition or rules of thumb alone are unlikely to operating optimally.

[1] This chapter was drafted by a team at the University of California at Berkeley led by Professor David Zilberman, backed up by David Roland Holst, Rebecca Taylor, Scott Kaplan and Eunice Kim; it was edited by Lloyd Timberlake

Thus a broad array of evidence-based analytical tools are now used to support decision-making in modern finance, technology, consumer products, and service sectors. The economic models used in this analysis are representative of this decision technology, combining economic theory and statistical data to improve visibility for strategic corporate planners.

This work on cocoa certification has developed both qualitative and quantitative analysis of industry and market impacts, using a basic mathematical model to determine how certification schemes, as envisioned by Mars and the rest of the industry, affect economic outcomes. Despite an exhaustive review of the industry and academic literature, no appropriate "off the shelf" model could be found, so the one appearing in Appendix A was developed. Inferences from this model were used to guide both the conceptual and quantitative analysis.

The model investigates how certification that may be associated with technological innovation increasing cocoa yields could affect the price and quantity of cocoa, earnings of farmers (both those who participate in certification and those who do not), and the cost to the buyers. It also reveals the primary drivers of program costs and benefits, highlighting the role of uncertainty regarding key parameters in particular, the scope of certification, technological change, and how the incremental cost of certification changes with the volume. The results are presented in detail below.

Main findings include:

- The introduction of certification will increase the price of cocoa, unless it is associated with increased productivity resulting from technological change.
- **Yields are the primary long-term driver of certification costs. If the level of technological change is sufficient, the price of cocoa will decline and quantity produced will increase because of certification.**
- If participation in certification provides access to yield increasing practices with sufficient impacts, so that the value of the extra benefits exceeds certification costs, certification may be self-financing. If the expansion of V4C, or similar programs, are not constrained by costs or scalability barriers, the extra benefits may induce voluntary participation in certification programs that link productivity enhancement with certification.
- Certification that increases productivity, because it confers lower costs on participating farmers, will lead to some industry restructuring, with higher cost, non-certified farmers exiting farming or switching to other crops.
- From both Mars and societal perspectives, there are optimal levels of certification. From Mars' perspective, this occurs when the incremental benefit in terms of revenue and goodwill is equal to the incremental cost,

and from a societal perspective, this occurs when the incremental benefit in terms of increased environmental benefit or consumer satisfaction is equal to the incremental cost of certification in terms of producer efforts and extra monitoring cost.

This modeling framework is quite flexible and can be applied more intensively (higher resolution data) and extensively (more diverse scenarios), but this is beyond the scope of this project. For this reason, an encapsulated version of the model is applied to generate the results below. The encapsulated model is presented in Appendix B and used here to identify the primary impacts of certification under three alternative situations:

1. Certification is costly and not associated with technological change
2. Technological change is concurrent with, but independent of, certification, i.e. productivity increases, but is not limited only to certified farmers
3. Certification is linked to increased productivity.

Results suggest that if certification is associated with technological change, the cost of certification to the buyer will be lower (they may even gain from it) and fall with certified production volume. On the other hand, if it is not associated with technological change, average certification cost will be significantly higher, and increase with certified volume.

Data

The empirical assessment relies on a variety of data and assumptions obtained directly from Mars and, where this was absent or comparisons were needed, from an exhaustive review of the industry and research literature. Mars provided estimates of certified and uncertified cocoa production through 2020. This data includes world aggregates and country level data for Cote d'Ivoire, Ghana, Indonesia, Nigeria, Cameroon, Brazil, and Ecuador. Table 1 shows estimates of global certified supply and demand. These estimates, especially those for certified demand, are used to calibrate the business-as-usual and mainstream scenarios.

Table 1: Global Supply and Demand Trends in Cocoa Certification

	Actual			Estimate							
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Global Certified Supply[1]	141,766	293,694	492,349	621,860	824,330	1,026,800	1,124,550	1,220,600	1,316,650	1,412,700	1,508,750
Global Certified Demand[2]											
Based on current committments[3]	75,341	148,781	309,994	430,423	533,634	683,922	800,610	979,254	1,139,467	1,340,658	1,471,614
Based on expected committments[4]	75,341	148,781	309,994	543,340	757,822	929,079	1,157,118	1,446,893	1,718,501	2,031,005	2,124,184
Based on 100% uptake of Big 5[5]	75,341	148,781	309,994	620346.44	908,123	1,081,280	1,383,370	1,746,865	2,092,950	2,479,916	2,530,324
1. Certifying bodies forecasts of supply, less 15% double counting											
2. 12% added to certified demand for 2013-2020 to reflect certified demand from "other" sources											
3. Currently declared commitments. Assumes that where there is no future commitment, company continues at its 2012 % commitment											
4. Assumes Lindt at 30%, Kraft at 75% and Nestle at 60% in 2020											
5. Assumes Lindt, Kraft and Nestle at 100% in 2020											

Table 2 shows Mars' estimates for quantities of certified and all cocoa produced by country between 2012 and 2017.

Table 2: Quantities of Cocoa Produced by Country

Origin		2012	2013	2014	2015	2016	2017
Cote d'Ivoire	Certified Cocoa	85,000	100,000	125,000	150,000		
	All Cocoa	1,396,000	1,396,000	1,396,000	1,396,000	1,396,000	1,396,000
Ghana	Certified Cocoa	25,000	40,000	60,000	80,000		
	All Cocoa	850,000	887,000	949,000	1,016,000	1,087,000	1,163,000
Nigeria	Certified Cocoa	7,500	15,000	30,000	40,000		
	All Cocoa						
Cameroon	Certified Cocoa	1,000	6,000	12,000	20,000		
	All Cocoa						
Indonesia	Certified Cocoa	20,000	40,000	55,000	70,000		
	All Cocoa	575,000	590,000	605,000	620,000	635,000	650,000
Ecuador	Certified Cocoa	1,000	5,000	15,000	20,000		
	All Cocoa						
Brazil	Certified Cocoa	5,000	10,000	15,000	20,000		
	All Cocoa						

For those countries missing estimates of *All Cocoa*, the 2012 quantity was estimated using FAOSTAT's 2010 cocoa production numbers. To calculate the remaining years, these numbers were extrapolated to 2020 using a growth rate similar to the World's *All Cocoa* growth rate. For those countries not included in this data (Papua New Guinea, Vietnam, and the Dominican Republic), *All Cocoa* numbers were again estimated using the FAOSTAT 2010 numbers, and *Certified Cocoa* numbers were then backed-out by multiplying each country's world market-share of *All Cocoa* by the World's *Certified Cocoa* estimates.

Demand elasticity for cocoa is assumed to be -0.2 based on the literature. [Berhman 1965; Dand 1999; ICCO Report 2012] Mars' assumptions were built upon: that 6% of cocoa farmers were certified in 2012, average land size per farmer is 3 hectares, and the current global average yield is 0.5 tonnes per hectare.

Calculating the average cost of certification between 2012 and 2020 required first estimating the total quantity of certified cocoa produced each year under both scenarios. This is done by extrapolating, at a constant growth rate, from the existing 2012 quantity of certified cocoa (309,994 tonnes) to a 2020 business-as-usual quantity (1.5MT) and to a 2020 mainstream quantity (2MT). Next, certification cost estimates from a study on Rainforest Alliance certification in Indonesia were used. This study, shown in Table 3 and based on a small

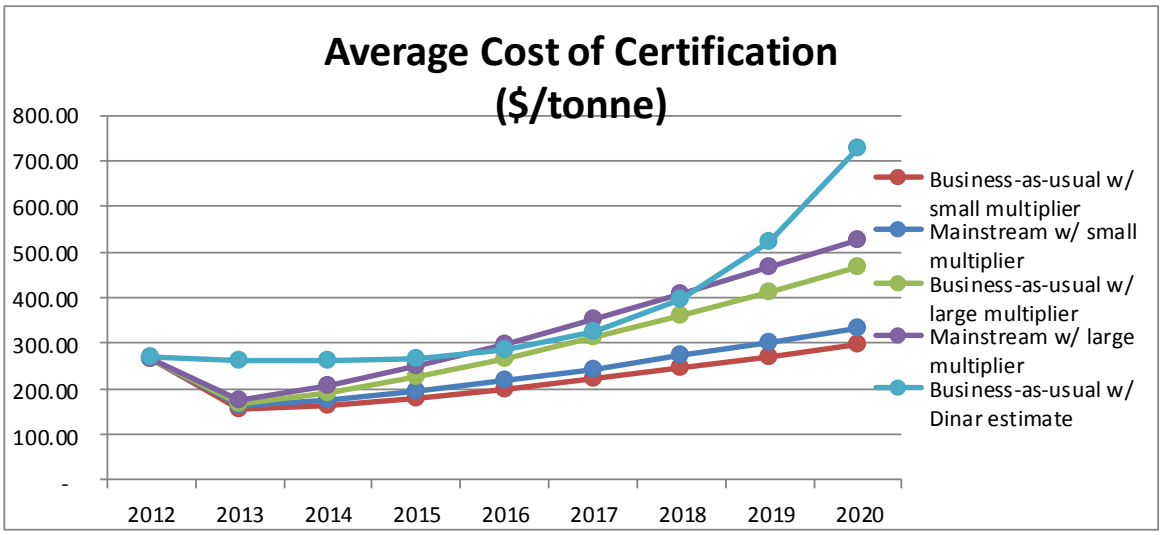
sample, found that for a given certified farmer, the cost of certification decreases from $268/tonne in the first year of certification to $87/tonne in the 10th year of certification.

Table 3: Average Global Certification Cost

	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year	10th Year
Farms in ha	500	500	500	500	500	500	500	500	500	500
Est. Yield ton/ha	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.5
Est. Volume in tonne	300	350	400	450	500	550	600	650	700	750
Certification Cost ($/tonne)	267.89	117.55	109.03	102.73	98.01	94.44	91.77	89.79	88.38	87.44

Making 2012 the baseline year allowed average certification costs to be calculated. However, as discussed earlier, while certification costs will decrease over time for a given farmer, the cost of certifying new farmers increases over time. To incorporate the increase in certification costs due to reaching new farmers, a multiplier that increases each year was included. Furthermore, with the uncertainty over how much costs will increase for expanding certification to new farmers, both a small multiplier that goes from 1 to 3 in increments of 0.25 each year and a large multiplier that grows from 1 to 5 by 0.5 increments were considered. For illustration, consider 2014 with the large multiplier. In 2014, certification costs equal $268×2 for tonnes first certified in 2014, $118×1.5 for tonnes first certified in 2013, and $109×1 for tonnes certified in 2012. Since 451,989 tonnes of cocoa will be certified in 2014 under the business-as-usual scenario and 494,101 tonnes under the mainstream scenario, the average certification costs estimates are $191.94/tonne and $272.93/tonne respectively. Figure 1 plots these average cost estimates by year.

Figure 1:



Note that in 2020 under business-as-usual with a small multiplier, average certification costs are approximately $300/tonne, while costs under the mainstream scenario are $330/tonne. With a larger multiplier, average costs rise to $470/tonne and $530/tonne respectively. To check the robustness of these cost estimates, cost estimation methods used in the literature were explored. Dinar [1996] estimates the average cost curve of public extension services to

farmers. Using the slope coefficients found in that study and the data on certified production of cocoa, cost estimates were found to be in line with our previous estimation methods. However, Dinar's work was done in the US, with its good infrastructure and communications, the marginal costs of certifying more cocoa farmers in, say, Cote d'Ivoire could be much higher.

Data by country

Vietnam hopes to become a major supplier of cocoa beans in the world market, with a goal of producing 50,000 tonnes of fermented beans by 2020. According to the director of the National Agriculture Extension Centre[2], Vietnam is already showing signs of rapid growth in cocoa production. Given this country's experience with coffee, there is reason to believe Vietnam could emerge rapidly. Over a decade, Vietnam went from essentially zero to become the second largest producer of *Robusta*, fundamentally altering global coffee market conditions. Total cultivated cocoa land in 2012 was approximately 20,100 ha, yielding 5,100 tonnes of fermented cocoa beans. This is more than 10 times the area planted in 2005 (2,000 ha).

While cocoa production in Vietnam is still in its infancy, cocoa has the advantage of lower labor costs than rival crops of coffee and rubber, and less water requirements compared to coffee. Furthermore, cocoa production in Vietnam has the potential to grow hand-in-hand with certification. According to Mars' certified cocoa supply estimates[3], Vietnam produced 1,200 tonnes of UTZ certified cocoa in 2011, which is one fifth of the cocoa produced in Vietnam that year.

Papua New Guinea produced 46,000 tonnes of cocoa a year on average between 2000 & 2010, 80% of which came from smallholders, according to FAO estimates. Mars estimates 1,000 tonnes of certified cocoa were produced in PNG in 2012 and projects growth to 6,000 tonnes by 2015. Both Fairtrade and RA have expressed interest in expanding certification in PNG[4]. However, cocoa certification in PNG may be complicated by changing pest control practices. The Cocoa Pod Borer has been a serious threat to the PNG cocoa industry since it was detected in 2006[5]. The PNG government first tried to eradicate the moth completely but has since switched to management and control techniques. While some of these techniques are supported by the majority of certifying bodies (i.e., encouraging natural enemies and improving sanitation in growing areas), other techniques are not

[2] http://vietnamnews.vn/Economy/226245/cocoa-growers-target-global-market.html
[3] *Certified Cocoa Supply Forecast* Spreadsheet
[4] http://www.trupela.com/wp-content/downloads/coffee/Fairtrade%20Feasibility%20Study%20PNG%20v6.pdf
[5] http://www.cabi.org/default.aspx?site=170&page=1017&pid=1483

support by all (i.e., the application of strong pesticides and the development of pest-resistant GMO cocoa varieties).

Brazil has produced an average of 200,000 tonnes of cocoa per year for the past 10 years, despite the disease of Witches' Broom still being prevalent. Recent research has shown breakthroughs in the fight against Witches' Broom[6] and thus production is expected to recover, especially as much of the industry's infrastructure remains intact.

In regard to certification, Brazil was estimated to have had 1,000 tonnes of cocoa certified in 2012, with this number growing to 20,000 tonnes by 2015 (Mars' data). Average certification costs per tonne could be lower in Brazil than in other countries due to its large average farm size. In contrast to the 3 ha smallholder farms in most cocoa producing countries, Brazil has an average farm size of 28 ha. [Rice & Greenburg 2000] And while Brazil may be larger than several of the other cocoa producing countries combined, its cocoa production is concentrated in the region of Bahia. Consequently, expanding certification to new farmers may be less costly.

The **Dominican Republic**, like PNG, experienced an average cocoa production of 46,000 tonnes between 2000 & 2010 (FAO estimates). Its certified production is expected to grow from 7,500 tonnes in 2012 to 13,750 tonnes in 2015 (Mars estimates). Certified production in the Dominican Republic was bolstered by a five-year, USAID-financed initiative with Kraft[7], announced in Nov. 2011, to "increase the supply of organic Fairtrade cocoa and provide an addition social premium for community investment and productivity improvements". This initiative has the goal of providing 10,000 small-scale cocoa farmers in the DR with training on improved farming techniques and post-harvest practices, and it is similar to an initiative in Ghana involving Fairtrade cooperatives and the Cocoa Board of Ghana.

Ecuador produces approximately 130,000 tonnes of cocoa per year and has a well-established certified market with the quantity of certified cocoa expected to grow from 5,000 to 20,000 tonnes by 2015. UTZ, Fairtrade, and RA have already certified farms and cooperatives in Ecuador.

For **Cote d'Ivoire, Ghana and Indonesia**, leaders in global cocoa production, Mars has produced medium term forecasts of expected certification volumes (Table 4).

[6] http://blogs.ft.com/beyond-brics/2012/05/23/brazilian-chocolate-makes-a-come-back/#ixzz2Ga5tIhcM

[7] http://agritrade.cta.int/Agriculture/Commodities/Cocoa/Long-term-supply-agreements-emerging-in-Dominican-Republic-cocoa-sector

Table 4: Country Certification Projections

Origin		2012	2013	2014	2015
Cote d'Ivoire	Certified Cocoa	85,000	100,000	125,000	150,000
	All Cocoa	1,396,000	1,396,000	1,396,000	1,396,000
Ghana	Certified Cocoa	25,000	40,000	60,000	80,000
	All Cocoa	850,000	887,000	949,000	1,016,000
Indonesia	Certified Cocoa	20,000	40,000	55,000	70,000
	All Cocoa	575,000	590,000	605,000	620,000

The quantity of certified cocoa produced in each of these countries is expected to grow over the next three years. While the greatest amount of certified cocoa is expected to come from Cote d'Ivoire, the growth rate of certified production in Indonesia is expected to be significantly higher than in the other two countries, with certified cocoa production doubling in 2012-2013.

Comparison of assumptions

Productivity and production cost estimates from several sources were considered, first the assumptions in Mars' ROI work. Under these, average land size per farmer is 3 ha and starting yield is 0.5 tonnes/ha. Yields increase by 0.15 tonnes/ha between 2012 and 2020 with farmer training alone and they increase by 0.25 tonnes/ha with fertilizer use alone. With training, fertilizer and better planting materials together, yields may increase 0.5-1.0 tonnes/ha. Currently 6% of farmers are certified, but only 50% of certified farmers use the full training-fertilizer-plant-material package. By 2020, 75% of certified farmers will use the full package. The certification costs per tonne (Table 5) decrease for certified farmers over time. Note that the cost of certifying new farmers is not included in these estimates.

Table 5: Estimated Cocoa Certification Costs per Tonne

		2012	2013	2014	2015	2016	2017	2018	2019	2020
Cert cost per tonne		$260	$271	$257	$244	$230	$216	$202	$189	$175

Source: Alastair Child

Second, the productivity and production cost assumptions from the study on RA certification in Indonesia were used (as discussed in Table 3 above). Similar to the ROI assumptions, under RA certification practices, cocoa yields increase from 0.6 tonnes/ha to 1.5 tonnes/ha, and certification costs decrease from $268/tonne in the first year of certification to $87/tonne in the 10th year of certification.

Scenarios and simulations

As explained in the introduction, uncertainties regarding future market conditions and technological change make a scenario framework the most appropriate economic assessment strategy. To examine how certification costs depend on these factors, the two "grand" scenarios specified in the terms of reference for this study are considered, as well as six additional sub-scenarios. These are summarized briefly in Table 6 below, and elaborated on in the results that follow. Briefly, the Business as Usual (BAU) scenario (S1) assumes markets remain stable to 2020, with certification following existing commitments of Mars and other major buyers (Ferrero, Hershey, etc.). The Mainstream scenario (S2) assumes that the major players in the industry adopt certification, and governments of both consuming and producing countries have produced consistent standards for the cocoa industry.

Table 6: Scenario Definitions

	Scenario
1	Business as Usual
2	Certification Becomes Mainstream
2.1	Scenario 2 with 30% Productivity Growth by 2020, Certified
2.2	Scenario 2 with 30% Productivity Growth by 2020, Non-Certified
2.3	Scenario 2 with 70% Productivity Growth by 2020, Certified
2.4	Scenario 2 with 70% Productivity Growth by 2020, Non-Certified
1.01	Scenario 1 with Program Scale Elasticity = .01
2.01	Scenario 2 with Program Scale Elasticity = .01

Global results

To elucidate the influence of technological change and program participation on certification costs, four sub-scenarios of the Mainstream case (S2) were developed. These allow for yield-enhancing technological progress, according to "bookend" estimates from the certification community.

At the lower range, it is assumed that farmers can achieve yields by 2020 that are 30% higher than observed levels in 2010. At the higher end, it is assumed that farmers can achieve 70% higher yields by 2020. In all cases, the number of farmers considered is determined by the scope of the certification program, but technological change is assumed to occur either inside or outside the certification program.

Half the sub-scenarios (S2.1 and S2.3) assume that only certified farmers experience yield improvements. This is intended to show how coupling productivity improvement with certification will change conditions for both producers and buyers of certified cocoa. In contrast to this, the other two sub-scenarios (S2.2 and S2.4) assume that only non-certified farmers experience productivity enhancement. This could happen, for example, if non-certified farmers invest in productivity to remain competitive with certified farmers, the latter having a market access advantage. To make appropriate comparisons, the same number of farmers were considered in the second two sub-scenarios.

The last two scenarios are included to test the robustness of the assumptions about how the cost of certification changes with land area, and are discussed in more detail below.

Table 7:

Scenario 1: Business-as-Usual

				Productivity Source			Certification Cost			
Year	Mars certified demand	Certified production	Yield (T/ha)	Other	Certified	Revenue Effect ($M)	Total ($M)	Net ($M)	Mars ($M)	Cost/Ton ($)
2012	94,587	492,349	0.45	0.00	0.00	$ 128	$ -	$ 128	$ 25	$ 260
2013	112,600	621,860	0.45	0.00	0.00	$ 169	$ -	$ 169	$ 31	$ 272
2014	137,943	824,330	0.45	0.00	0.00	$ 237	$ -	$ 237	$ 40	$ 288
2015	182,663	1,026,800	0.45	0.00	0.00	$ 309	$ -	$ 309	$ 55	$ 301
2016	210,963	1,124,550	0.45	0.00	0.00	$ 344	$ -	$ 344	$ 65	$ 306
2017	250,250	1,220,600	0.45	0.00	0.00	$ 380	$ -	$ 380	$ 78	$ 311
2018	296,250	1,316,650	0.45	0.00	0.00	$ 416	$ -	$ 416	$ 94	$ 316
2019	364,500	1,412,700	0.45	0.00	0.00	$ 453	$ -	$ 453	$117	$ 320
2020	415,000	1,508,750	0.45	0.00	0.00	$ 490	$ -	$ 490	$135	$ 325

Note: Based on the existing commitments of Mars and others (Ferrero, Hershey, etc.). Certifying body's forecasts of Certified Production, less 15% double counting.

Table 7 summarizes the results of the first scenario: Business-as-Usual (BAU). The second and third columns contain trends for certified demand and supply, the former for Mars only and the latter for global certified production. These numbers are taken from Mars' own projections as cited above. The fourth column contains the assumed level of global cocoa yield, which in this scenario is calibrated to the 2010 level and held constant for the decade under consideration. Columns five and six will, in sub-scenarios, show assumptions regarding productivity change among certified and non-certified producers, but for this reference scenario no productivity change is assumed. The column entitled Revenue Change refers to the income effect that would result if certified farmers experienced productivity growth, lowering average costs, increasing output, and reducing market prices. This revenue change is assumed to be reflected in certified cocoa costs to buyers, lower if farmers make more money from higher yields, higher if yields are undercut. Appendix B explicates the role of this revenue change in determining net certification costs. For the present scenario, this term is zero.

The last four columns of these scenario tables are most important, comprising a variety of certification program costs. The first is total cost (in millions of USD) of the global program to buyers of certified cocoa. Unsurprisingly, this rises with the scale of certification, increasing in this scenario from about $260M to $325M over nine years. Net global program cost, because there are no productivity effects in S1, is the same. Mars own total cost for certified cocoa, based on its buying commitment in the second column, goes from $25M to $135M over the same period. The last column reveals the unit cost of certification, which is relatively high and rising over time (about 25%) in the BAU scenario.

Table 8 shows what would happen if the certification scheme went mainstream (S2). Again, no productivity improvements are assumed, so program costs in the aggregate and on a per tonne basis will be even higher by 2020. Mars buying remains the same, but their cost rises with the unit certification cost. Thus mainstreaming certification has the potential to increase buyer costs, as more marginal farms are brought into the program.

Table 8:

Scenario 2: Certification Mainstream

				Productivity Source			Certification Cost			
Year	Mars certified demand	Certified production	Yield (T/ha)	Other	Certified	Revenue Effect ($M)	Total ($M)	Net ($M)	Mars ($M)	Cost/Ton ($)
2012	94,587	492,349	0.45	0.00	0.00	$ 128	$ -	$ 128	$ 25	$ 260
2013	112,600	680,805	0.45	0.00	0.00	$ 189	$ -	$ 189	$ 31	$ 277
2014	137,943	869,262	0.45	0.00	0.00	$ 253	$ -	$ 253	$ 40	$ 291
2015	182,663	1,057,718	0.45	0.00	0.00	$ 320	$ -	$ 320	$ 55	$ 302
2016	210,963	1,246,175	0.45	0.00	0.00	$ 389	$ -	$ 389	$ 66	$ 312
2017	250,250	1,434,631	0.45	0.00	0.00	$ 461	$ -	$ 461	$ 80	$ 321
2018	296,250	1,623,087	0.45	0.00	0.00	$ 535	$ -	$ 535	$ 98	$ 329
2019	364,500	1,811,544	0.45	0.00	0.00	$ 610	$ -	$ 610	$123	$ 337
2020	415,000	2,000,000	0.45	0.00	0.00	$ 687	$ -	$ 687	$143	$ 343

Fortunately, this cost escalation is by no means inevitable. As the results of Scenario 2.1 (Table 9) indicate, when mainstreaming global certification is associated with even modest (30%) yield improvements for participating farmers, unit certification costs drop by half.

For Mars, the difference means $90M in savings. Note that, although higher productivity reduces average (and therefore Total) cost, Net cost is about a third lower than Total cost because of the revenue gains to certified farmers. These gains result because productivity enables program farmers to increase output and, because prices fall by less than this increase in percentage terms, they reap higher revenue. As discussed above, it is assumed that these revenue increases offset the cost to certified cocoa buyers.

Table 9:

Scenario 2.1: Mainstream - 30% Productivity Growth by 2020 - Certified

				Productivity Source			Certification Cost			
Year	Mars certified demand	Certified production	Yield (T/ha)	Other	Certified	Revenue Effect ($M)	Total ($M)	Net ($M)	Mars ($M)	Cost/Ton ($)
2012	94,587	492,349	0.45	0.00	0.00	$ 128	$ -	$ 128	$ 25	$ 260
2013	112,600	680,805	0.47	0.00	0.04	$ 180	$ (5)	$ 175	$ 29	$ 257
2014	137,943	869,262	0.48	0.00	0.08	$ 232	$ (16)	$ 215	$ 34	$ 248
2015	182,663	1,057,718	0.50	0.00	0.11	$ 281	$ (34)	$ 247	$ 43	$ 234
2016	210,963	1,246,175	0.52	0.00	0.15	$ 329	$ (59)	$ 270	$ 46	$ 217
2017	250,250	1,434,631	0.53	0.00	0.19	$ 375	$ (93)	$ 282	$ 49	$ 197
2018	296,250	1,623,087	0.55	0.00	0.23	$ 419	$(135)	$ 284	$ 52	$ 175
2019	364,500	1,811,544	0.57	0.00	0.26	$ 461	$(185)	$ 276	$ 56	$ 152
2020	415,000	2,000,000	0.58	0.00	0.30	$ 501	$(244)	$ 258	$ 53	$ 129

Table 10:

Scenario 2.2: Mainstream - 30% Productivity Growth by 2020 - Non-Certified

				Productivity Source			Certification Cost			
Year	Mars certified demand	Certified production	Yield (T/ha)	Other	Certified	Revenue Effect ($M)	Total ($M)	Net ($M)	Mars ($M)	Cost/Ton ($)
2012	94,587	492,349	0.45	0.00	0.00	$ 128	$ -	$ 128	$ 25	$ 260
2013	112,600	680,805	0.47	0.04	0.00	$ 180	$ -	$ 180	$ 30	$ 265
2014	137,943	869,262	0.48	0.08	0.00	$ 232	$ -	$ 232	$ 37	$ 267
2015	182,663	1,057,718	0.50	0.11	0.00	$ 281	$ -	$ 281	$ 49	$ 266
2016	210,963	1,246,175	0.52	0.15	0.00	$ 329	$ -	$ 329	$ 56	$ 264
2017	250,250	1,434,631	0.53	0.19	0.00	$ 375	$ -	$ 375	$ 65	$ 262
2018	296,250	1,623,087	0.55	0.23	0.00	$ 419	$ -	$ 419	$ 77	$ 258
2019	364,500	1,811,544	0.57	0.26	0.00	$ 461	$ -	$ 461	$ 93	$ 255
2020	415,000	2,000,000	0.58	0.30	0.00	$ 501	$ -	$ 501	$104	$ 251

One of the main findings of the analysis is that yield growth can lower costs for certified cocoa buyers. Would the same be true if only non-certified farmers experienced productivity improvements? The answer is mixed, as the results of Scenario 2.2 in Table 10 indicate. If only (an equal number of) non-certified farmers have modest (30%) yield gains, then unit and total program costs will still be lower, with Mars saving about $50M. Benefits are not as great for cocoa buyers because they cannot share the benefit of enhanced producer revenue with non-certified farmers. Moreover, certification program recipients are missing the benefits of higher productivity.

Between these two extreme cases (all certified or all non-certified), there is a continuum of outcomes, but two conclusions apply to all such cases. Higher yields lower certified buyer cost, regardless of what kind of producer increases productivity. This biggest cost benefit, however, comes when productivity is part of the certification activity.

Table 11:

Scenario 2.3: Mainstream - 70% Productivity Growth by 2020 - Certified

				Productivity Source			Certification Cost			
Year	Mars certified demand	Certified production	Yield (T/ha)	Other	Certified	Revenue Effect ($M)	Total ($M)	Net ($M)	Mars ($M)	Cost/Ton ($)
2012	94,587	492,349	0.45	0.00	0.00	$ 128	$ -	$ 128	$ 25	$ 260
2013	112,600	680,805	0.49	0.00	0.09	$ 170	$ (12)	$ 159	$ 26	$ 233
2014	137,943	869,262	0.53	0.00	0.18	$ 208	$ (35)	$ 173	$ 28	$ 200
2015	182,663	1,057,718	0.57	0.00	0.26	$ 242	$ (70)	$ 172	$ 30	$ 162
2016	210,963	1,246,175	0.61	0.00	0.35	$ 272	$(118)	$ 153	$ 26	$ 123
2017	250,250	1,434,631	0.65	0.00	0.44	$ 298	$(179)	$ 119	$ 21	$ 83
2018	296,250	1,623,087	0.68	0.00	0.53	$ 322	$(252)	$ 70	$ 13	$ 43
2019	364,500	1,811,544	0.72	0.00	0.61	$ 344	$(338)	$ 6	$ 1	$ 3
2020	415,000	2,000,000	0.76	0.00	0.70	$ 363	$(435)	$ (72)	$ (15)	$ (36)

Table 12:

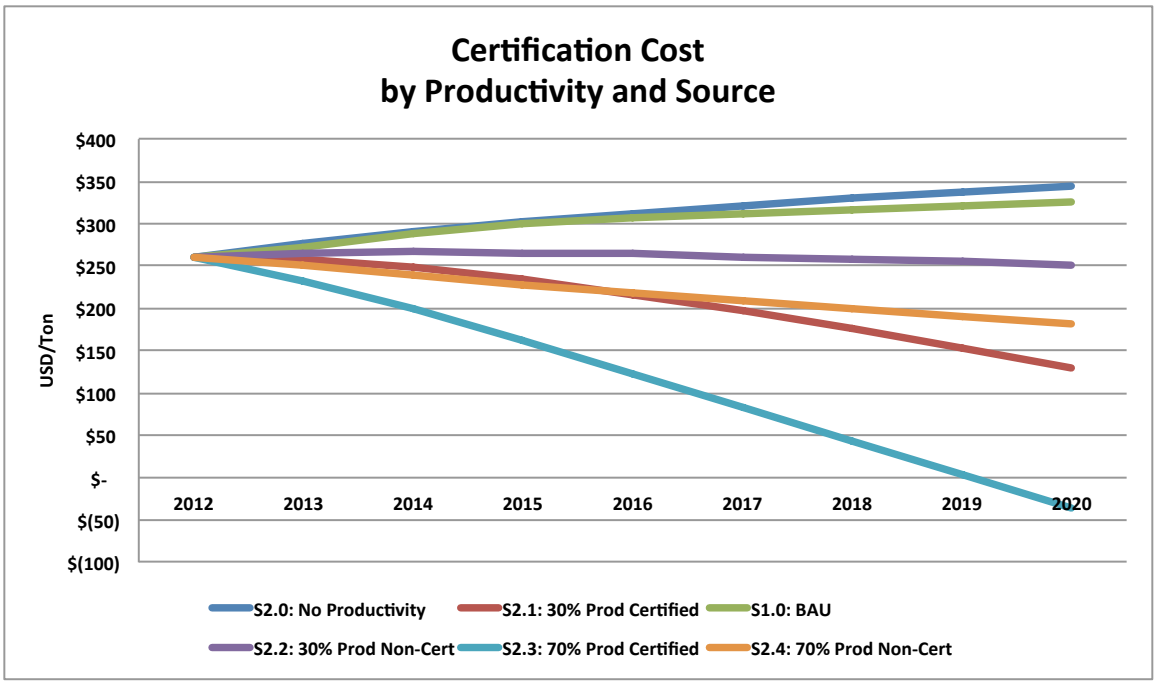
Scenario 2.4: Mainstream - 70% Productivity Growth by 2020 - Non-Certified

				Productivity Source			Certification Cost			
Year	Mars certified demand	Certified production	Yield (T/ha)	Other	Certified	Revenue Effect ($M)	Total ($M)	Net ($M)	Mars ($M)	Cost/Ton ($)
2012	94,587	492,349	0.45	0.00	0.00	$ 128	$ -	$ 128	$ 25	$ 260
2013	112,600	680,805	0.49	0.09	0.00	$ 170	$ -	$ 170	$ 28	$ 250
2014	137,943	869,262	0.53	0.18	0.00	$ 208	$ -	$ 208	$ 33	$ 240
2015	182,663	1,057,718	0.57	0.26	0.00	$ 242	$ -	$ 242	$ 42	$ 229
2016	210,963	1,246,175	0.61	0.35	0.00	$ 272	$ -	$ 272	$ 46	$ 218
2017	250,250	1,434,631	0.65	0.44	0.00	$ 298	$ -	$ 298	$ 52	$ 208
2018	296,250	1,623,087	0.68	0.53	0.00	$ 322	$ -	$ 322	$ 59	$ 199
2019	364,500	1,811,544	0.72	0.61	0.00	$ 344	$ -	$ 344	$ 69	$ 190
2020	415,000	2,000,000	0.76	0.70	0.00	$ 363	$ -	$ 363	$ 75	$ 182

How far this cost reduction process can go is suggested by the results in the next two tables, essentially repeating the last two scenarios with a 70% productivity improvement. Here the unit cost is being driven nearly to zero by enhanced productivity associated with certification and its attendant revenue benefits. When only non-certified producers increase yield, certified buyers still benefit but not nearly as much.

For the six main scenarios and sub-scenarios already discussed, Figure 2 summarizes the unit cost estimates obtained from the model. Clearly, yields can make an enormous difference to certification program costs from a buyer's perspective, and the source of the productivity growth (in or out of certification) is of at least equal importance.

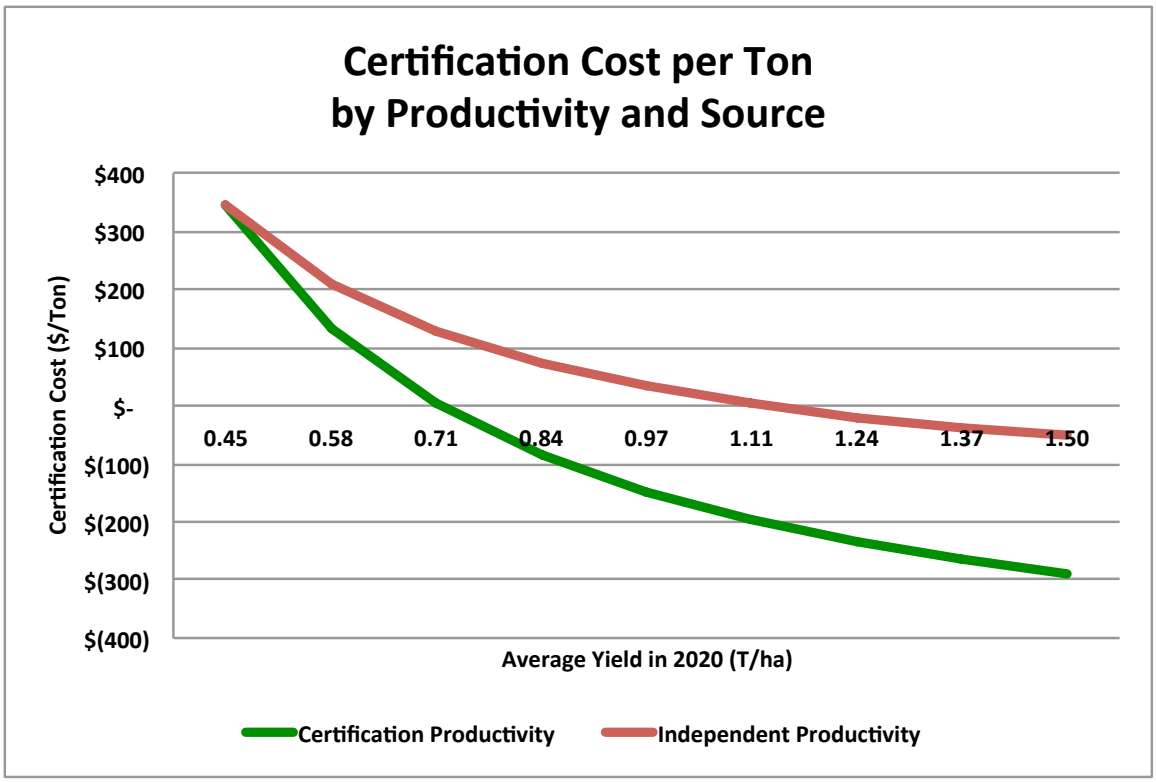
Figure 2:



It is worth emphasizing that the yield numbers used here encompass estimates of certifiers, essentially representing productivity spillovers from the practical implementation of certification systems. Although the details are vague on causal links between the programs and yield enhancement, it should be emphasized that these are relatively modest gains over an eight-year period. The agronomic and technical literature on cocoa suggests that 150% improvement in average yields is within reach. To see how this would affect certification program costs, we simulated the Mainstream scenario across a full spectrum of average yields, from the 0.45T/ha baseline to a more aspirational 1.50T/ha. Assuming again that either certified or non-certified farmers experience all the yield dividends, the resulting unit costs are presented in Figure 3.

Clearly, yield improvements that are deemed agronomically feasible would change the fundamentals of certification finance dramatically. If certified farmers were enabled to increase yields by about 71% or more, certification would essentially become self-financing. That is to say, after this point farmers would have an economic incentive to participate in certification at their own expense, with enhanced revenue fully or more than offsetting certification costs. Even if only non-certified farmers were able to increase yields, the aggregate price benefit to certified buyers would outweigh program costs, but this time only if yields increase by more than 115%. If certification is truly the goal of the buyers committed to this program, it would clearly be beneficial to them to bundle certification with yield enhancing technology and training.

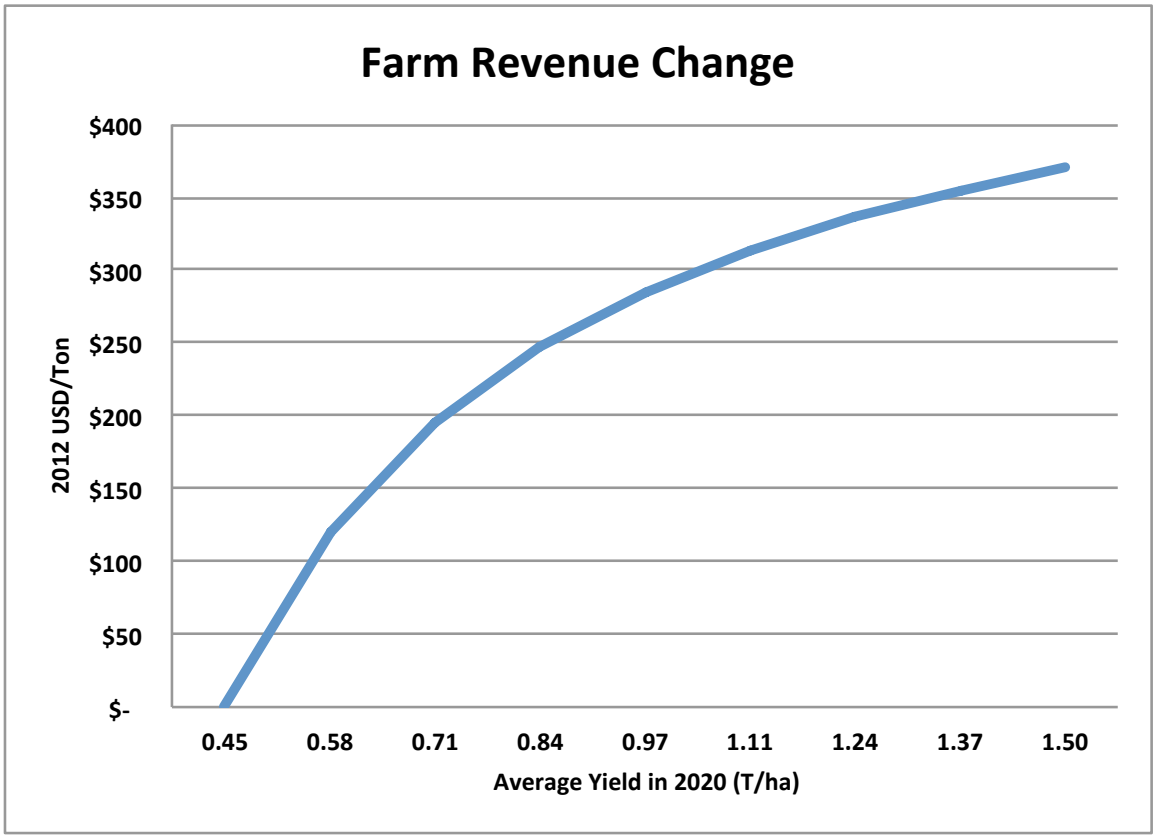
Figure 3:



Beyond benefits to certified and other buyers, the revenue dividend of higher yield of course benefits cocoa farmers, the vast majority of whom are low-income smallholders. Cocoa certification has been promoted for many reasons, including forest conservation, other sustainability criteria, labor standards, etc. From a basic livelihoods perspective, the approach to certification suggested by these results (science- or technology-based certification) could greatly benefit the rural poor. Generations of development show that many other social and environmental conditions improve with basic incomes, including childhood education, women's rights, family planning, and ambient environmental standards.

How much could farmers potentially benefit? Figure 4 illustrates the same spectrum of yield scenarios in terms of increases in farm revenue per tonne of cocoa. It shows that farmers could increase income by up to 40% against a standard producer price of $1400/Tonne.

Figure 4:


Farm Revenue Change
$400
$350
$300
$250
$200
$150
$100
$50
$-
2012 USD/Ton
0.45
0.58
0.71
0.84
0.97
1.11
1.24
1.37
1.50
Average Yield in 2020 (T/ha)

Calibration scenarios

Finally, Tables 13 and 14 summarize results of "calibration" scenarios S1.01 and S2.01. As indicated in the model summary (Appendix B), it is assumed that certification cost has some elasticity, or rate of increase, as the program must cover more land. This parameter reflects the fact that any area program costs will rise with scope as more remote, less organized farmers are recruited. The agricultural extension literature suggests that the parameter equals 0.2 for the first six scenarios. In the S1.01 and S2.01 scenarios, this value is cut in half to see how robust the estimates might be. As would be expected, lower cost elasticities lead to low program costs for the same levels of certification. The differences, however, are much smaller than the difference in parameter values. Since all the other scenarios use a consensus median value for the research community, these cost estimates appear robust.

Table 13:

Scenario 1.01: Scenario 1 with Beta=1

				Productivity Source			Certification Cost			
Year	Mars certified demand	Certified production	Yield (T/ha)	Other	Certified	Revenue Effect ($M)	Total ($M)	Net ($M)	Mars ($M)	Cost/Ton ($)
2012	94,587	492,349	0.45	0.00	0.00	$ 128	$ -	$ 128	$ 25	$ 260
2013	112,600	621,860	0.45	0.00	0.00	$ 165	$ -	$ 165	$ 30	$ 266
2014	137,943	824,330	0.45	0.00	0.00	$ 225	$ -	$ 225	$ 38	$ 273
2015	182,663	1,026,800	0.45	0.00	0.00	$ 287	$ -	$ 287	$ 51	$ 279
2016	210,963	1,124,550	0.45	0.00	0.00	$ 317	$ -	$ 317	$ 59	$ 282
2017	250,250	1,220,600	0.45	0.00	0.00	$ 347	$ -	$ 347	$ 71	$ 284
2018	296,250	1,316,650	0.45	0.00	0.00	$ 377	$ -	$ 377	$ 85	$ 286
2019	364,500	1,412,700	0.45	0.00	0.00	$ 407	$ -	$ 407	$105	$ 288
2020	415,000	1,508,750	0.45	0.00	0.00	$ 438	$ -	$ 438	$120	$ 290

Table 14:

Scenario 2.01: Scenario 1 with Beta=1

				Productivity Source			Certification Cost			
Year	Mars certified demand	Certified production	Yield (T/ha)	Other	Certified	Revenue Effect ($M)	Total ($M)	Net ($M)	Mars ($M)	Cost/Ton ($)
2012	94,587	492,349	0.45	0.00	0.00	$ 128	$ -	$ 128	$ 25	$ 260
2013	112,600	680,805	0.45	0.00	0.00	$ 182	$ -	$ 182	$ 30	$ 268
2014	137,943	869,262	0.45	0.00	0.00	$ 239	$ -	$ 239	$ 38	$ 275
2015	182,663	1,057,718	0.45	0.00	0.00	$ 296	$ -	$ 296	$ 51	$ 280
2016	210,963	1,246,175	0.45	0.00	0.00	$ 355	$ -	$ 355	$ 60	$ 285
2017	250,250	1,434,631	0.45	0.00	0.00	$ 414	$ -	$ 414	$ 72	$ 289
2018	296,250	1,623,087	0.45	0.00	0.00	$ 475	$ -	$ 475	$ 87	$ 292
2019	364,500	1,811,544	0.45	0.00	0.00	$ 536	$ -	$ 536	$108	$ 296
2020	415,000	2,000,000	0.45	0.00	0.00	$ 597	$ -	$ 597	$124	$ 299

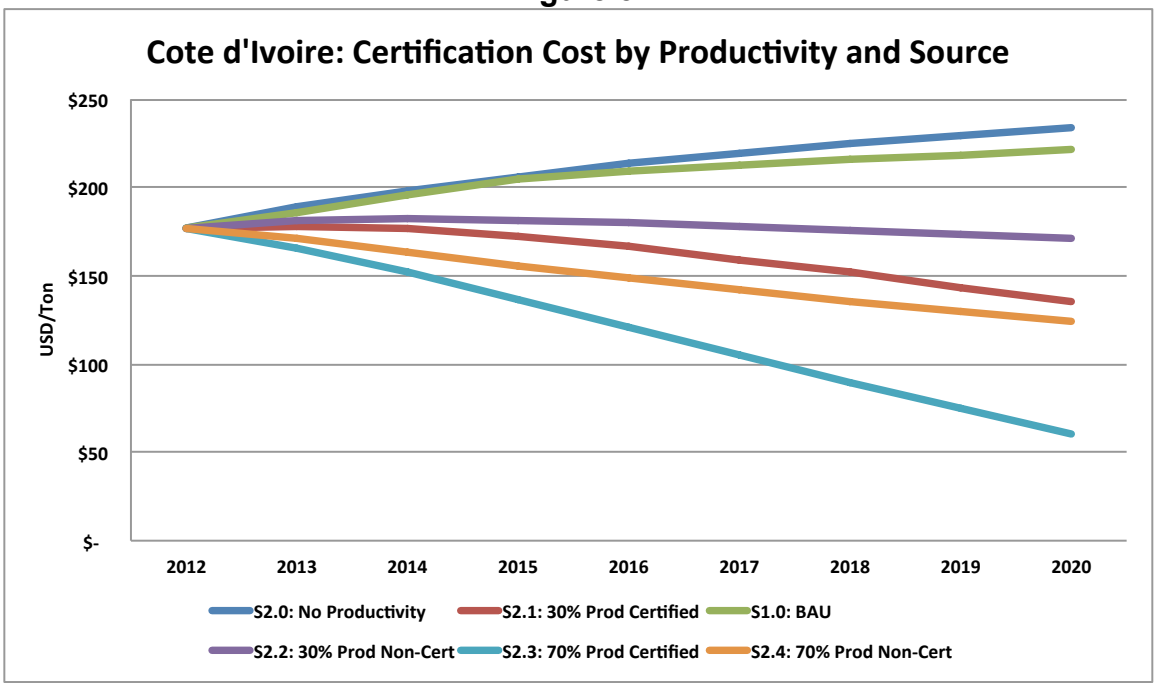
Individual countries

Given the diversity of cocoa-producing countries, the analytical models used here predict that certification costs would vary across them. As was emphasized in the quantitative analysis, it is reasonable to assume that institutional and other heterogeneity mean that certification program design and targeting will need to be adapted to local conditions. The latter challenge is well beyond the scope of this study, although more intensive data development could support this activity. However, this study has disaggregated the global simulation work of the last sub-section and applied it across the main producing countries.

The following figure shows scenarios S1-S2.4 applied to Cote d'Ivoire. The most arresting result in these findings is much lower average certification costs. Across all scenarios, unit certification costs are less than half their global counterparts for the same scenarios. This finding is a direct result of the country's higher average yields (0.660 tonnes/ha vs the global average of 0.450), which reduce the area increases needed to meet a given target for certified cocoa tonnage.

The ordering of scenarios in terms of relative costs is the same as in the global case, not surprising since the same basic drivers are at work. It should be noted, however, that potential cost savings from productivity enhancement appear more limited, for two reasons. The first is the same as that for lower initial program costs. Because Cote d'Ivoire already has yields 50% above global averages, incremental yield improvements will be more expensive. Secondly, the country simulation experiments are different because we only consider demand effects of a single global market.

Figure 5:



These results pose and interesting challenge for certification policy. Clearly, Cote d'Ivoire would be an attractive candidate for a focus on certification. Depending on other country programs and independent, non-certified investment decisions; however, competitive conditions could change and induce shifting of market share between countries. Some of this uncertainty can be hedged with contracting systems, but analyzing these insurance mechanisms is again outside of the boundaries of this study. Clearly, however, the dynamic nature of inter-country diversity poses substantive risks for both local and foreign investors.

Table 15:

Certification Costs by Country and Scenario, 2020 (USD/Ton)

	Global	Ivory Coast	Ghana	Indonesia	Nigeria	Cameroon	Brazil	Ecuador	Dom Rep	PNG	Other
Scenario 1	$ 325	$ 221	$ 359	$ 439	$ 370	$ 544	$ 409	$ 397	$ 397	$ 397	$ 397
Scenario 2	$ 343	$ 234	$ 380	$ 464	$ 391	$ 575	$ 433	$ 420	$ 420	$ 420	$ 420
Scenario 2.1	$ 129	$ 135	$ 257	$ 316	$ 275	$ 414	$ 309	$ 303	$ 305	$ 305	$ 296
Scenario 2.2	$ 251	$ 171	$ 277	$ 339	$ 286	$ 420	$ 316	$ 307	$ 307	$ 307	$ 307
Scenario 2.3	$ (36)	$ 60	$ 164	$ 204	$ 187	$ 293	$ 217	$ 215	$ 219	$ 220	$ 202
Scenario 2.4	$ 182	$ 124	$ 201	$ 246	$ 207	$ 304	$ 229	$ 222	$ 222	$ 222	$ 222

All the scenarios have been run for nine individual producing countries and one residual, rest-of-world (ROW) region (Table 15). While there are hours of interpretation at the national level, data constraints undermine the resolution of some of these details.[8] Nevertheless, careful review of country level results suggests that the same general insights emerge for decision makers:

- National level certification costs vary significantly, inversely with average initial yield, and increase with certified crop size.

- **Potential cost reductions vary inversely with initial yields, i.e. countries with the lowest efficiency levels can reduce certification costs the most with yield enhancement. This means that yield-enhancing programs structurally are pro-poor, and can promote economic convergence, with the poorest farmers advancing the most rapidly in percentage terms.**

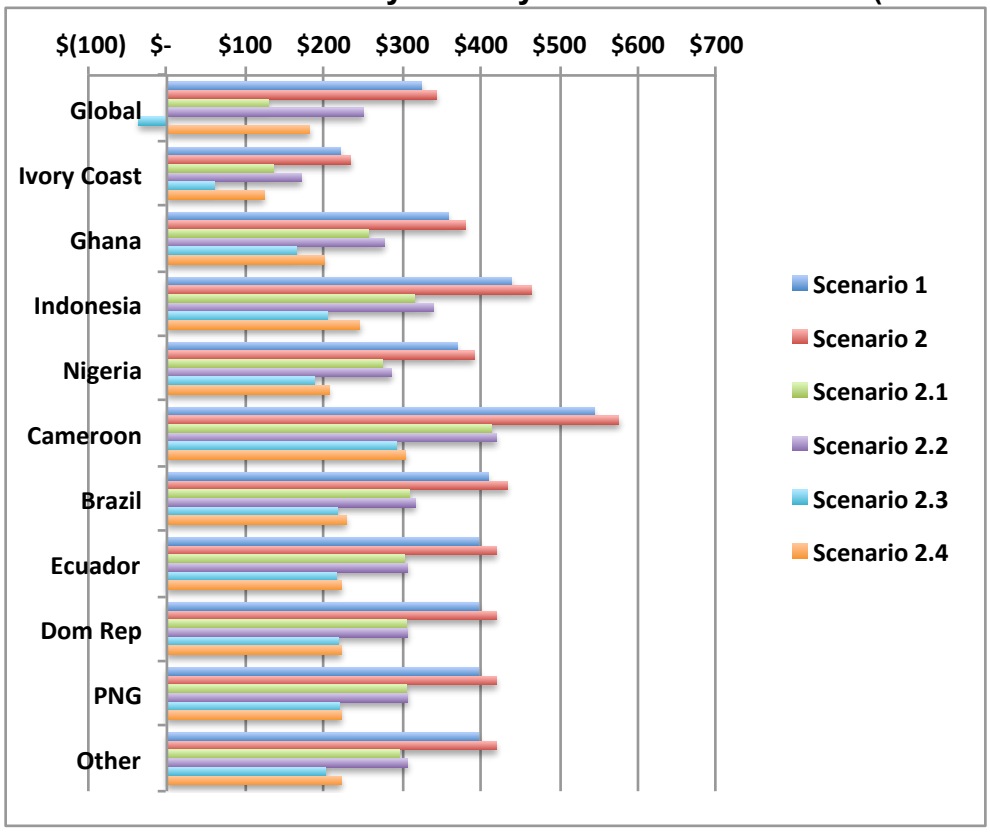
The national economy findings are summarized in Table 15 above and in the following figure. In the former, it is clear that certification policy coherence will be very important in predicting the outcomes and economic stakes, at the national level and globally. If, for example, Cote d'Ivoire can improve yields 70% for participating farmers, its certified cocoa can be sold to buyers at the same price

[8] For example, because of data constraints, we have had to assume that some countries (Ecuador, Dominican Republic, and PNG, have the same initial yields as the residual group.

as non-certified cocoa. If Cote d'Ivoire leaves productivity investment to non-certified farmers (S2.3) while less efficient Ghana and Indonesia pursue S2.4, the latter two will be more competitive than a country that had half their certification cost in the baseline S2 Mainstream scenario. The degree of heterogeneity in national outcomes is even more apparent in Figure 6.

Clearly, many challenges remain to devise a certification policy that is efficient at the national and global levels, taking reasonable account of the interests of even more diverse stakeholders.

Figure 6: Certification Costs by Country and Scenario in 2020 (USD/Tonne)



Conclusions and opportunities

This chapter presents a quantitative assessment of certified cocoa market fundamentals, going forward to 2020 under a variety of scenario assumptions. An analytical economic model predicts program costs to buyers of certified cocoa, income effects on farmers, and examines how these would change with program characteristics. Salient findings include the following:

- The introduction of certification will increase the price of cocoa, unless it is associated with increased productivity increases resulting from technological changes.
- Certification costs are strongly affected by the scale of the certification and by yields. Without technological, productivity-enhancing change, the average costs of certification will increase with volume, and the annual costs of certification to Mars may plausibly exceed $150 million. If the level of technological change is sufficient, the price of cocoa will decline and the quantity produced will increase because of certification.
- If participation in certification provides access to yield increasing practices with sufficient impacts (as with V4C), so that the value of the extra benefits exceeds certification costs, certification may be self-financing. This holds the prospect of farmers being eager to join and comply with certification programs that link productivity enhancement with certification.
- Certification programs may lead to some industry restructuring. If it leads to sufficient expansion of supply, higher cost non-certified farmers may switch to other crops.

Opportunities: Because of data and resource constraints, this work is preliminary, supporting strategic decision making in an indicative, rather than definitive, manner.

Given the stakes involved, as well as significant uncertainty surrounding a variety of important model characteristics, as well as the complexity of the underlying issues and actors, it would be advisable to consider extending this approach with more determined investments in data and analysis. This would not only sharpen the estimates presented here, but also significantly enlarge the scope of decision problems that can be addressed.

More extensive, timely, and higher resolution data would also enlarge the stakeholder audience that can be addressed by this policy analysis. This can be a valuable investment for recruiting allies among expected program beneficiaries, as well as anticipating the adjustment needs of others.