

The Role of Markets, Technology and Policy in Generating Palm Oil Demand in Indonesia

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8 Indonesia produces more palm oil and consumes more palm oil per capita than any
9 country in the world. This paper examines the processes through which Indonesia has
10 promoted palm oil consumption and some of the consequences of that transformation.
11 Partial equilibrium modeling shows that Indonesia's remarkable increase in palm oil
12 consumption since 1985 is not largely attributable to population and income growth.
13 Instead, much of Indonesia's palm oil consumption growth results from substitution
14 away from coconut oil, a process that was facilitated by government policies around
15 technology, pricing, distribution, and trade. The switch from coconut oil to palm oil in
16 Indonesia was associated with increased land conversions to agriculture and
17 diminished smallholder competitiveness. Despite lower rates of cooking oil
18 substitution in the future, simulations suggest that Indonesia's total palm oil
19 consumption in 2035 will be at least double that of 2010.

1 INTRODUCTION

2 Palm oil production has doubled every ten years since the 1960s, surpassing soybean oil in
3 2007 to become the world's dominant vegetable oil (USDA 2011). With rapid production
4 increases have come economic windfalls and environmental devastation. Indonesia, as the
5 world's largest palm oil producing country, is at the forefront of these changes. Palm oil has
6 been Indonesia's largest agricultural export for the last decade and has employed, in
7 production and processing, some 2-3 million Indonesians, or about 2 % of Indonesia's labor
8 force (World Growth 2011; World Bank & IFC 2011). Palm oil production also threatens
9 Indonesia's extensive tropical forests including the biodiversity, carbon sequestration, and
10 other ecosystem services that these forests provide (Carlson et al 2012; Wilcove, & Koh
11 2010). Across Asia, oil palm producers have relied almost exclusively (92%) on area
12 expansion as opposed to intensification to meet demand (USDA 2011), a trend that puts
13 enormous pressure on natural landscapes.

14
15 The rate at which palm oil plantations will continue to spread in Indonesia and elsewhere is a
16 function of supply constraints: land and labor costs, yields, and other factors that affect both
17 the intensive and extensive margin of production. But the structure of demand is equally
18 important in determining palm oil's price and, consequently, the incentives facing producers.
19 This paper focuses on the evolution of cooking oil demand in Indonesia; however, cooking oil
20 trends in other major palm oil consuming countries, such as India and China, also shape the
21 global market. Lessons from Indonesia's experience can give insights into the drivers of palm
22 oil consumption growth in these other countries. Ultimately, future of palm oil expansion

1 patterns cannot be understood without a comprehensive analysis of the factors that determine
2 demand.

3 This paper comprises two sections. The first section evaluates the sources of palm oil demand
4 growth in Indonesia using a partial equilibrium framework. This approach is insufficient to
5 explain demand trends, so the second section of the paper introduces the role of Suharto-era
6 policies in altering cooking oil preferences. Supplementing the economic model with an
7 understanding of development projects and programs that promoted palm oil is necessary in
8 order to fully explain the agricultural development transformation that drove Indonesian
9 consumption dynamics.

11 **A PARTIAL EQUILIBRIUM APPROACH TO DEMAND ANALYSIS: AN** 12 **EXERCISE IN HIND-CASTING**

13 It is impossible to properly estimate a demand equation for palm oil given the paucity of data
14 on relative domestic cooking oil prices and given simultaneity issues in the data. A quick
15 glance, however, at trends in the basic structural determinants of demand – population,
16 income, urbanization, and prices – reveals a striking non-linearity in palm oil consumption
17 dynamics over the past twenty-five years. Each of these variables -- with the exception of the
18 price of palm oil, for which the demand elasticity is assumed to be negative -- has increased:
19 Indonesia's population grew by 42% between 1985 and 2010; per capita incomes more than
20 doubled in real terms; and the urban population grew at 7.5% per annum – faster even than
21 the rate of urbanization in China (6.3%) or India (4.3%) (World Bank 2010). While Indonesia

typifies population and income growth trends across Asia, Indonesia is an outlier in terms of palm oil consumption growth. Total Indonesian palm oil consumption grew ten-fold between 1985 and 2010, from five hundred thousand to five million tons (USDA 2011). In per capita terms, no other country has experienced similarly large increases in palm oil consumption.

The following sections describe the potential contribution of population, income, urbanization, and prices to higher palm oil consumption in Indonesia. The second half of the paper explains how higher Indonesia palm oil consumption was the result of historical policies and programs that promoted palm oil over coconut oil in terms of both supply and demand.

Population effects

Population growth accounts for between 5% and 33% of Indonesia's palm oil consumption growth between 1985 and 2010. Total consumption growth can be expressed in terms of population growth and per capita consumption growth as follows:

$$T_2 - T_1 = P_2 C_2 - P_1 C_1 = C_1 (P_2 - P_1) + P_1 (C_2 - C_1) + (P_2 - P_1)(C_2 - C_1)$$

where T is total consumption; P is population; C is per capita consumption; and the subscripts 1 and 2 denote time periods 1985 and 2010, respectively. Thus, the difference in total consumption between 1985 and 2010 is the sum of: a term that depends only on population growth, $(P_2 - P_1)$; a term that depends only on per capita consumption growth $(C_2 - C_1)$; and a term that depends on the interaction between population growth and consumption growth.

1 Graphically, the shaded areas in figure 1 show the magnitudes of these three terms. The
2 smaller light gray rectangle, accounting for 5% of total consumption growth, represents
3 consumption growth that is uniquely due to population growth, holding per capita
4 consumption constant at the 1985 level. The dark gray rectangle, accounting for 28% of total
5 consumption growth, represents the interaction of income growth and higher per capita
6 consumption. The large, light gray rectangle, accounting for 67% of total consumption
7 growth, represents consumption growth that is separate from population growth. At
8 Indonesia's 1985 population level, total consumption at today's palm oil consumption level of
9 21 kg/capita would be 290 million tonnes, rather than the actual figure of 420 million tonnes.
10 Population growth and per capita consumption growth are both important to demand, but per
11 capita growth has been the more important factor and is also more uncertain when it comes to
12 future trends.

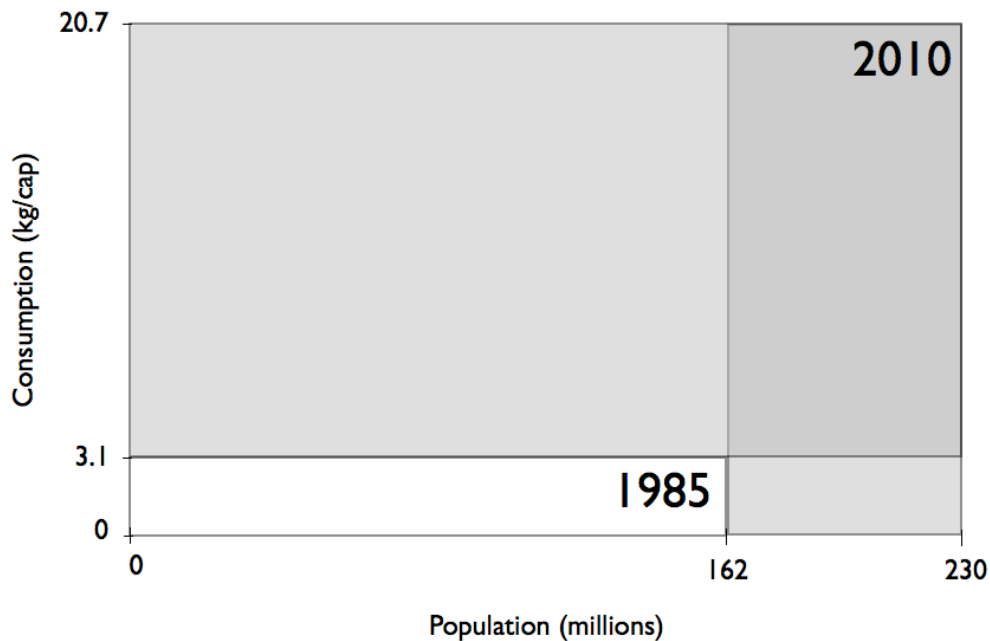


Figure 1. Population's contribution to higher Indonesian palm oil consumption.

The total shaded area represents Indonesia's increase in palm oil consumption between 1985 and 2010. Interior rectangles show the contribution of population growth (large light gray rectangle); population growth * per capita consumption growth (dark gray rectangle) and per capita consumption growth (small light gray rectangle). Data sources: (USDA 2011) (World Bank 2010)

Income effects

An obvious explanation for a surge in per capita Indonesian palm oil consumption is income growth: as incomes rise, Indonesians have more money to spend on food. Income elasticities of consumption are particularly high when people start out poor because the poor spend a larger fraction of their incomes on food (Timmer et al 1983) (USDA 2010). In 1992, the

World Bank estimated Indonesian vegetable oil income elasticities within a range of 0.6 – 0.8 (World Bank 1992). Indonesia's income elasticity of palm oil consumption for 2007, estimated across six income classes using national household survey data, is 0.4 (Badan Pusat Statistik (BPS) 2009). This coefficient suggests that Indonesia's income elasticity of consumption for vegetable oils is falling over time, as expected.¹

Income growth explains less than a fifth, of Indonesia's higher per capita palm oil consumption. Despite strong economic performance – Indonesian real incomes have more than doubled in the past 25 years, from \$476 per capita to \$1124 (World Bank 2010) -- explaining all of Indonesia's higher per capita palm oil consumption based on higher incomes alone would require an improbable income elasticity of 4.2. A high, but more reasonable income elasticity estimate of 0.8 still explains only 19% of Indonesia's observed increase in per capita palm oil consumption for food (see table 1). An income elasticity of 0.4 applied across Indonesia explains a jump in palm oil consumption of 1.7 kg per capita, or about 10% of the observed per capita consumption growth.

Table 1 Income elasticities and higher per capita palm oil consumption, 1985 – 2010.

Income elasticity assumption	Comments	Predicted increase in Indonesian per capita palm oil consumption, 1985 – 2010 (kg) ^a	% of observed increase
0.4	Derived from 2002 Susenas ^b	1.7	10
0.8	High estimate	3.4	19
4.2	Max required to uniquely explain observed increase	17.6	100

^aAuthor's calculations based on a simple regression framework

¹ By contrast, the income elasticity of demand for Indonesia's main staple, rice is approximately 0.1, and may soon be negative (Timmer et al 2010).

^bIndonesia's national socioeconomic survey

In the future, as Indonesian incomes continue to rise, palm oil consumption for food will level off. Patterns of palm oil consumption by income class reveal some 'topping out' at the highest income levels, particularly among rural consumers (Indonesian Palm Oil Board 2008); however, an important caveat is that the Susenas surveys do not account for palm oil consumed outside the home that is incorporated into prepared foods as part of the overall palm oil consumption figures. Urban consumers show less evidence in the Susenas data of reaching a maximum level of consumption. In 2007, the median rural consumer in Indonesia used 0.14 L/week of cooking oil, 67% of the maximum rural value of 0.21. Thus, as incomes grow, there is significant room for expansion towards this suggested ceiling.

Urbanization effects

Indonesia's urban population grew rapidly in the past quarter century, faster even than China's. While China and India saw urban population growth rates of 6.3% per annum and 4.4% per annum, respectively, between 1985 and 2010, Indonesia's urban population grew by 7.5% (World Bank 2010). Indonesia's household survey for 2002 shows slightly higher palm oil consumption in urban areas (Indonesian Palm Oil Commission (IOPC) 2004) (Indonesian Palm Oil Commission (IOPC) 2006). Holding incomes constant, a paired t-test shows urban Indonesians consumed significantly more cooking oil, on average, than rural Indonesians in the same income bracket ($p = 0.01$). However, the mean difference was only 0.01 kg / capita /

1 week or 5% of average consumption². In 2007, a similar survey reveals no significant
2 difference between rural and urban palm oil consumption, conditional on income. Thus, there
3 is some evidence for convergence in consumption patterns between rural and urban
4 consumers; however, since the Susenas surveys do not account for palm oil consumed outside
5 the home that is incorporated into prepared foods as part of the overall palm oil consumption
6 figures, the urban-rural difference in cooking oil consumption is likely larger than the data
7 suggest. Urbanization may contribute to diets that are heavier in cooking oil as workers and
8 their families substitute towards fast-food type fried meals³ that they purchase on the street.

9
10 Whether the difference in palm oil consumption between urban and rural Indonesians is zero
11 or as large 20%, the direct impact of urbanization on palm oil consumption is small.

12 Assuming that urban Indonesians consume 20% more palm oil than rural Indonesians implies
13 that as urbanization jumped from 26% to 53% in Indonesia between 1985 and 2010, migration
14 accounted for only a 0.24 kg/capita consumption increase on average for the country⁴ out of a
15 total increase of 18 kg / capita, holding incomes constant. This small effect is not the ‘missing
16 factor’ that explains Indonesia’s extraordinary growth in palm oil consumption.

² Difference for the median income group was 0.03 kg/cap/week; with only 9 income classes, it is not known whether the data are normally distributed.

³ These street foods include fried rice (*nasi goreng*), fried noodles (*mie goreng*), fried chicken (*ayam goreng*), etc.

⁴ Analysis assumes migrants consumed the average amount of palm oil in 2010.

1 **Own-price effects**

2 Combined, demographic factors explain less than a quarter of Indonesia's growth in palm oil
3 demand between 1985 and 2010. Lower palm oil prices also are not a powerful explanatory
4 variable. International palm oil prices fell an average of 1.3% per year between 1985 and
5 2005, or 13% in real terms,⁵ due to falling input costs and higher yields relative to demand
6 growth (Global Financial Data 2011). Domestic cooking oil prices fell less steeply. In
7 Jakarta, the price per bottle of cooking oil fell at an inflation adjusted rate of 0.7% per year
8 between 1985 and 2005, a more moderate decline that reflects government efforts to stabilize
9 cooking oil prices through export taxes and other price policies (Badan Pusat Statistik (BPS)
10 2006). Both price series are tremendously volatile. In the more recent period between 2005
11 and 2010, international palm oil prices went back up, gaining 14% annually in real terms,
12 from \$422⁶ per ton in 2005 to \$798 in 2010 (World Bank 2011). Some fraction of this price
13 increase was transmitted to domestic Indonesian cooking oil prices.

14
15 Older estimates put the own-price elasticity of vegetable oil demand in Indonesia at -1.3 to -
16 0.26, with poorer consumers and rural consumers responding the most to price changes
17 (Monteverde 1987). Price elasticities for vegetable oil are probably lower (in absolute value)
18 in Indonesia today than they were in the 1980s because incomes have risen⁷. Own-price
19 elasticities for any individual vegetable oil, including palm oil, are theoretically higher than

⁵ World Bank Indonesian GDP deflator

⁶ 2005 dollars

⁷ Poorer and urban consumers spend more of their incomes on cooking oil so a price decline (increase) makes them relatively wealthier (poorer), amplifying the price change's effect.

1 the own-price elasticity for vegetable oil as a category since individual vegetable oils
2 substitute easily with one another.
3
4 Regardless of whether the own-price elasticity of demand is approximated as -0.3 or -1.3,
5 falling international prices explain less than 10% of Indonesia's extraordinary per capita palm
6 oil consumption growth. And, in fact, prices have not fallen consistently. A price elasticity of
7 -0.3 explains 2% of the observed increase in per capita consumption and a price elasticity of -
8 1.3 explains 9%. Using domestic cooking oil prices rather than international palm oil prices
9 for the period 1985 – 2005 generates similar results: the overall increase in Indonesian
10 consumption during this period was less, but the price changes within Indonesia were also
11 more moderate due to government consumption subsidies and trade barriers. Domestic
12 Indonesian cooking oil's downward price trend explains between 2% and 8% of per capita
13 palm oil consumption growth during this period.

14 **Substitution effects**

15 The impact of cross-price effects (changes in the prices of substitute commodities) on
16 Indonesian palm oil consumption is difficult to ascertain, because national price statistics
17 report 'cooking oil' prices rather than prices for unique oils such as coconut oil or palm oil.
18 What is clear is that substitution has been the primary cause of higher per capita palm oil
19 consumption in Indonesia. Palm oil's ascendance in Indonesian diets, as illustrated in figure
20 2, is equally a story of coconut oil's decline: as coconut oil consumption has declined, palm
21 oil consumption has increased. In 1965, the vast majority (98%) of Indonesian cooking oil

came from coconut with only a tiny amount (2%) coming from palm oil. In 1985 over half (54%) of cooking oil still came from coconut. Today, the situation is reversed: 94% of cooking oil comes from palm oil, with only 3% coming from coconut. The change in forty years has been dramatic.

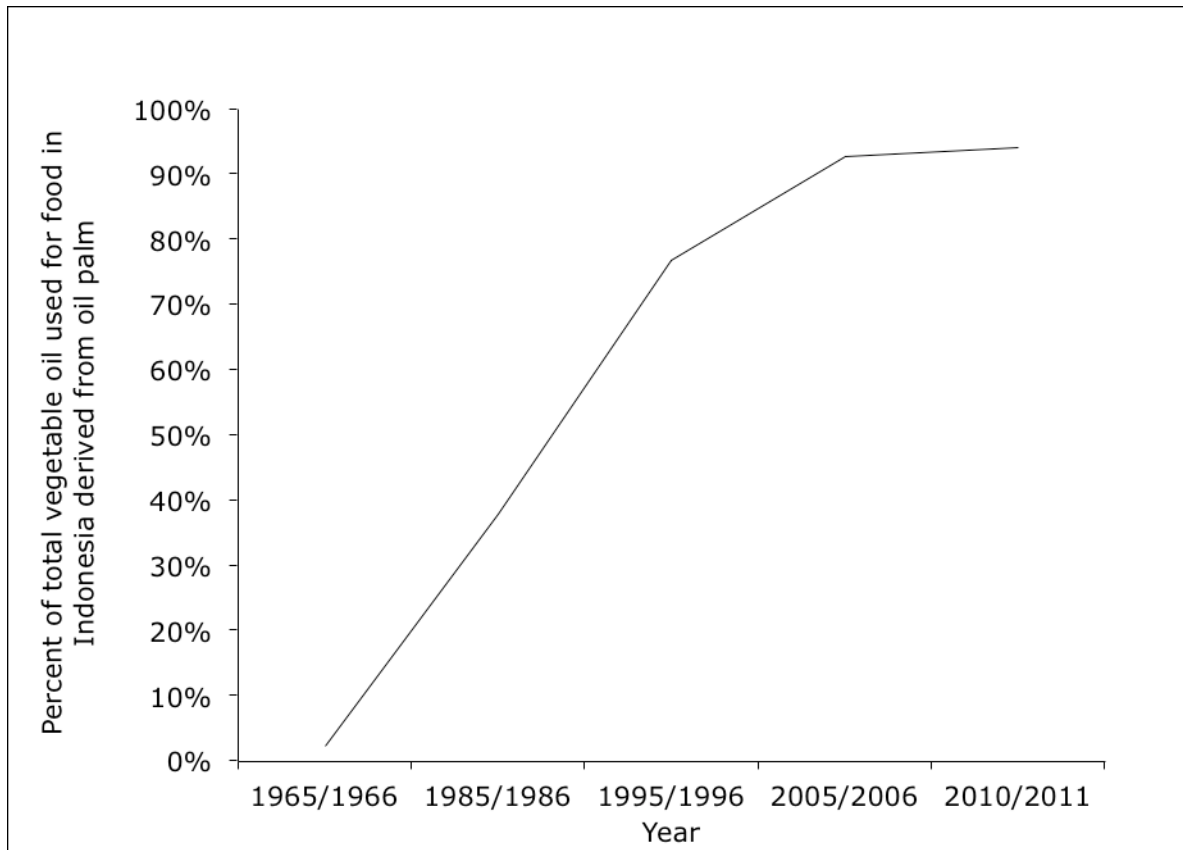


Figure 2. Palm oil has displaced coconut oil for cooking in Indonesia.

The solid line shows palm oil's share of the domestic cooking oil market growing, from 2% in 1965 to 94% in 2010. Coconut oil's share of total vegetable oil consumption declined from 98% to 3% over the same time period. Source: (USDA 2011)

The sizeable fraction of consumption growth that remains to be explained after accounting for higher incomes, urbanization, and falling prices is explained by substitution between coconut oil and palm oil. The impact of substitution on higher per capita palm oil consumption is

approximated by multiplying the change in palm oil's share of total vegetable oil consumption by the current level of vegetable oil consumption. This calculation is the difference between the current level of per capita palm oil consumption and the quantity that would be demanded if Indonesians consumed palm oil and other vegetable oils in the same proportions as they did historically. The shift towards palm oil, away from coconut oil, accounts for an impressive 70% of observed per capita palm oil consumption growth in Indonesia (see table 2) and more than half of total demand growth.

Table 2. Results of a partial equilibrium model explaining per capita palm oil consumption growth in Indonesia, 1985 - 2010.

Income elasticity = 0.8; Price elasticity = -0.5; Urban multiplier = 0.2. Source data: (USDA 2011) (Global Financial Data 2011) (World Bank 2010)

Variable	Attributed increase in palm oil consumption (kg/cap)
Palm oil price	0.6
Urbanization	1.0
Income growth	3.4
Substitution	12.4
Total observed increase, 1985-2010	17.6

What drove this substitution trend? Internationally, the relative prices of coconut and palm oil varied considerably during the 1970's and 1980's but did not trend strongly in a single direction, suggesting perhaps a weak role for international markets in the substitution process. In contrast to peanut oil and soybean oil that have become marginally more expensive relative to palm oil over time, with relative prices growing at 0.2% per year on average between 1985 and 2010 (Global Financial Data 2011), coconut oil has become slightly cheaper in

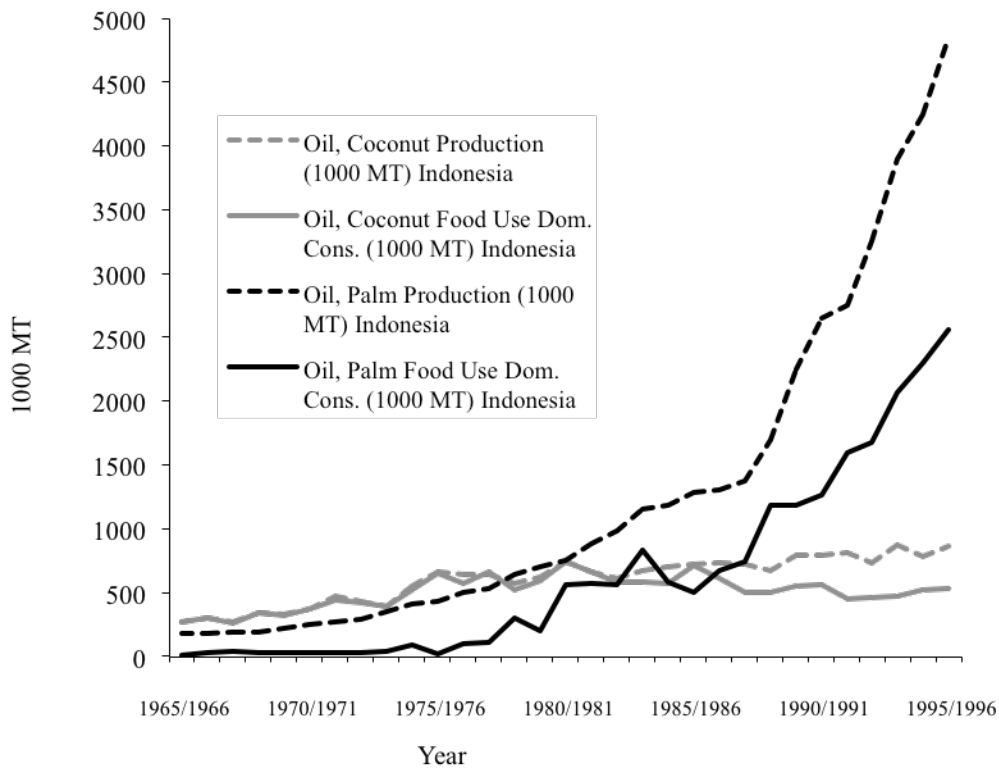
1 international markets relative to palm oil, with the international price falling relative to palm
2 oil at an average rate of 0.1% per year. Thus, changes in international prices do not easily
3 explain Indonesia's vegetable oil substitution process.

4
5 The conversion from coconut oil to palm oil in Indonesian diets – and in Indonesian
6 agricultural landscapes – can be explained by a set of political and economic factors
7 including: local production trends, international trading patterns, innovations in crude palm oil
8 (CPO) processing capacity, and a concerted national policy effort to change dietary
9 preferences and promote palm oil. This dietary conversion went hand in hand with changes in
10 who was farming cooking oil commodities and which types of land.

12 **POLICY AND TECHNOLOGY: A TALE OF TWO PALMS**

13 Cooking oil is one of Indonesia's nine 'essential' food commodities of which the government
14 obligates itself to ensure sufficient supplies. As a result, government policy controls
15 significant aspects of cooking oil production, marketing, and price formation in Indonesia.
16 Together, policy and market forces dramatically transformed Indonesia's cooking oil
17 landscape: from the late 1960's through the 1970's, Indonesia exported some palm oil and
18 was essentially self-sufficient in coconut oil, increasing its coconut oil production on par with
19 domestic consumption (see figure 3). Indonesians began consuming palm oil in the late
20 1970's and early 1980's; eventually, palm oil displaced coconut oil demand. By the mid

1 1980s, Indonesia was exporting coconut oil into the world market. Meanwhile, palm oil
2 production grew exponentially in Indonesia, permanently surpassing coconut oil production in
3 1982. Five years later, in 1987, palm oil consumption permanently surpassed coconut oil
4 consumption. Figure 3 details the rise of palm oil production and consumption, relative to
5 coconut oil, over time. Table 3 summarizes this transition in terms of three distinct phases and
6 the different policies that were active during each phase. Several political and technological
7 developments were crucial in allowing palm oil to outcompete coconut oil as Indonesia's
8 staple cooking oil.



9
10 **Figure 3. Palm oil versus coconut oil production and consumption in Indonesia.**
11 Palm oil, in black, has increased dramatically in terms of both production (dotted line) and
12 consumption (solid line). Coconut oil, in gray, has seen level production (dotted line) and
13 slightly declining consumption (solid line). Palm oil consumption permanently surpassed
14 coconut oil consumption in 1987. Source: (USDA 2011)
15

Table 3 Summary of Indonesia's vegetable oil transition.

Period	Before 1974	1974 – 1985	After 1985
Production trends	Self-sufficiency in coconut oil production (no coconut oil exports). Slightly less crude palm oil production, all of which was exported.	Palm oil production expands.	Indonesia becomes world's largest palm oil producer
Consumption trends	Only coconut oil	Becoming equal shares	Becoming mostly palm oil
Price and policy environment	Failed attempt (Repelita 1) to boost coconut oil production. Fractionation economics for palm oil become favorable in 1973.	Promotion of nucleus-estate schemes. Concerted government intervention in pricing and distribution.	Indonesia signs GATT in 1985. Tariff and quota structures favor coconut exports.

Early period, before 1974

Throughout the 1960's and 1970's, Indonesia produced enough palm oil to meet about 80% of its domestic cooking oil needs. Most of this production was exported in the form of crude palm oil (CPO). The lack of palm oil processing or imports for domestic consumption during this period is surprising in light of Indonesia's current appetite for palm oil and doubly surprising in light of the high price that coconut oil, if exported, would have fetched on the world market.

Part of the explanation for Indonesia's vegetable oil consumption patterns during this period was the organization of Indonesia's copra processing industry. Coconut oil consumption can

1 take two forms: Fresh nuts can be processed using minimal technology on the farm to produce
2 klentik oil; or, copra (dried coconut meats) can be processed at an industrial facility. Klentik
3 production is less efficient but was expanded because copra-processing factories on the island
4 of Java enjoyed a monopsony that effectively depressed farm-gate coconut prices.

5 Approximately equal shares of coconut production went to direct local consumption (either as
6 fresh coconut or klentic oil) and to copra production with the share of copra production rising
7 over time (Gwyer, & Avontroodt 1974) (p.84, Table 5). The low prices offered by copra
8 processors discouraged farmers from selling downstream to export markets and encouraged
9 local processing and consumption.

10 Coconut production was distributed across Indonesia's outlying islands on small farms
11 averaging 1.5 Ha in size (Gwyer, & Avontroodt 1974). These farms were minimally
12 productive: coconut production rose just enough to keep up with domestic consumption.
13 During Repelita 1 (1969 – 1974), Indonesia's first economic development plan, Indonesia's
14 government, with assistance from international donors, underwent an unsuccessful effort to
15 boost coconut production (World Bank 1985). The plan seems to have failed for several
16 reasons: coconut farmers were remote and hard to reach; new coconut trees that did make it
17 into the ground were often planted in unsuitable terrain; and the project had serious
18 management problems (World Bank 1985).

19 Despite coconut farms' remoteness and their minimal productivity, coconut farming remained
20 attractive to farmers because it was flexible in the face of drought or price shocks. Unlike oil
21 palm fruit, coconuts can be consumed on-farm in response to low market prices. In addition,

1 coconut farmers often multicrop with estate crops such as cocoa, clove, and coffee that have
2 complementary labor (and sunlight) requirements, a diversification strategy that serves to
3 minimize risk.

4 Palm oil, meanwhile, grew on large government-owned plantations and was exported rather
5 than consumed domestically. Exported palm oil took the form of crude palm oil rather than
6 refined, edible oil. Indonesia had minimal refining capacity: In 1974 there were four
7 fractionation plants in Indonesia that could separate liquid palm olein (used for cooking oil)
8 from solid palm stearin, possibly two of which were in operation. One factory had a capacity
9 of 9,000 tons of crude palm oil per year. These processing plants faced both management and
10 economic problems that kept them from being successful. Of the small amount (28,000 tons)
11 of palm oil that did not go to export, 15,000 tons went to solid baking fats and margarine
12 while the remainder went to soap (Gwyer, & Avontroodt 1974). In 1968, Indonesia's
13 government nationalized private estates in an attempt to capture a larger share of export
14 earnings. At the time, palm oil made up about 5% of total agricultural export earnings (Food
15 and Agriculture Organization (FAO) 2011).

16 Indonesia's vegetable oil system - marginally productive coconut oil for domestic
17 consumption, crude palm oil for export – was destabilized in 1973. At this time, a domestic
18 drought, coupled with a global soybean shortage that sent international coconut prices
19 soaring, caused Indonesia's domestic cooking oil price to spike. In an archipelago with
20 porous borders, strict export controls were ineffective at keeping domestic prices low. High
21 domestic cooking oil prices increased the profitability of domestic palm oil fractionation.

1 Exporting coconut oil while consuming palm oil domestically generated greater foreign
2 exchange savings.

3 Struggling to fill the domestic consumption gap for cooking oil, keep prices low, and avoid
4 importing coconut oil from the Philippines, Indonesia's government looked to palm oil
5 production. Palm oil was a prominent component of Indonesia's second planning period
6 (Repelita II), from 1974 – 1979, which focused on agricultural development, infrastructure,
7 and development in Indonesia's outlying islands. Thirty-five percent of the funds for this
8 development program came from foreign international sources, including the World Bank and
9 the Asian Development Bank.

10 **Middle period, 1974 - 1985**

11 The period from 1974 to 1985 saw a transformation in Indonesian diets as palm oil gained
12 acceptance as cooking oil – a change from the early 1970s, when Indonesia's palm oil exports
13 had been un-refined and unsuitable for cooking (palm oil was used domestically for some
14 soap and a tiny amount of margarine / solid fat consumption). As price increases for coconut
15 oil made palm oil refining economically more attractive, taste became the salient barrier:
16 Indonesians were not accustomed to eating palm oil. Indonesia's plantation ministry
17 advocated locally grown palm oil as a substitute for coconut oil (Chaudhuri 1994).
18 Simultaneously, aggressive production policies produced steady palm oil output growth on
19 new plantations, keeping prices low. A concerted ministry-sponsored palm oil marketing
20 effort, coupled with favorable economics, eventually succeeded, by the mid 1980s, in

1 bringing domestic palm oil consumption on par with coconut oil consumption while retaining
2 Indonesia's role as a significant palm oil exporter.

3 As domestic coconut oil demand grew in the 1970s, the government looked to palm oil as a
4 substitute in order to keep cooking oil prices low. Other vegetable oil candidates were not as
5 promising: palm kernel oil (PKO) shares more properties with coconut oil than palm oil does,
6 but PKO production quantities are smaller than those of palm oil and production costs are
7 higher. Peanut oil, which (unlike palm oil in the 1970s) already supplied a small amount of
8 cooking oil, had similar problems of scale. Rice-bran oil struggled not only with scale, but
9 also with rancidity and transportation challenges.

10 Palm oil, too, was not an easy consumption substitute for coconut oil. In order to achieve a
11 significant market share, palm oil had to overcome issues of taste, colour, fractionation, and
12 refining. At first, manufacturers blended palm oil with coconut oil or flavored the palm oil to
13 make it more palatable (Piggott et al 2010). Palm oil had to be refined from red to pale
14 yellow and deodorized to make it less different from coconut oil. Fractionation was also
15 critical because without fractionation, palm oil's semi-solid nature could remind consumers of
16 pork fat – not an attractive quality in a predominantly Muslim society. Refining was a
17 relatively expensive process; nevertheless both private and state-owned factories received
18 new investments. By 1981, Indonesia had approximately 1 million tons of fractionation
19 capacity of which half was utilized (World Bank 1985). Even after being refined and
20 deodorized, palm oil's yellow colour stood out. A government-funded marketing campaign
21 originated the name '*kencana*', Javanese for 'golden,' to make palm oil seem more familiar

1 and appealing to consumers. In addition, palm-based cooking oil was marketed to industrial
2 *krupuk* (cassava chips) manufacturers who were more sensitive to price and less sensitive to
3 appearances. Palm oil's frying properties proved to be tremendous in this regard, and palm oil
4 came to be considered of higher quality than locally-distributed coconut oil.

5 By 1981, Indonesia's 1.1 million ton domestic cooking oil market comprised a combination of
6 palm oil (39%), coconut oil (50%) and palm kernel oil (PKO) (11%). Some analysts at the
7 time believed that coconut oil's market share could not decline further due to the high demand
8 for fresh coconuts and the high lauric acid content of coconut oil which, analysts believed,
9 was necessary for cooking (World Bank 1985). In fact, the cross-elasticity between coconut
10 and palm oil appeared to stay high with increasing substitution, defying expectations.

11 Indonesia undertook large and sustained investments in tree crops during Repelita 3 (1979 –
12 1984), planting approximately 178 thousand new hectares of coconut and 121 thousand
13 hectares of new oil palm, again with World Bank assistance (World Bank 1985). Overall
14 agricultural investment was large, sustained, dominated by foreign capital, and focused on
15 tree crops more than food crops (World Bank 1992).

16 Palm oil production flourished during this period while coconut oil production stagnated.
17 Possibly, the absence of good cash-crop alternatives to oil palm kept smallholders producing
18 oil palm fruit, even at a relatively low farm gate price. In contrast, coconut producers had
19 cocoa, coffee, and the option of home consumption. Overall, the marginal production costs of
20 large palm oil estates were lower than the marginal production costs of smallholder coconut

1 farms. Indonesian palm oil production received a massive boost from the nucleus estate
2 scheme (NES) that began in 1977. NES had both a production objective - to boost output and
3 facilitate technological transfer - as well as the broader political-economic objectives of
4 developing land and settling transmigrants in Indonesia's outlying islands (Booth 1988).
5 Plantations under this scheme tended to be large: although there was a ban on foreign land
6 ownership and a legal limit on land holdings by Indonesians, estates could obtain permission
7 to use land that they did not 'own' (World Bank 1985). The scheme did promote some
8 smallholder development: Indonesia's first smallholder palm oil plantations were established
9 in 1978 under the NES; and, land titles for smallholders could be granted at the discretion of
10 the state-owned plantation company (PTP) (World Bank 1985) (p. 16). Still, by 1982
11 smallholders produced only 0.3 percent of total palm oil production (World Bank 1989). In
12 terms of land, palm oil plantations were 2% smallholder-owned, 28% private, and 70%
13 government-owned (World Bank 1985).

14 Coconut oil production did not benefit from a similar organizational transformation. Local
15 smallholders, who undertook only minimal new plantings, continued to dominate production,
16 accounting for 98 percent of planted area in 1982 (World Bank 1989). Between 1980 and
17 1985, the average age of coconut trees increased and production remained stable. In contrast
18 to oil palm, there were few new farms and new transmigrant farmers. Coconut production saw
19 some benefit from higher yielding hybrid seeds starting in 1979 (Piggott et al 2010), but
20 overall coconut production benefited less than oil palm from government support and
21 continued to operate at higher cost.

1 As a whole, palm oil exports nearly doubled through the late 1970s to four hundred thousand
2 tons before the government intervened in an effort to lower domestic prices and ensure
3 domestic availability of cooking oil, a key staple. Various types of export restraints were used
4 at different points in time, ranging from export taxes to export bans (World Bank 1985). In
5 general during this period, processors received monthly allocations of crude palm oil to
6 purchase from producers, who were required to sell at a fixed price. Then, palm oil was
7 distributed through a system of exclusive (and profitable) distribution rights. Locally
8 powerful distribution monopolies with special privileges from the government further
9 established palm oil as the dominant cooking oil (Peter Timmer, personal communication).

10 In 1978, the first year that the government regulated edible oil exports, 36% of total palm oil
11 production was explicitly allocated to the domestic market and the rest could be exported
12 (World Bank 1985). The following year, in 1979, government policy allocated 60% of palm
13 oil production to domestic use at below market prices (Piggott et al 2010). By 1981,
14 government requirements forced almost all palm oil onto the domestic market. Exports of
15 crude and refined palm oil remained restricted in 1983 to prevent price increases (Piggott et
16 al 2010). In 1984, Indonesia suffered \$369 million dollars in forgone export earnings due to
17 restrictions on palm oil exports (World Bank 1992). These export restrictions represented a
18 large implicit subsidy to domestic refiners at the expense of mostly state-owned plantations
19 and at the expense of smallholder farmers who produced the oil palm fruit.

20 Efforts to lower coconut oil prices depressed local production but failed to keep prices low for
21 consumers. In 1976, Bulog, the national logistics agency, imported copra and sold it at a loss

1 to decrease domestic prices (Piggott et al 2010). A shortfall of this approach was that
2 coconut processors (the majority of whom, by volume, were located on Java) had substantial
3 market power. Copra sold for \$140 at the farmgate price compared with a \$298 copra
4 equivalent price for cooking oil (World Bank 1985). Farm gate taxes on copra served to
5 further discourage coconut production.

6 **Current period, 1985 – present**

7 Between 1985 and 2010, palm oil came to dominate Indonesian vegetable oil production and
8 consumption. In recent years, government interventions in cooking oil markets have been
9 fewer, yet palm oil remains the chosen cooking oil for Indonesian consumers.

10 Tax structures in the late 1980s continued to favor domestic palm oil consumption. Palm oil
11 faced a 10% export tax in 1989 (Piggott et al 2010), plus quotas that forced palm oil onto the
12 domestic market at below-export prices (Piggott et al 2010). In July 1997, with palm oil
13 prices steady, the export tax rates were reduced, but the massive depreciation of the rupiah
14 against the U.S. dollar in late 1997 triggered explosive increases in the prices of cooking oil
15 and other basic commodities. In response, between November 1998 and March 1998, the
16 government tried and discarded several policies in quick succession: an informal quota;
17 selective export quotas; tariff rate quotas based on domestic sales; a three-month ban on palm
18 oil and olein; a broader temporary ban including crude palm oil, stearin and palm kernel oil;
19 and then an indefinite ban on CPO. These policies were variously plagued by smuggling,
20 reduced foreign exchange earnings, inefficiencies, and allegations of unfairness. Export taxes
21 for coconut oil were introduced to thwart smugglers who were circumventing the palm oil

1 export ban by disguising palm oil as coconut oil (Marks et al 1998). Finally, as part of an
2 agreement with the IMF, the government decided remove the export bans and to rely instead
3 on taxes not to exceed 20 percent. Initially, the ban was replaced by export taxes at high rates,
4 but these taxes were reduced over the course of the year, as the rupiah strengthened. Export
5 taxes for crude palm oil in May 2104 were 12%, with increasing pressure to lower tax rates to
6 incentivize value-added and to keep Indonesia's products globally competitive.

7 Indonesia's domestic processing capacity grew, although it remained highly concentrated. In
8 1989, a single conglomerate controlled 45% of the licensed capacity for fractionation and
9 refining (World Bank 1989). Malaysia had subsidized palm oil refineries as part of its
10 industrial strategy, stunting Indonesia's domestic capabilities. Indonesia had only a small
11 handful of processing factories in 1974, even fewer of which were in operation. By 1981,
12 Indonesia's CPO processing capacity had grown to one million tons; by 1997 it was 2.4
13 million tons; and by 2006, processing capacity had risen to more than 29 million tons⁸
14 (Gwyer, & Avontroodt 1974) (Indonesian Palm Oil Board 2008) (World Bank 1985).

15 Despite unfavorable export policies during this period, palm oil production surged. The palm
16 oil plantings undertaken starting in 1984 as part of Repelita 4 were 'the most ambitious ever
17 attempted for these crops in the world' (World Bank 1985). At the end of the campaign,
18 Indonesia boasted 18% of world production of 5.5. million tons with a low-age distribution of
19 trees (World Bank 1992). As the trees matured, yields increased. Including smallholders,

⁸ Capacity figures for 1997 and 2006 represent actual CPO use and are therefore minimum estimates of installed capacity.

1 however, remained challenging. Private estates that replaced government PTPs in the
2 transmigration program had even less interest in smallholder welfare. Recent evidence
3 suggests that contract farming on nucleus-estate schemes is dominated by households with
4 greater asset endowments and is unlikely to benefit poor smallholders (Cahyadi 2013).

5 The dramatic change in the composition of domestic vegetable oil production and
6 consumption that took hold in the 1980s persists today. Substitution towards palm oil has
7 even reached Indonesia's outlying islands where home-produced klentic oil used to be the
8 dominant oil. In the Ujung Padang area of South Sulawesi, palm oil's market share went from
9 zero in 1986 to 60% in 1996. In the 1970s, this area had approximately 20 factories making
10 coconut oil from fresh coconuts or copra; in 1996 there were only six factories, of which three
11 produced refined cooking oil and three produced crude coconut oil. Coconut cooking oil
12 factories on Indonesia's outlying islands, as on Java, struggled to improve quality and keep
13 prices competitive as the world prices for their raw materials (coconuts, copra, and crude
14 coconut oil) increased and as palm export taxes kept domestic palm oil prices low.

15 **Future consumption growth**

16 That so much of Indonesia's historical palm oil consumption growth has come from
17 substitution away from other oils suggests that Indonesia's future palm oil consumption will
18 grow more slowly. Over 90% of Indonesian vegetable oil⁹ now comes from palm oil, leaving
19 very little coconut oil (or other oil) to be replaced in Indonesian diets. Going forward, any
20 increase in palm oil consumption will come from higher overall vegetable oil consumption,

⁹ Used for food

1 rather than substitution. Substitution among vegetable oils accounted for half of Indonesia's
2 growth in palm oil consumption between 1985 and 2010. In the future, palm oil consumption
3 growth will therefore be less than half as large given (1) the lack of further substitution
4 possibilities and (2) declining consumption elasticities for vegetable oil (3) lower rates of
5 population and income growth.

6 As population growth slows, as income growth slows, and as the income elasticity of palm oil
7 consumption falls, overall vegetable oil consumption will grow more slowly. Lower
8 vegetable oil consumption growth implies lower palm oil consumption growth. Table 4
9 shows annualized rates of palm oil consumption growth between 1985 and 2010 along with
10 simulated growth rates between 2010 and 2035 under both a baseline and a high-growth
11 scenario. In the baseline model, Indonesian palm oil consumption, which grew 9.4% p.a., on
12 average, over the past twenty-five years, is likely to grow by 2.9% p.a. between 2010 and
13 2035. This estimate assumes constant prices, no urbanization effect, constant vegetable oil
14 shares (no further substitution towards palm oil), and population and income growth
15 predictions in line with USDA (2010) estimates. The high-growth model simulates higher
16 income growth (4.5% p.a.), higher population growth (1.07%), and falling real palm oil prices
17 (-2.0% p.a.). Under this scenario, palm oil consumption grows at 3.8 % p.a., a stronger
18 growth rate but still far from the 9.4% annual growth rate that Indonesia experienced between
19 1985 and 2010.

20 Even at slower rates of growth relative to the past 25 years, Indonesia's total palm oil
21 consumption in 2035 will be at least double that of 2010. Some of this increased consumption

1 will be met through yield increases, for example through replacing existing oil palm trees with
2 higher-yielding clones as plantations are replanted (typically every 25 years). Still, a doubling
3 of palm oil demand over 25 years suggests that pressure to convert currently forested land into
4 palm oil production will continue to be substantial throughout Indonesia.

5 At the global scale, cooking oil consumption patterns in China and India -- vastly different
6 from Indonesia's trends -- are critical to the palm oil industry. China had just 5% of its
7 cooking oil from palm oil in 1985 and today still has only one fifth of its cooking oil from
8 palm oil. India is the world's largest palm oil consuming country despite the fact that only
9 44% of its vegetable oil consumption is from palm. An increase in this share increase due to
10 changes in trade policy or other factors would substantially affect global palm oil demand. In
11 addition, non-food uses for palm oil have the potential to upend the current structure of oil
12 markets. The potential demand for palm-based biodiesel, at a favorable price, is practically
13 infinite: palm-based biofuels, in the case where diesel prices or government mandates provide
14 adequate production incentives, would lead to a different qualitative conclusion about the
15 future of palm oil demand. Palm oil has demonstrated its viability relative to coconut oil over
16 the past twenty-five years; in the next twenty-five years, will palm oil prove to be more viable
17 than crude oil? Whereas food consumption policies have been critical to palm oil markets in
18 the past, energy policies may define palm oil demand -- and patterns of agricultural
19 development -- in the future.

20 CONCLUSION

1 Indonesia's conversion from coconut oil to palm oil - in both diets and production emphasis -
2 has had far reaching consequences. During the 1970s and 1980s, smallholders produced the
3 majority of coconuts whereas oil palm grew on large plantations with much higher yields per
4 hectare. The displacement of coconut oil by palm oil in Indonesian diets and in Indonesian
5 agricultural landscapes has boosted agricultural productivity. Indonesia is now the world's
6 largest palm oil producer with oil palm companies contributing approximately 3 dollars to
7 Indonesia's economy for every dollar of profit (Hunt 2010). Indonesia's ongoing challenge is
8 to balance economic growth and efficiency with agricultural policies that benefit smallholders
9 and the poor. As the palm oil industry grows and globalizes, other countries can learn from
10 Indonesia's experience how to harness the nutritional and economic benefits of this industry
11 while minimizing the social costs.

12

Table 4 Historical and predicted palm oil consumption.

	Value, 2010	Compound annual growth, 1985 - 2010	Value, 2035 Baseline ^b	Compound annual growth, 2010-2035, Baseline ^b	Value, 2035 High Estimate	Compound annual growth, 2010-2035, High Estimate
<i>Variable estimates</i>						
Population (millions) ^a	230	1.40%	285	0.87%	300	1.07%
Income per capita (yr 2000 USD) ^a	1124	3.50%	3085	4.12%	3380	4.5
Palm oil price (real USD) ^c	486.12	-2.00%	486	0%	293	-2%
Urbanization rate ^d	52.60%	2.80%	52.6	0%	52.6	0%
Fraction of vegetable oil from palm ^e	94.19	3.70%	94.19	0%	94.19	0%
<i>Parameter estimates</i>						
Income elasticity	0.8	-	0.5	-	0.6	-
Price elasticity	-0.5	-	n.a.	-	-0.5	-
Urban differential	1.2	-	1	-	1	-
<i>Simulation results</i>						
Palm oil consumption (kg per capita)	20.66	7.90%	34.4	2.06%	40.3	2.71
Palm oil consumption (total tonnes, thousands)	4750	9.40%	9804	2.94%	12090	3.81%

^aPopulation and income growth estimates are informed by (USDA ERS, 2010).

^bBaseline projection assumes constant prices, no urban consumption differential, no substitution between oils, and an income elasticity of 0.5.

^c (Global Financial Data 2011) ^d (World Bank 2010) ^e (USDA 2011)

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