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International prices for teak

Historical and current, and price forecasts

Guillermo A. Navarro
Rodolfo J. Vieto Morales

Centro Agronómico Tropical de Investigación y Enseñanza, CATIE
Programa de Bosques, Biodiversidad y Cambio Climático
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Acronyms

AARPC:	Average annual rate of price change
ARPC:	Average rate of price change
CATIE:	Centro Agronómico Tropical de Investigación y Enseñanza / Tropical Agricultural Higher Education and Research Center
CIF:	Cost, insurance and freight (price). The price of a good delivered at the importing country.
CPI:	Consumer price index (in this study “All consumers price index”)
FAO:	Food and Agriculture Organization of the United Nations.
FOB:	Free on board (price). The price charged to deliver at the exporting country’s shipping port.
ITTO:	International Tropical Timber Organization
MUV:	Manufacturers unit value (index)
USD:	USD:United States dollars

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1 Introduction

Between 1994 and 2000 several global wood supply studies were conducted by academia, consultants or international organizations. Most of them concluded that industrial roundwood needs will be properly supplied, by year 2050, in large proportion by plantation wood with no foreseen real price increase for wood fibers (Nilsson and Bull 2005). However, as mentioned by the authors, since those studies were completed, many market and non-market conditions and assumptions have strongly changed. These changed conditions are setting warnings for important wood supply unbalances, demanding an updated global wood supply analysis.

This study has been prepared by CATIE, as a request from ECOS, as an exploratory study on teak prices. The report is based on the information available from organizational reports and internet sites; it is valid only as an internal reference, since it only summarizes the evidence found. CATIE does not take responsibility for business and investment decisions based on the information offered.

Quality controlled data received from Steve Johnson and Fran Maplesden, from ITTO, is sincerely acknowledged. Rigoberto Aguilar, from the Commemorative Orton Library IICA/CATIE, is also acknowledged for his help during the data acquisition process.

1.1 General objective

Investigate both current and historical price behavior for teak wood in the international market, in respect to other tropical fine/hard woods, and make price forecasts.

1.2 Specific objectives

- Investigate price evolution for hard/fine tropical wood logs in the international market, both in general and for teak specifically. Determine price growth trends for different spans (last 10, 20, 30, 40 and more years, if possible). Trends will be expressed in constant 2009-USD. Price data series for natural forest and plantation wood will be analyzed, separately.
- Investigate historical and current international market prices for plantation teak logs by diameter class, mainly for Asian markets. FOB prices will be expressed in in USD/m^3.
- Obtain log price growth trends based on historical data, and forecast plantation teak log prices. Provide literature-supported recommendations on future price behavior.

2 Methods

2.1 Historical price evolution

- Historical price information was obtained from FAO's Forestry Papers (# 23, 38, 46, 95, and 125) and Bebarta (1999). Electronic format data published by ITTO's Tropical Timber Market Reports was directly obtained from them.
- All price data from different sources, currencies and wood volume measurement units was standardized to FOB prices in USD/m^3.
- Several consulted sources show historical data in plain graphical format, constraining the process of good quality data gathering. Some professional and inter-institutional links were contacted, but only ITTO shared an important batch of information that greatly helped in a time consuming database building process.
- ITTO has been improving data quality controls, and they seem to have filtered the SG-3 logs price data. For this reason it was excluded from this study.
- From 1997, teak average prices were calculated for five different log qualities: Veneer 4th, SG-1, SG-2, SG-4, and SG-6. The resulting values fit well the average trend of the data available from India and Thailand.
- It was not possible to find teak prices for the period 1991-1996. For that reason, prices were interpolated from SG-3 and SG-4 graphical data offered by Centeno (2001). However, due to log qualities, the level of prices were lower than average. Nevertheless, as the price behavior of all log qualities is consistent (Figure 9), it was fair enough to proportionally level up the prices to average levels.
- Historical data includes prices in current USD. This data was later converted to constant 2009-USD. For this purpose, two different indexes were tested: the "all US consumers price index" (CPI), and the "manufacturers unit value index" (MUV[1]), as provided by the World Bank.
- Constant 2009-USD were calculated according to Klemperer (1996).
  First, the average annual inflation rates (f) were calculated for every year (multiple periods from year 0 to year "n"), using the considered indexes, according to the following equations: $f_n = \sqrt[n]{CPI_n \div CPI_0} - 1$ and $f_n = \sqrt[n]{MUV_n \div MUV_0} - 1$, where "n" is the number of years in the period.

[1]"This index is generally accepted as a proxy for the price of developing country imports of manufactures in US dollar terms…" "The index is a weighted average of export prices of manufactured goods for the G-5 economies (United States, Japan, Germany, France, and the United Kingdom), with local-currency based prices converted into current US dollars using market exchange rates."

Second, the constant 2009 dollar prices were calculated using these average annual inflation rates (f_n) as follows: $\text{Constant Price}_n = \text{Current Price}_n \div (1+ f_n)^n$, where "n" is the number of years in the period, and f_n is the calculated average annual inflation rate for the period from year 0 to year "n".

- The price growth rates—average annual rates of price change (AARPC) —where obtained from best fit linear regressions by species and group of species with the following equation: $[\sum_{N}^{i=0}(m \div P_i)]/N$, where "m" is the linear regression slope in USD a year; P_i is the linear regression calculated price for year i, and "N" is the total number of years in the period of analysis.
- Current and constant USD values were drawn together only for Asian and African species, as well as for the initial teak figures. After that, all figures and analyses are elaborated with constant 2009-USD.

2.2 International log prices

- Current international market prices for plantation teak logs by diameter class were mainly obtained from internet sites (vorras.net, alibaba.com, woodbusinessportal.com and madera.fordaq.com); historical plantation data was gathered from published reports (Navarro *et ál.* 2005, Pérez 2005, Buvaneswaran 2005). Confidential sources contributed valuable data too.
- Log-price data includes characteristics such as log length from 2.2 to 11.8 meters, and the use of girth and diameter measurements. Although girths are obtained from perimeters measured at log mid lengths, they were transformed and used as small diameters.
- With the obtained data, best fit linear regressions were achieved for every diameter class. A couple of important missing points (one for each 10-20 cm, and 70-80 cm diameter class) were estimated with best fit linear regressions calculated transversally across diameter classes at specific moments in time, as well as for different periods.
- Not enough data, or no data at all was available for the 50-60 cm and the 60-70 cm diameter classes. However, the corresponding forecasts were based on the calculated regressions and assumptions explained latter.

2.3 Price forecasts

Both the annual price change rates and the price change rates across diameter classes produced average, maximum and minimum values. These values were combined to generate different forecast scenarios.

3 Results

3.1 Historical price evolution

3.1.1 Asian timber

The historical price behavior for the Asian fine timber species is offered in Figure 1. This figure shows evident differences in relation to 1993 prices as reported by Centeno (2001), as well as prices reported by ITTO. After the late 90's—especially from year 2003 and on—, when the Asian economic crisis took place, these species experienced interesting price increases. As noticeable, price increases showed an inverted relationship among species. That is to say, meranti, balau and selangan batu log prices were historically below kapur's and keruing's; nonetheless, from 2003 this relationship inverted.

Figure 1. Average FOB prices and price trends (1973-2009) in current US$ for Asian fine wood logs, by species

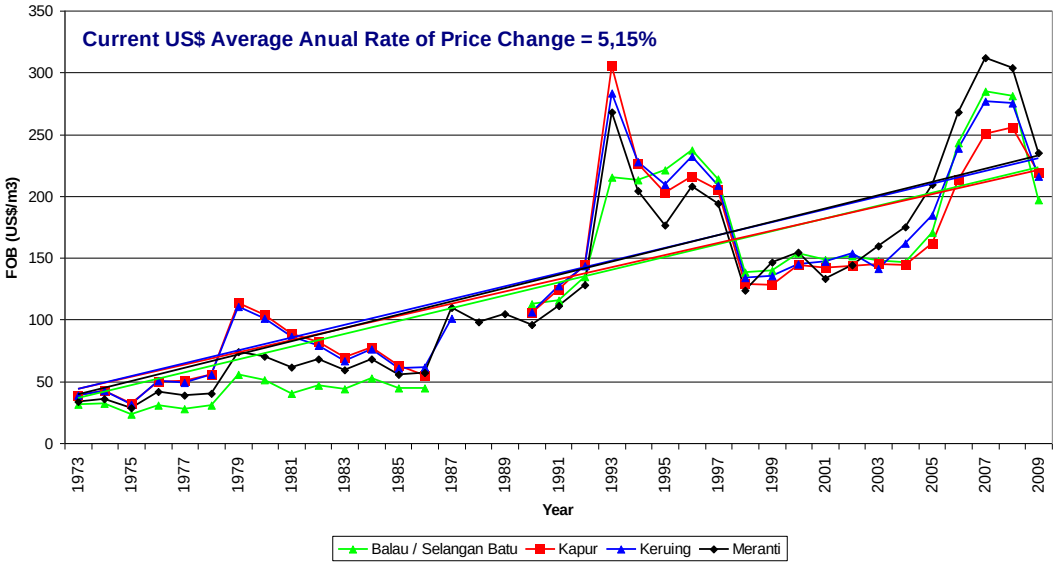

Figure 1. Average FOB prices and prices trends (1973-2009) in current US$ for Asian fine wood logs, by species
Sources: FAO forestry papers; ITTO's Tropical Timber Market Reports
Balau *(Shorea maxwelliana)* Selangan batu y meranti (*Shorea* sp.) Kapur (*Dryobalanops* sp.) Keruing (*Dipterocarpus* sp.)

The resulting average annual rate of price change (AARPC) is lower than Centeno's (7.5%). This difference is explained by a strong price decreasing trend at the end of the period of analysis, in response to the international financial crisis, and the fact of having adjusted the

regression equations to known initial positive prices (positive b –intersection– values in y=mx+b). Although using a different base year than Centeno (2009 versus1990) in constant US dollars price calculations, the AARPC results are perfectly comparable among the two studies. As shown in Figure 2, the AARPC for Asian hardwoods is, as expected, minimal and smaller than Centeno's (2.91%).

Figure 2. Average FOB prices and price trends (1973-2009) in current and constant 2009 US$ for Asian fine wood logs

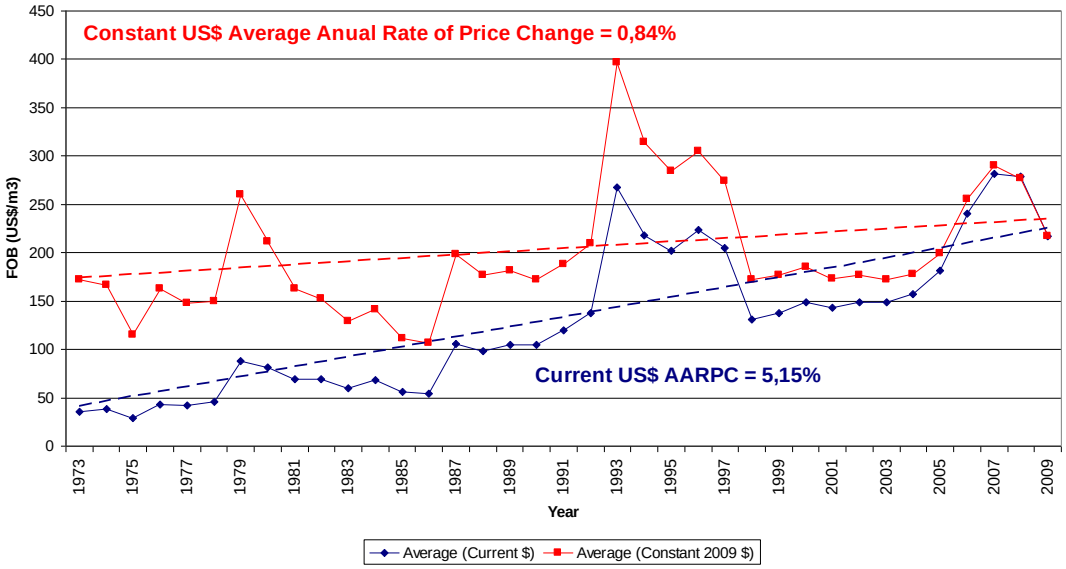

Figure 2. Average FOB prices and prices trends (1973-2009) in current and constant 2009 US$ for Asian fine wood logs
CPI source: www.bls.gov

3.1.2 African timber

Comparing figures 1 and 2 to figures 3 and 4, it is observed that the Asian species' AARPC is larger than that of the African species. This explains why, even if the initial (1973) prices of African fine woods more than doubled (100+% larger) those of Asian fine woods, currently, 36 years later, these prices are just about 35% larger.

Figure 3 shows the okoume prices losing value respect to iroko's and sapeli's from 1996, with a recovery trend from 2006. Although, its price trend gets below the prices of Asian species.

Figure 3. Average FOB current prices and price trends (1963-2009) in current US$ for African fine wood logs, by species

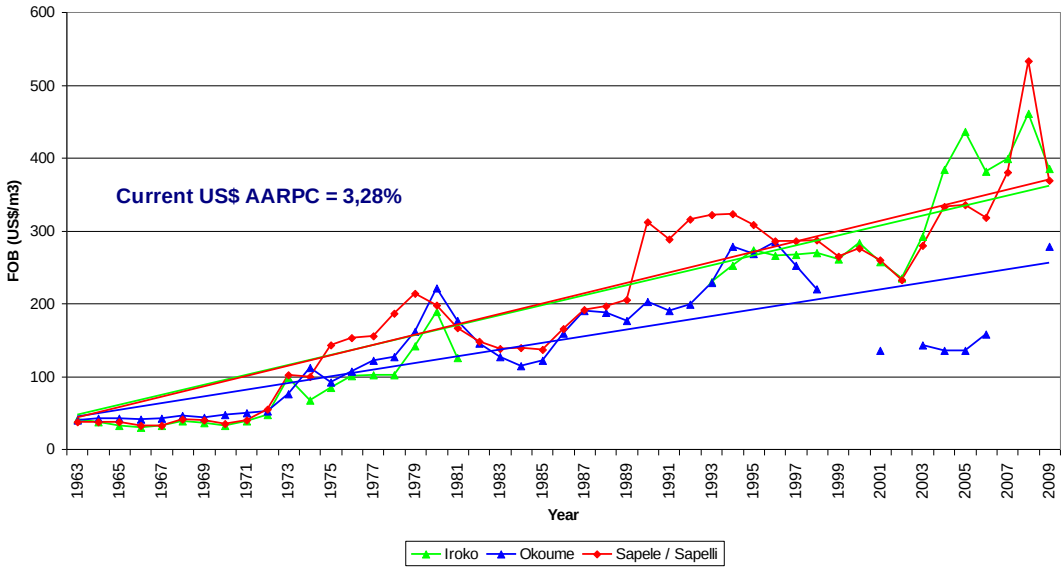

Figure 3. Average FOB current prices and price trends (1963-2009) in current US$ for African fine wood logs, by species
Sources: FAO forestry papers; ITTO's Tropical Timber Market Reports
Iriko *(Milicia excelsa)* Okoume *(Aucoumea klaineana)* Sapele/sapelli *(Entandrophragma cylindricum)*

3.1.3 Teak (natural forest)

Teak is naturally distributed in several countries in Southeast Asia, but historical FOB price data was only found for India, Thailand and Myanmar. As Centeno (2001) explains, the historical price data for India and Thailand was interrupted in 1990 (Figure 5), due to imposed export bans in both countries. International average natural forest log teak prices show increasing current USD prices, with the most drastic historical pattern change to fast decreasing prices starting in 2007 (Figure 5).

From the data in Figure 5, Figure 6 presents current USD average prices, as well as the constant 2009-USD prices calculated for both the MUV and the CPI indices. Because they are more conservative, the results obtained with the CPI are preferred. Henceforth, the constant USD values are to be calculated only with the CPI.

Figure 5. Average FOB prices in current US$ for natural forest Teak logs, by country of origin

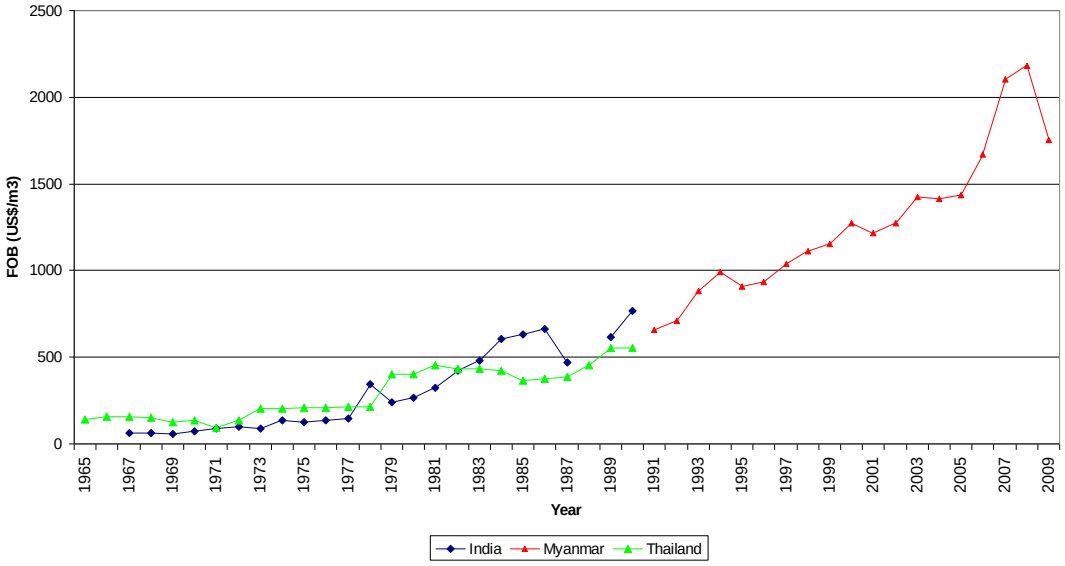

Figure 5. Average FOB prices in current US$ for natural forest teak logs, by country of origin
Sources: FAO forestry papers; ITTO's Tropical Timber Market Reports; Centeno (2001)

Figure 6. Average FOB prices in current and constant 2009 US$ for natural forest Teak logs, using the Consumers Price Index (CPI) and the Manufacturesrs Unit Value (MUV)

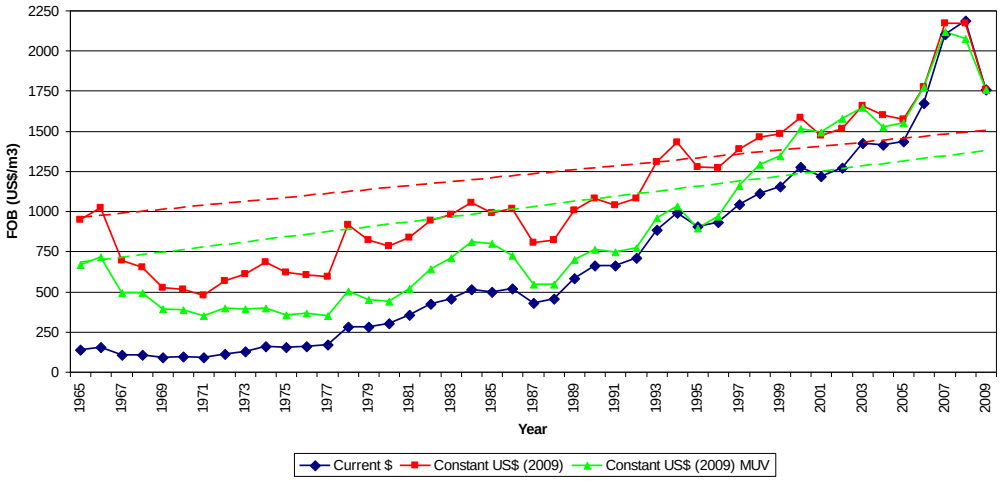

Figure 6. Average FOB prices in current and constant 2009 US$ for natural forest teak logs using the CPI and the MUV
Sources: CPI: www.bls.gov; MUV: econ.worldbank.org

Considering 14 more years in the calculations, both current and constant average annual rates of price change are slightly smaller than Centeno's (5.67% vs. 1.31%, respectively) (Figure 7). From 1997, the calculation of average teak prices included a low-quality class (SG-6) and three higher-quality log classes (veneer 4th, SG-1 and SG-2). The latter showed lower AARPC's; by contrast, from 2004 the low-quality log class (SG-6) showed a very high AARPC (Figure 9). This fact, coupled with the sharp reduction in the historical price of teak in the international market—as a consequence of the financial crisis—explained the low annual average rates in price change. In addition, further rates for shorter periods (from 1 to 4 previous decades) were calculated as of 2009 (Table 1).

Figure 7. Average FOB prices and price trends (1965-2009) in current and constant 2009 US$ dollars for natural forest Teak logs

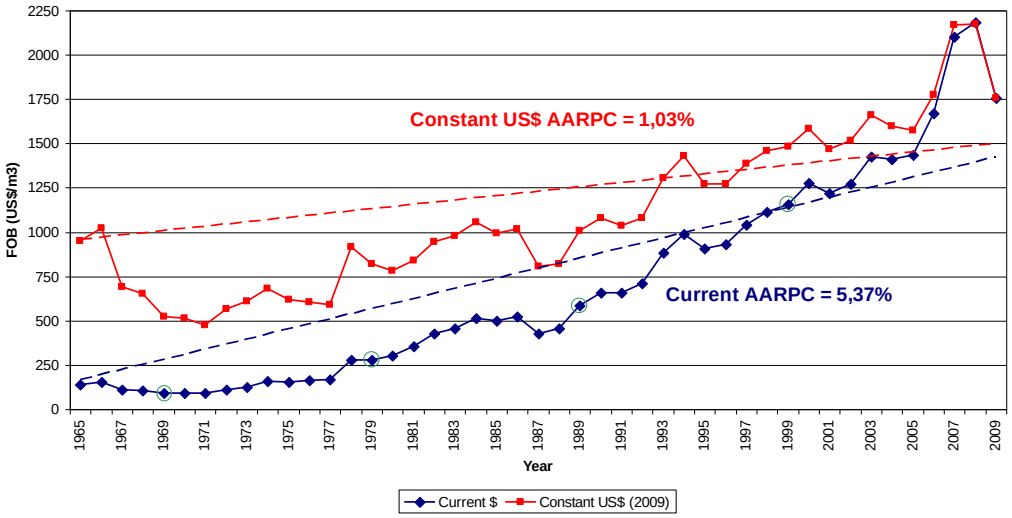

Figure 7. Average FOB prices and Price Trends (1965-2009) in current and constant 2009 US$ for natural forest teak logs

Table 1. Annual rates of price change for natural forest teak logs, for different periods of analysis, in current and constant 2009-USD

Period	Avg. ARPC*	Max. ARPC	Min. ARPC
Current USD (%)			
1965-2009	5.37	20.45	2.05
1969-2009	7.40	39.13	2.35
1979-2009	6.02	16.25	2.77
1989-2009	5.62	10.21	3.36
1999-2009	4.75	6.04	3.77
1999-2007	6.90	9.46	5.11
Constant 2009-USD (%)			
1965-2009	1.03	1.30	0.83
1969-2009	3.02	5.80	1.75
1979-2009	2.58	3.87	1.79
1989-2009	3.15	4.37	2.33
1999-2009	2.45	2.78	2.17
1999-2007	3.76	4.46	3.18

*The average values are not arithmetic but weighted averages, reason why they are skewed.

For the current USD AARPC, the maximum and minimum values show large variation ranges, while the constant 2009-USD ranges are, proportionally, much smaller. The current USD AARPCs show decreasing price growth rates for shorter periods of analysis. That is to say, the price growth rates are reduced as we approach 2009. This effect has a twofold explanation: a) that these AARPCs are calculated from best fit linear regressions (figures in Appendix A), and b) that from 1969 on, the price trend is more linear (straight), with progressively stronger negative influence on the averages due to the price fall at the end of each period of analysis. If an arithmetic approach had been followed, in the case of the current USD prices, these rates would have been calculated based on lines drawn from the circled prices (green circles) in Figure 7, to the 2009 price. This approach would have yielded always increasing rates of price change.

The 1999-2007 period of analysis was included to observe the price trend behavior before the international financial crisis; which was high in terms of current USD, and the highest in terms of constant 2009-USD. For current USD prices, the rates had a continuously decreasing trend while for constant 2009-USD prices these rates showed a cyclic behavior with a peak in 2007.

The constant 2009-USD price behavior summary for Asian and African hard/fine woods and teak from natural forest is shown in Figure 8. As evident, the real prices of teak have steadily increased in the long run, while the Asian and African species prices have grown very little. Since the early 70's, the real prices of teak have more than tripled those of the Asian and African species. Figure 9 shows the consistent (constant USD) price behavior among different natural forest teak log qualities from Myanmar.

Figure 8. Average FOB prices in constant 2009 US$ for Teak, Asian and African fine wood logs

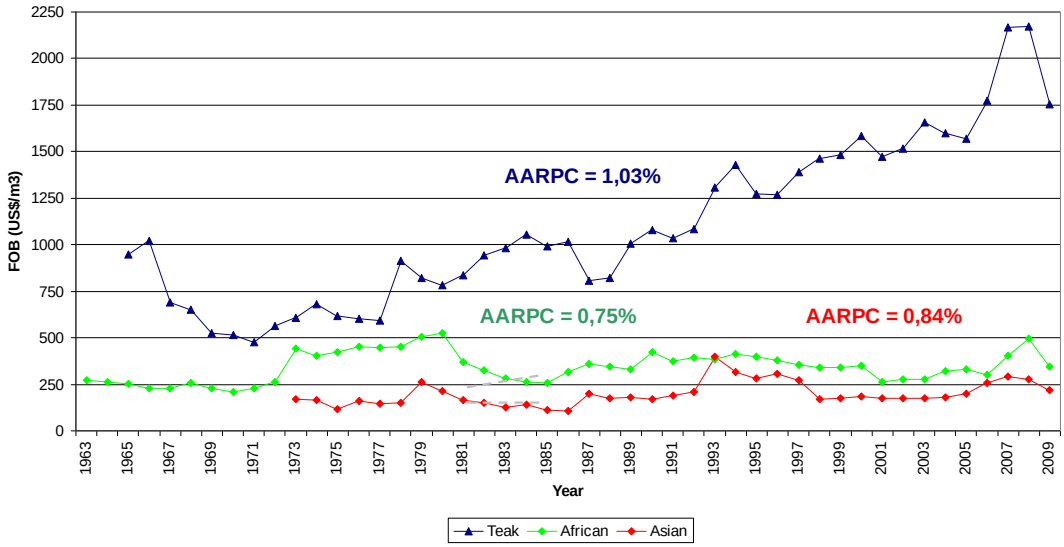

Figure 8. Average FOB prices in constant 2009 US$ for teak, Asian and African fine wood logs

Figure 9. Average FOB prices in constant 2009 US$ for different qualities of Myanmar's natural forest Teak logs

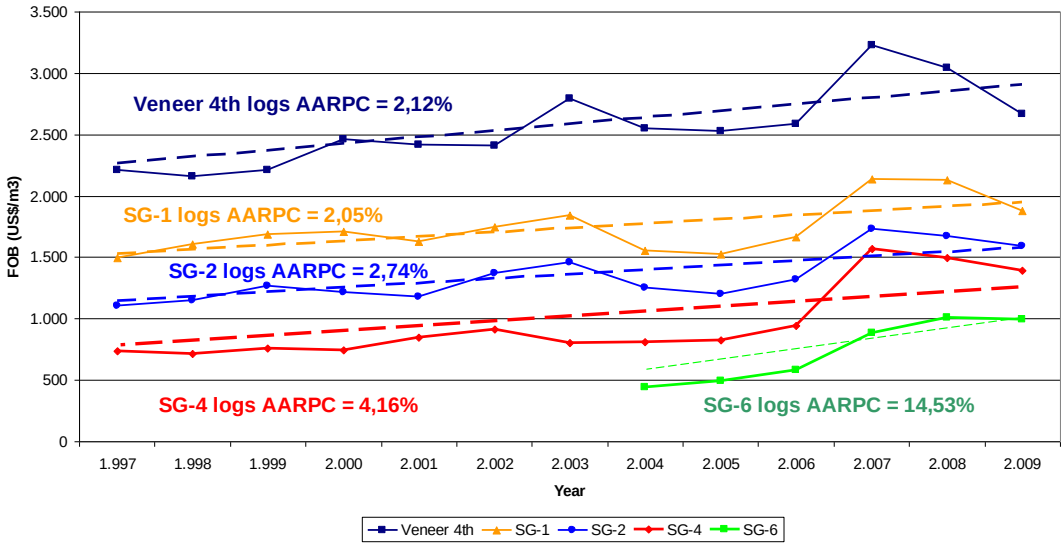

Figure 9. Average FOB prices in constant 2009 US$ for different qualities of Myanmar's natural forest teak logs

Figure 4. Average FOB prices and price trends (1963-2009) in current and constant 2009 US$ for African fine wood logs

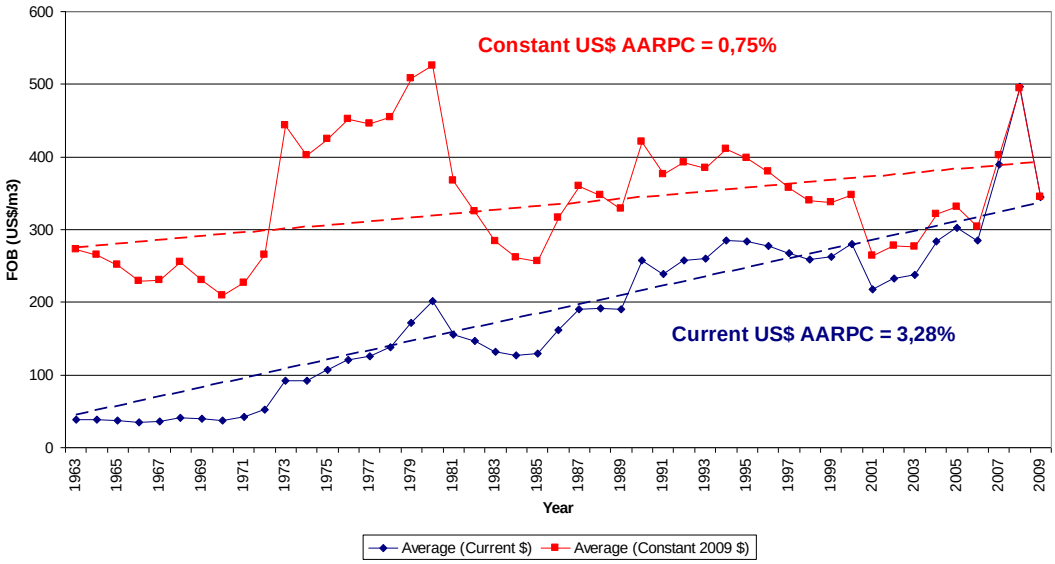

Figure 4. Average FOB prices and price trends (1963-2009) in current and constant 2009 US$ for African fine wood logs
CPI source: www.bls.gov

3.2 International log prices (plantation teak)

The average plantation prices per year and country calculated from the available data (202 observations) are shown in Figure 10. Most of these international prices count on diameter class data attached to them, but it was not possible to complete time series (historical) data for the different diameter classes by country of origin—that would be a very ambitious objective. Most of the available price observations correspond to the years 2009, 2004 and 1998.

Figure 10. Average FOB prices in constant 2009 US$ for plantation Teak logs, by year and country of origin

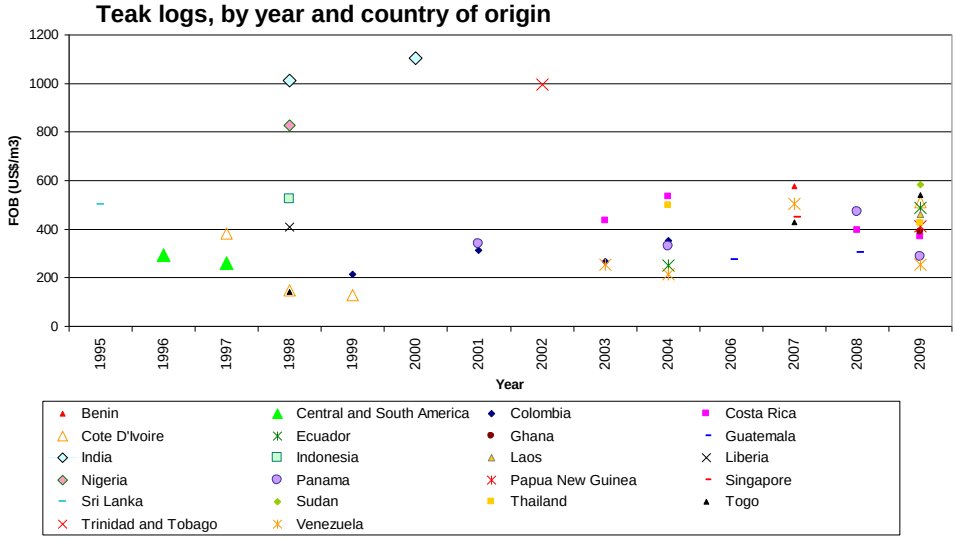

Figure 10. Average FOB prices in constant 2009 US$ for plantation teak logs, by year and country of origin

Linear regressions were fitted pulling together the data from the Latin American countries. Following the same approach in data treatment, average price calculations were made for plantation teak logs from Asian and African countries. Figure 11 was obtained from overlapping averages on Figure 10.

Figure 11. Average FOB prices in constant US$ 2009 for plantation Teak logs, by year and country of origin

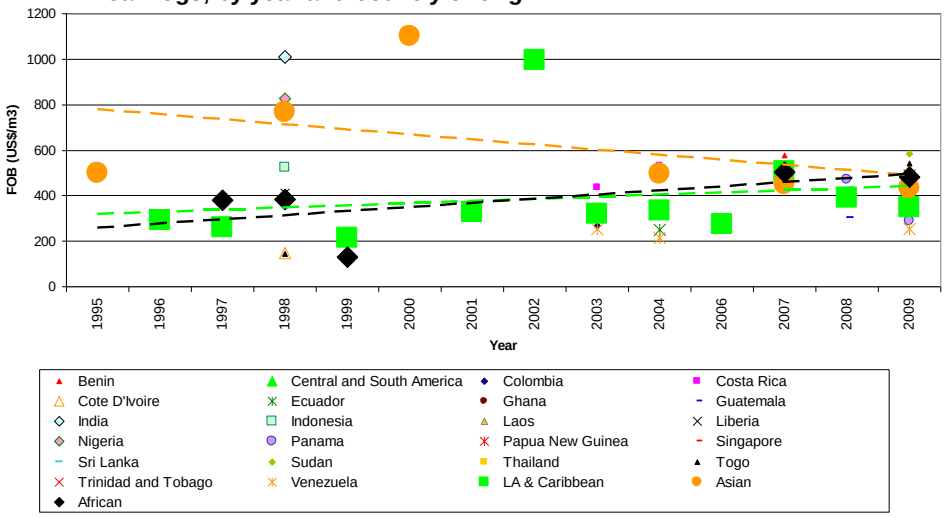

Figure 11. Average FOB prices in constant US$ 2009 for plantation teak logs, by year and country of origin

Linear regressions for regional average data were only obtained to illustrate middling levels of constant USD FOB prices by geographical region. The corresponding regression lines in Figure 11 depict a higher value given to Asian plantation teak, while African and Latin American prices compete very closely. Larger distances from Latin American countries to the Asian market will be reflected in CIF prices; so, a relative higher value or preference may be assumed for Latin American teak, respect to the African.

According to price data from ITTO and in agreement with Centeno (2001), the lowest Myanmar's logs export grade would be SG-4 (sawing grade 4) with a minimum length of 2.4 m, and a minimum diameter of 40 cm. SG-5 and SG-6 prices are now being reported (SG-6 since 2004); the first one corresponds to assorted logs and the second to "domestic market quality".

For teak plantation to reach average diameters of 40 cm, rotations from 20 to 30 years are required, depending on site quality, genetic material and management. Assuming these sorts of rotation lengths for most teak plantation investments, it may be expected that under current market conditions, plantation teak prices are facing a roof at the level of SG-4 log prices (Centeno 2001).

From Figure 12 it may be concluded that, up to now, for Latin American plantation teak logs, such price roof for 20 to 30 years plantation teak logs could be considered not very conservative, given that the 70 to 80 cm diameter class is currently below the SG-6

(domestic) log prices. The linear regression equations illustrated in Figure 12, calculated for Latin American teak logs, are presented with more detail in Figure 13.

Figure 12. Average FOB prices and trends (1997-2009) in constant 2009 US$, for Latin American Plantation Teak logs, by diametric class (cm), compared to Myanmar's SG-4's and SG-6's

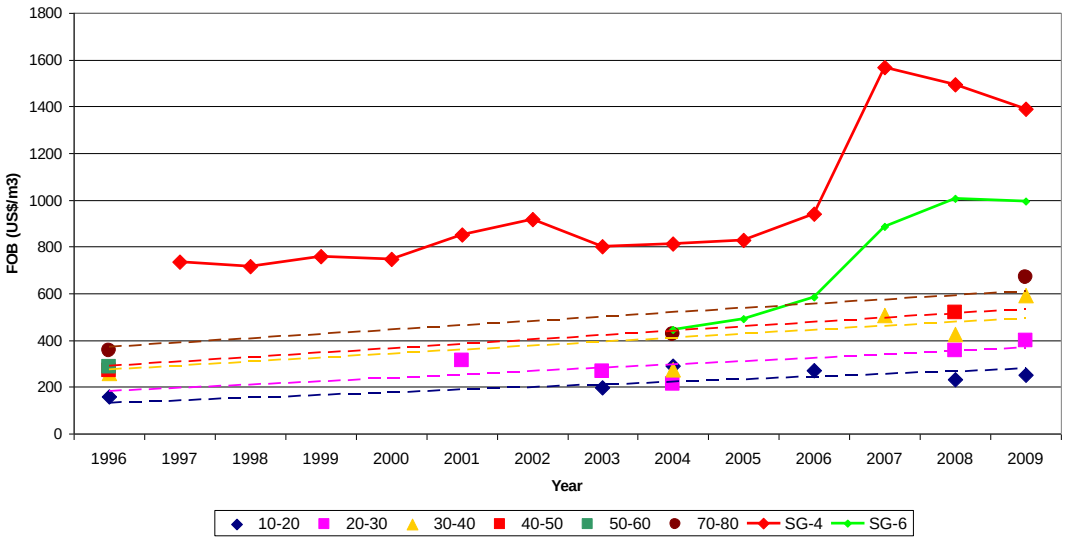

Figure 12. Average FOB prices and trends (1997-2009) in constant 2009 US$, for Latin American plantation teak logs, by diameter class (cm), compared to Myanmar's SG-4 and SG-6

Figure 13. Average FOB prices and trends (1997-2009) in constant 2009 US$, for Latin American Plantation Teak logs, by diametric class (cm)

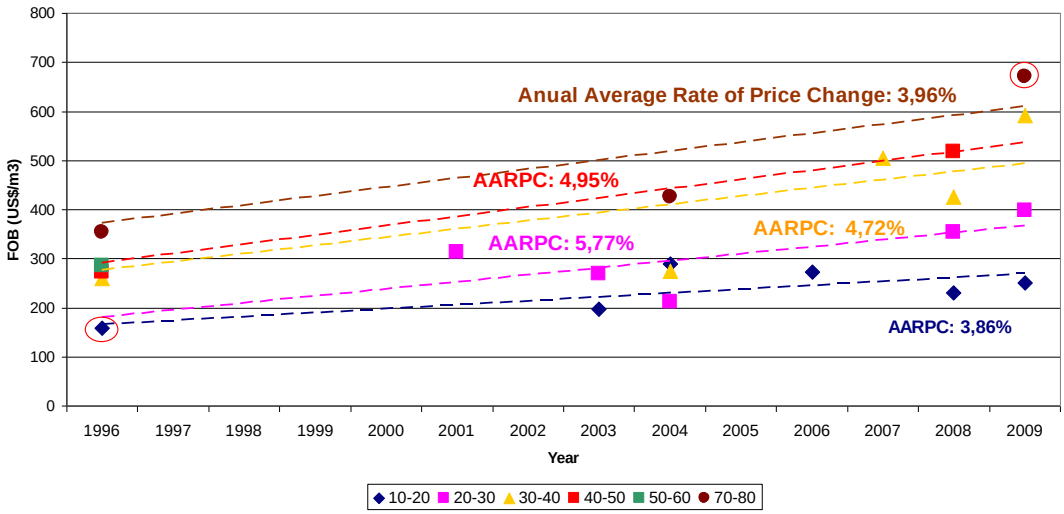

Figure 13. Average FOB prices and trends (1997-2009) in constant 2009 US$, for Latin American plantation teak logs, by diameter class (cm)

The values circled in red (Figure 13) were calculated from the regressions obtained for price changes in time among diameter classes. Four different time horizons were defined according to data availability (1996, 1996-2009, 2001-2009, 2006- 2009). The indicated values were calculated with the 1996 and 2006-2009 regressions, respectively. Conversely, Table 2 summarizes the average, maximum and minimum ARPC calculated from the linear regressions obtained for each diameter class.

Table 2. 1996-2009 Annual rates of price change for Latin American (plantation) teak logs, by diameter class

Diameter class (cm)	Avg. ARPC (%)	Max. ARPC (%)	Min. ARPC (%)
10-20	3.86	5.00	3.03
20-30	5.77	8.50	4.04
30-40	4.72	6.48	3.52
40-50	4.95	6.89	3.63
70-80	3.96	5.15	3.09
General average	4.65	5.77	3.86

Avg. average Max. maximum Min. minimum

Plantation log prices in Table 2 show larger AARPCs than natural forest teak log AARPCs in Table 1 (a top value of 3.76% for 1999-2007 in constant 2009-USD). However, the natural forest SG-4 logs showed an AARPC of 4.16% (Figure 9), which is close to the general average in Table 2.

There was insufficient data to fit linear regressions for the 50-60 and 60-70 cm diameter classes. However, the price forecasts will include these diameter classes with few data points estimated (as shown in Figure 13) with the linear regressions calculated transversally among diameter classes (Figure 14).

Figure 14. Average FOB price trends within diametric classes for different time periods in constant 2009 US$, for Latin American Plantation Teak logs

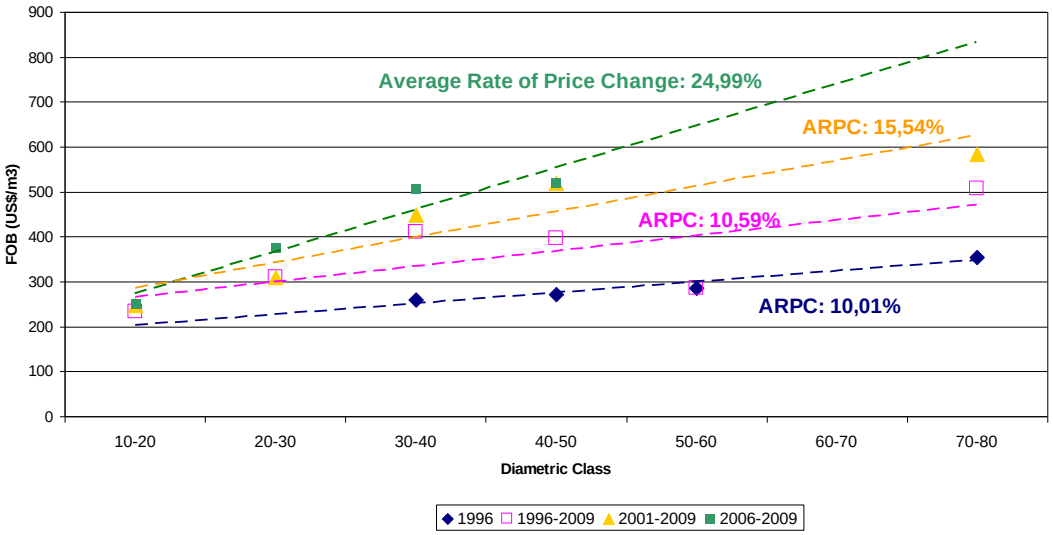

Figure 14. Average FOB price trends within diameter classes for different time periods in constant 2009 US$, for Latin American plantation teak logs

The obtained regressions show a directly proportional relationship between time and the ratio high/low diameter class log prices. That is to say, the value of logs from higher diameter classes has been increasing proportionally over time. The average rate of price change through diameter classes (10-20 through 70-80 cm) has increased from 10.01% in 1996 to 24.99% in 2009. Table 3 summarizes the average, maximum and minimum average rates of price change obtained for the linear regressions calculated transversally among diameter classes under different time frames.

Table 3. Rates of price change for Latin American (plantation) teak logs, among diameter classes for different time frames

Time frame (year or period)	Avg. ARPC (%)	Max. ARPC (%)	Min. ARPC (%)
1996	10.01	13.54	7.47
1996-2009	10.59	14.57	7.77
2001-2009	15.54	24.73	9.96
2006-2009	24.99	51.50	12.59
General average	15.28	24.99	10.01

3.3 Price forecasts

Combining the general average rates of price change in tables 2 and 3, nine possible forecast scenarios could be generated (Table 4). From these, scenarios 1, 5 and 9 were chosen to obtain minimum, average and maximum price increase forecasts (Tables 5 to 7).

Table 4. Rates of price change assumptions for each price forecast scenario for Latin American (plantation) teak logs

Price forecast scenario	Min. Avg. Max. ARPC (% by diameter class)	Min. Avg. Max. ARPC (% among diameter classes)
1	3.86	10.01
2		15.28
3		24.99
4	4.65	10.01
5		15.28
6		24.99
7	5.77	10.01
8		15.28
9		24.99

Table 5. Latin American (plantation) teak log FOB price forecasts by diameter class for the period 2009-2015, under minimum price increase assumptions (Scenario # 1*)

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	250.00	275.03	300.05	325.08	350.10	375.13	400.15
2010	259.65	285.64	311.63	337.62	363.61	389.60	415.60
2011	269.30	296.26	323.21	350.17	377.13	404.08	431.04
2012	278.95	306.87	334.80	362.72	390.64	418.56	446.49
2013	288.60	317.49	346.38	375.27	404.16	433.04	461.93
2014	298.25	328.10	357.96	387.81	417.67	447.52	477.38
2015	307.90	338.72	369.54	400.36	431.18	462.00	492.82

* AARPC= 3.86%; ARPC= 10.01%

Table 6. Latin American (plantation) teak log FOB price forecasts by diameter class for the period 2009-2015, under average price increase assumptions (Scenario # 5*)

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	250.00	288.20	326.40	364.60	402.80	441.00	479.20
2010	261.63	301.60	341.58	381.55	421.53	461.51	501.48
2011	273.25	315.00	356.76	398.51	440.26	482.01	523.77
2012	284.88	328.40	371.93	415.46	458.99	502.52	546.05
2013	296.50	341.81	387.11	432.42	477.72	523.03	568.33
2014	308.13	355.21	402.29	449.37	496.45	543.53	590.61
2015	319.75	368.61	417.47	466.32	515.18	564.04	612.90

* AARPC= 4.65%; ARPC= 15.28%

Table 7. Latin American (plantation) teak log FOB price forecasts by diameter class for the period 2009-2015, under maximum price increase assumptions (Scenario # 9*)

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	250.00	275.03	300.05	325.08	350.10	375.13	400.15
2010	264.43	290.89	317.36	343.83	370.30	396.77	423.24
2011	278.85	306.76	334.68	362.59	390.50	418.41	446.33
2012	293.28	322.63	351.99	381.35	410.70	440.06	469.42
2013	307.70	338.50	369.30	400.10	430.90	461.70	492.50
2014	322.13	354.37	386.61	418.86	451.10	483.35	515.59
2015	336.55	370.24	403.93	437.62	471.30	504.99	538.68

* AARPC= 5.77%; ARPC= 24.99%

In the scenarios above, the assumed base price was the corresponding to the 10-20 cm diameter class for 2009 (250 USD). That value was just below the 251.76 USD average value observed for the period 2006-2009. All other values (through time and diameter classes) are calculated from the linear regressions obtained.

Tables 8 through 10 summarize the results for the same scenarios. In these cases, some of the 2009 prices were calculated from the 2006-2009 observed averages (bold font in the table).

Table 8. Latin American (plantation) teak log FOB price forecasts from 2006-2009 observed and estimated initial prices, by diameter class for the period 2009-2015 under minimum price increase assumptions (Scenario # 1*)

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	**251.76**	**376.66**	**507.76**	**518.51**	570.41	622.31	674.21
2010	261.48	391.20	527.36	538.52	592.43	646.33	700.24
2011	271.19	405.74	546.96	558.54	614.44	670.35	726.26
2012	280.91	420.28	566.56	578.55	636.46	694.37	752.29
2013	290.63	434.82	586.16	598.56	658.48	718.40	778.31
2014	300.35	449.36	605.76	618.58	680.50	742.42	804.34
2015	310.07	463.90	625.36	638.59	702.52	766.44	830.36

* AARPC= 3.86%; ARPC= 10.01%

Table 9. Latin American (plantation) teak log FOB price forecasts from 2006-2009 observed and estimated initial prices, by diameter class for the period 2009-2015 under average price increase assumptions (Scenario # 5*)

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	**251.76**	**376.66**	**507.76**	**518.51**	597.73	676.96	756.19
2010	263.46	394.18	531.37	542.62	625.53	708.44	791.35
2011	275.17	411.69	554.98	566.73	653.32	739.92	826.52
2012	286.88	429.21	578.59	590.84	681.12	771.40	861.68
2013	298.58	446.72	602.21	614.95	708.91	802.88	896.84
2014	310.29	464.24	625.82	639.06	736.71	834.36	932.00
2015	322.00	481.75	649.43	663.17	764.50	865.83	967.17

* AARPC= 4.65%; ARPC= 15.28%

Table 10. Latin American (plantation) teak log FOB price forecasts from 2006-2009 observed and estimated initial prices by diameter class for the period 2009-2015 under maximum price increase assumptions (Scenario # 9*)

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	**251.76**	**376.66**	**507.76**	**518.51**	648.08	777.66	907.23
2010	266.28	398.39	537.06	548.42	685.48	822.53	959.58
2011	280.81	420.13	566.36	578.34	722.87	867.40	1011.92
2012	295.34	441.86	595.66	608.26	760.26	912.27	1064.27
2013	309.86	463.60	624.95	638.18	797.66	957.14	1116.62
2014	324.39	485.33	654.25	668.10	835.05	1002.01	1168.97
2015	338.92	507.06	683.55	698.01	872.45	1046.88	1221.31

* AARPC= 5.77%; ARPC= 24.99%

Complementarily, figures 15 (data in tables 10, B2a and B4a, Appendix B) and 16 (data in tables 10, B2b and B4b, Appendix B) illustrate the forecast scenarios 3, 6, and 9. All these scenarios assume a rate of price change among diameter classes of 24.99%, which is the rate of price change observed among diameter classes for the period 2006-2009. The changing assumption is the AARPC, which is presumed the same for all diameter classes in each scenario: 3.86%, 4.65% and 5.77%, for scenarios 3, 6 and 9, respectively.

In Figure 15, the even distribution between the 2009 prices is the result of being estimated under the ARPC = 24.99% assumption. The assumed price for the 10-20 diameter class is 250 USD/m3. This price is just the rounded up value for the 2006-2009 average price (251.76 USD/m3).

Figure 16 illustrates the same rate of price change assumptions but, in this case, the 2009 prices are average 2006-2009 observed prices for the four lowest diameter classes. The prices for the three highest diameter classes are estimated from the 40-50 cm diameter class value (the highest diameter class observed average price). The 30-40 and 40-50 cm diameter classes show very similar 2009 average prices.

The first four diameter classes (with observed average initial prices) show a similar behavior than the ones in Figure 15. Although, the three highest diameter classes, when comparing to the levels in the sample data (figures 10 and 11), look possible but too enthusiastic. Results for additional (secondary) forecast scenarios are included in the Appendix B.

Figure 15. Average FOB prices (1997-2009) in constant 2009 US$, and average, minimum and maximum forecast price trends (2009-2015) for Latin American Plantation Teak logs, by diametric class (cm), using estimated prices for 2009

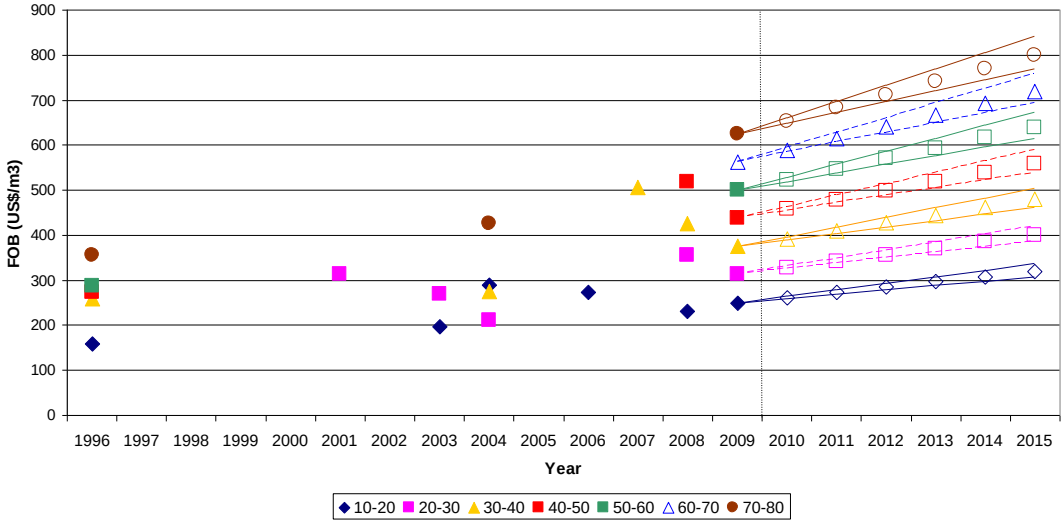

Figure 15. Average FOB prices (1997-2009) in constant 2009 US$, and average, minimum and maximum forecast price trends (2009-2015) for Latin American plantation teak logs, by diameter class (cm), using estimated prices for 2009

Figure 16. Average FOB prices (1997-2009) in constant 2009 US$, and average, minimum and maximum forecast price trends (2009-2015) for Latin American Plantation Teak logs, by diametric class (cm), using average and estimated prices for 2009

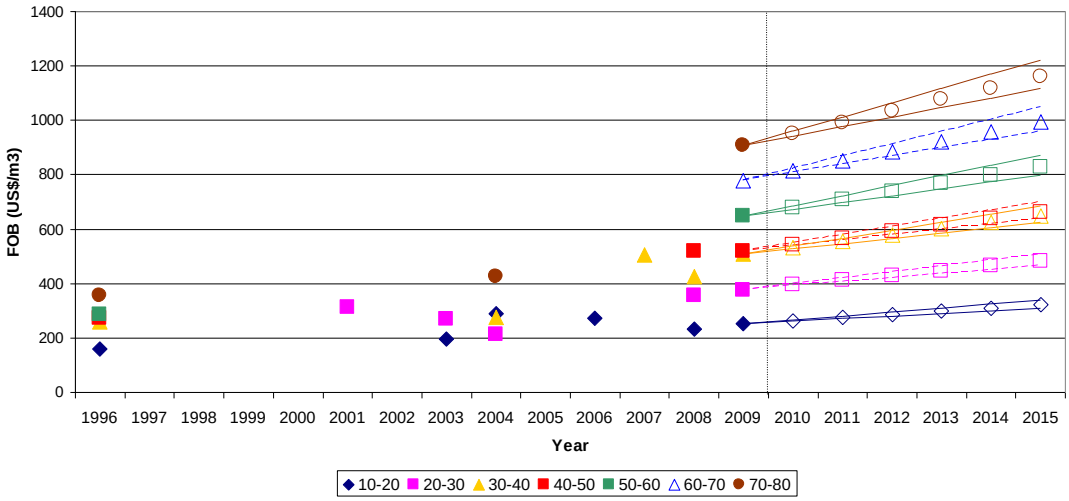

Figure 16. Average FOB prices (1997-2009) in constant 2009 US$, and average, minimum and maximum forecast price trends (2009-2015) for Latin American plantation teak logs, by diameter class (cm), using average and estimated prices for 2009

3.4 Safe price forecasts

Different positions are found about possible future wood market scenarios. For example, Clark (2001) takes a conservationist sector position, stating that *"No evidence was found of increasing real prices for wood over the long-term, indicating that there is no looming global wood shortage."*

On the other hand, the teak reforestation market has offered, in the past, controversially high returns with negative consequences for responsible reforestation initiatives. There are many factors that will influence future price trends; Nilsson and Bull (2005) suggest that objective projections require an updated world wood supply analysis. Nevertheless, this is out of the scope of this exploratory study.

However, our study provides evidence that reinforces the analysis offered by Nilsson and Bull on the important changes[2] occurred to the underlying assumptions of prior world wood supply analyses. It is supposed that future real prices of teak will recover to growing trends. At which rate is not clear, but paraphrasing Centeno's (2001) suggestion, there is enough evidence to believe that, at least in the mid run, teak will continue being to other timbers what gold is to other metals.

[2] Booming consumption in emerging economies / increased illegal logging / over harvesting of existing forest capital in important supply countries / over enthusiasm for plantation supply / a downward trend in available supply in important supply regions / changes in climate and changing demands on the forest where environmental concerns are a significant factor / increasing rate of natural disturbances that is reducing the forest capital / rapid technological and biotechnological developments (Fenning and Gershenzon 2002) / more efficient industrial processes / increasing competition for wood fibers between the energy industry and the traditional forest industry / increased use of recovered paper / shifts in the number and composition of populations / etc.

4 Conclusions

4.1 Historical price evolution

- The data available on international wood historical prices is scattered and, much of it, in non-user-friendly formats. On behalf of future studies, the source data for most graphics found on the web should be made available, especially by international institutions with such mandate.
- ITTO's efforts on data quality control reveal possible bad quality data from different sources.
- Although Asian hard/fine wood logs have shown historically lower international prices than their African pairs, the Asian species annual rates of price change have been higher. This has allowed a historical recovery of Asian over African species. In this manner, okoume (African species) has shown international prices below those of the Asian species for close to four years.
- Using different base years in constant USD price calculations do not invalidate comparisons between resulting annual average rates of price change.
- Constant 2009-USD calculated from all consumers price index (CPI) were preferred over those calculated from manufacturers unit value (MUV), because of the first one resulting in more conservative values.
- For strict comparison purposes with Centeno (2001), it would have made sense to use the same SG-3 and SG-4 log prices he used. However, the SG-3 data was not made available by ITTO, as they are implementing data quality controls. This data was also filtered in publications like Keogh (2008). Even when we could recover information from ITTO's monthly publications, it was decided not to use quality log prices.
- The current financial crisis caused the worst drawback in up to date international teak price history.
- Contrary to the expected results from an arithmetic approach, the linear regression method to calculate the AARPC of natural forest teak prices resulted in decreasing values for shorter (closer to 2009) periods of analysis. This effect has a twofold explanation: that these AARPCs are calculated from best fit linear regressions, and that from 1969 on, the price trend is more linear (straight), with progressively stronger negative influence on the averages due to the price fall at the end of each period of analysis.

4.2 International log prices

- Because of private interests, plantation teak data is very heterogeneous in product characteristics, and scattered in time and geographically (country wise).
- The assumption of mid length log diameter (calculated from girth values) as the smallest log diameter underestimates product prices and, in consequence, becomes a conservative decision.
- Comparing African with Latin American international (plantation) teak log prices, the second ones seem to enjoy advantages.

- Evidence from this study suggests that, under current market conditions, (natural forest) SG-4 international log prices seem a reasonable price roof for international (20-30 year rotation) Latin American plantation teak prices. Although, evidence also suggests that this may be a conservative assumption, as SG-6 log prices are still over the Latin American plantation available prices.
- The average rate of price change by diameter class, for logs from Latin America, shows a directly proportional relationship between time and the high/low price ratio by diameter class. That is to say, the value of logs from higher diameter classes (10-20 through 70-80 cm) has been increasing proportionally over time, from 10.01% in 1996 to 24.99% in 2009.

4.3 Price forecasts

- Available data and supplementary calculations yielded consistent results in the average annual rates of increase in prices for plantation teak.
- Including different quality log prices in natural forest teak log average price calculations does not affect any assumption in the construction of forecast scenarios. The rates of price change in these scenarios were obtained from plantation logs data.
- For comparison purposes between both natural forest and plantation log prices, it is recommended to choose SG-4 logs; which are considered the roof for international plantation log prices; in fact, SG-4 logs show very similar AARPC to those of plantation logs obtained separately.
- The obtained teak plantation general average annual rates of price increase are above the general averages for natural forest logs, except for those of the SG-4 logs. This AARPC seem to validate the annual average rates assumed in the construction of forecast scenarios.
- The AARPC for plantation logs are obtained from evidence found up to date. Future trends are not possible to objectively be forecasted on the basis of this exploratory study.
- General average values were combined in the construction of forecast scenarios. This may be considered another conservative decision.
- Common knowledge suggests that forecast scenarios based on average AARPC and ARPC (Table 4) imply safe enough “optimistic” assumptions (Figure 15, Table 10, Appendix B (B2a and B4a).

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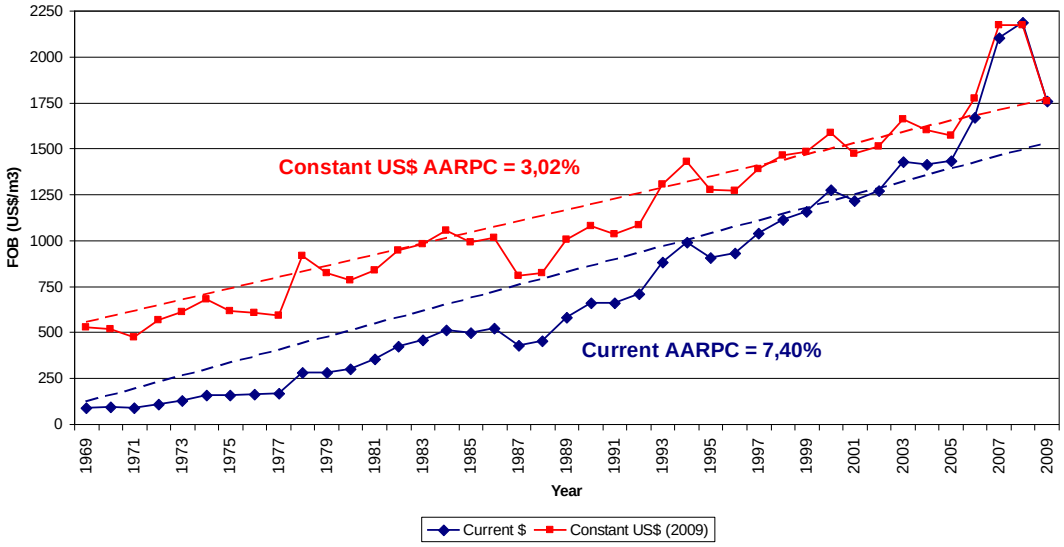
Appendix

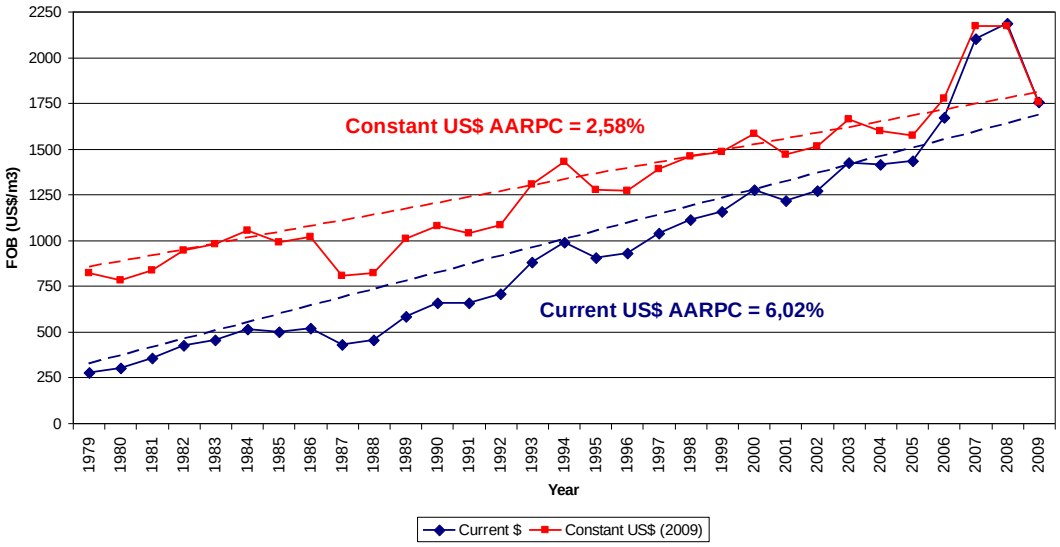
Appendix A. Figures for the additional periods of analysis of price behavior for natural forest teak logs

Average FOB prices and price trends (1969-2009) in current and constant 2009 US$ for natural forest Teak logs



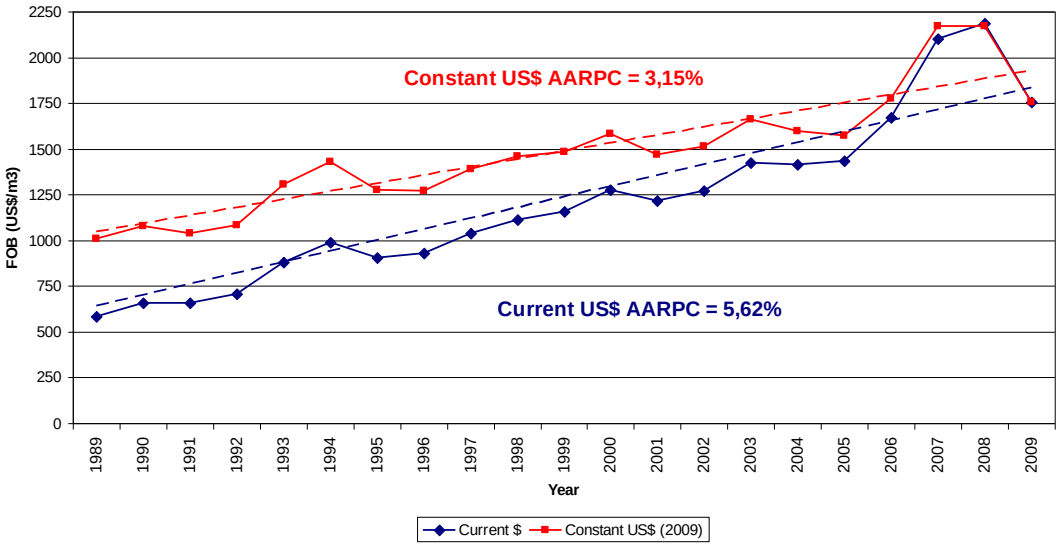
Average FOB prices and price trends (1969-2009) in current and constant 2009 US$ for natural forest teak logs

Average FOB prices and price trends (1979-2009) in current and constant 2009 US$ for natural forest Teak logs



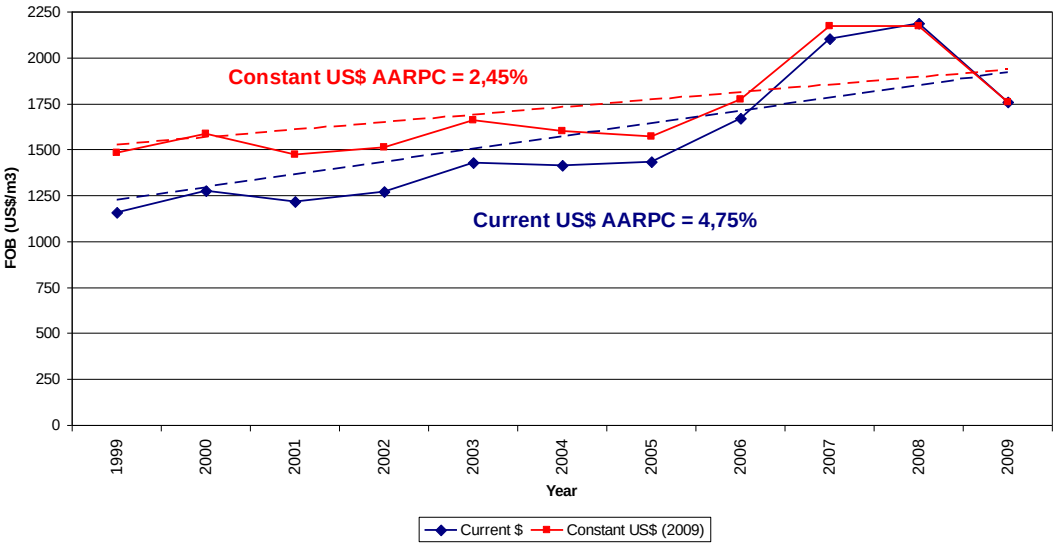
Average FOB prices and price trends (1979-2009) in current and constant 2009 US$ for natural forest teak logs

Average FOB prices and price trends (1989-2009) in current and constant 2009 US$ for natural forest Teak logs



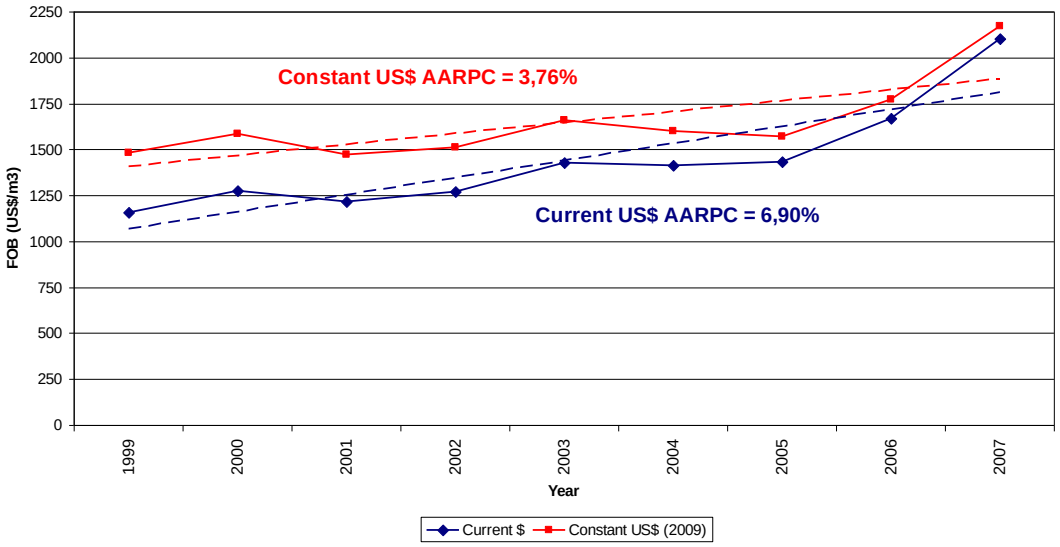
Average FOB prices and prices trends (1989-2009) in current and constant 2009 US$ for natural forest teak logs

Average FOB prices and price trends (1999-2009) in current and constant 2009 US$ for natural forest Teak logs



Average FOB prices and prices trends (1999-2009) in current and constant 2009 US$ for natural forest teak logs

Average FOB prices and price trends (1999-2007) in current and constant 2009 US$ for natural forest Teak logs



Average FOB prices and price trends (1999-2007) in current and constant 2009 US$ for natural forest teak logs

Appendix B. Supplementary results on international Latin American plantation log price forecast scenarios

Table B1a. Latin American (plantation) teak log FOB price forecasts from estimated initial prices, for the period 2009-2015, under the assumptions for Scenario # 2*

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	250.00	288.20	326.40	364.60	402.80	441.00	479.20
2010	259.65	299.32	339.00	378.67	418.35	458.02	497.70
2011	269.30	310.45	351.60	392.75	433.90	475.05	516.19
2012	278.95	321.57	364.20	406.82	449.44	492.07	534.69
2013	288.60	332.70	376.80	420.89	464.99	509.09	553.19
2014	298.25	343.82	389.40	434.97	480.54	526.11	571.69
2015	307.90	354.95	401.99	449.04	496.09	543.14	590.18

*AARPC= 3.86%; ARPC= 15.28%

Table B1b. Latin American (plantation) teak log FOB price forecasts from 2006-2009 observed and estimated initial prices, for the period 2009-2015, under the assumptions for Scenario # 2*

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	**251.76**	**376.66**	**507.76**	**518.51**	597.73	676.96	756.19
2010	261.48	391.20	527.36	538.52	620.81	703.09	785.38
2011	271.19	405.74	546.96	558.54	643.88	729.22	814.57
2012	280.91	420.28	566.56	578.55	666.95	755.35	843.76
2013	290.63	434.82	586.16	598.56	690.02	781.48	872.95
2014	300.35	449.36	605.76	618.58	713.10	807.62	902.13
2015	310.07	463.90	625.36	638.59	736.17	833.75	931.32

*AARPC= 3.86%; ARPC= 15.28%

Table B2a. Latin American (plantation) teak log FOB price forecasts from estimated initial prices, for the period 2009-2015, under the assumptions for Scenario # 3*

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	250.00	312.48	374.95	437.43	499.90	562.38	624.85
2010	259.65	324.54	389.42	454.31	519.20	584.08	648.97
2011	269.30	336.60	403.90	471.19	538.49	605.79	673.09
2012	278.95	348.66	418.37	488.08	557.79	627.50	697.21
2013	288.60	360.72	432.84	504.96	577.08	649.21	721.33
2014	298.25	372.78	447.32	521.85	596.38	670.91	745.45
2015	307.90	384.84	461.79	538.73	615.68	692.62	769.57

*AARPC= 3.86%; ARPC= 24.99%

Table B2b. Latin American (plantation) teak log FOB price forecasts from 2006-2009 observed and estimated initial prices, for the period 2009-2015, under the assumptions for Scenario # 3*

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	**251.76**	**376.66**	**507.76**	**518.51**	648.08	777.66	907.23
2010	261.48	391.20	527.36	538.52	673.10	807.67	942.25
2011	271.19	405.74	546.96	558.54	698.11	837.69	977.27
2012	280.91	420.28	566.56	578.55	723.13	867.71	1012.29
2013	290.63	434.82	586.16	598.56	748.14	897.73	1047.31
2014	300.35	449.36	605.76	618.58	773.16	927.74	1082.33
2015	310.07	463.90	625.36	638.59	798.18	957.76	1117.35

*AARPC= 3.86%; ARPC= 24.99%

Table B3a. Latin American (plantation) teak log FOB price forecasts from estimated initial prices, for the period 2009-2015, under the assumptions for Scenario # 4*

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	250.00	312.48	374.95	437.43	499.90	562.38	624.85
2010	261.63	327.01	392.39	457.77	523.15	588.53	653.91
2011	273.25	341.54	409.82	478.11	546.39	614.68	682.96
2012	284.88	356.07	427.26	498.45	569.64	640.83	712.02
2013	296.50	370.60	444.69	518.79	592.88	666.98	741.07
2014	308.13	385.13	462.13	539.13	616.13	693.13	770.13
2015	319.75	399.66	479.56	559.47	639.37	719.28	799.18

*AARPC= 4.65%; ARPC= 10.01%

Table B3b. Latin American (plantation) teak log FOB price forecasts from 2006-2009 observed and estimated initial prices, for the period 2009-2015, under the assumptions for Scenario # 4*

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	**251.76**	**376.66**	**507.76**	**518.51**	570.41	622.31	674.21
2010	263.46	394.18	531.37	542.62	596.93	651.25	705.56
2011	275.17	411.69	554.98	566.73	623.46	680.19	736.92
2012	286.88	429.21	578.59	590.84	649.98	709.12	768.27
2013	298.58	446.72	602.21	614.95	676.50	738.06	799.62
2014	310.29	464.24	625.82	639.06	703.03	767.00	830.97
2015	322.00	481.75	649.43	663.17	729.55	795.94	862.32

*AARPC= 4.65%; ARPC= 10.01%

Table B4a. Latin American (plantation) teak log FOB price forecasts from estimated initial prices, for the period 2009-2015, under the assumptions for Scenario # 6*

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	250.00	312.48	374.95	437.43	499.90	562.38	624.85
2010	261.63	327.01	392.39	457.77	523.15	588.53	653.91
2011	273.25	341.54	409.82	478.11	546.39	614.68	682.96
2012	284.88	356.07	427.26	498.45	569.64	640.83	712.02
2013	296.50	370.60	444.69	518.79	592.88	666.98	741.07
2014	308.13	385.13	462.13	539.13	616.13	693.13	770.13
2015	319.75	399.66	479.56	559.47	639.37	719.28	799.18

*AARPC= 4.65%; ARPC= 24.99%

Table B4b. Latin American (plantation) teak log FOB price forecasts from 2006-2009 observed and estimated initial prices, for the period 2009-2015, under the assumptions for Scenario # 6*

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	**251.76**	**376.66**	**507.76**	**518.51**	648.08	777.66	907.23
2010	263.46	394.18	531.37	542.62	678.22	813.82	949.42
2011	275.17	411.69	554.98	566.73	708.35	849.98	991.60
2012	286.88	429.21	578.59	590.84	738.49	886.14	1033.79
2013	298.58	446.72	602.21	614.95	768.62	922.30	1075.98
2014	310.29	464.24	625.82	639.06	798.76	958.46	1118.16
2015	322.00	481.75	649.43	663.17	828.90	994.62	1160.35

*AARPC= 4.65%; ARPC= 24.99%

Table B5a. Latin American (plantation) teak log FOB price forecasts from estimated initial prices, for the period 2009-2015, under the assumptions for Scenario # 7*

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	250.00	275.03	300.05	325.08	350.10	375.13	400.15
2010	264.43	290.89	317.36	343.83	370.30	396.77	423.24
2011	278.85	306.76	334.68	362.59	390.50	418.41	446.33
2012	293.28	322.63	351.99	381.35	410.70	440.06	469.42
2013	307.70	338.50	369.30	400.10	430.90	461.70	492.50
2014	322.13	354.37	386.61	418.86	451.10	483.35	515.59
2015	336.55	370.24	403.93	437.62	471.30	504.99	538.68

*AARPC= 5.77%; ARPC= 10.01%

Table B5b. Latin American (plantation) teak log FOB price forecasts from 2006-2009 observed and estimated initial prices, for the period 2009-2015, under the assumptions for Scenario # 7*

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	**251.76**	**376.66**	**507.76**	**518.51**	570.41	622.31	674.21
2010	266.28	398.39	537.06	548.42	603.32	658.22	713.12
2011	280.81	420.13	566.36	578.34	636.23	694.13	752.02
2012	295.34	441.86	595.66	608.26	669.15	730.03	790.92
2013	309.86	463.60	624.95	638.18	702.06	765.94	829.82
2014	324.39	485.33	654.25	668.10	734.97	801.85	868.72
2015	338.92	507.06	683.55	698.01	767.88	837.76	907.63

*AARPC= 5.77%; ARPC= 10.01%

Table B6a. Latin American (plantation) teak log FOB price forecasts from estimated initial prices, for the period 2009-2015, under the assumptions for Scenario # 8*

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	250.00	288.20	326.40	364.60	402.80	441.00	479.20
2010	264.43	304.83	345.23	385.64	426.04	466.45	506.85
2011	278.85	321.46	364.07	406.67	449.28	491.89	534.50
2012	293.28	338.09	382.90	427.71	472.52	517.34	562.15
2013	307.70	354.72	401.73	448.75	495.77	542.78	589.80
2014	322.13	371.35	420.57	469.79	519.01	568.23	617.45
2015	336.55	387.97	439.40	490.82	542.25	593.67	645.10

*AARPC= 5.77%; ARPC= 15.28%

Table B6b. Latin American (plantation) teak log FOB price forecasts from 2006-2009 observed and estimated initial prices, for the period 2009-2015, under the assumptions for Scenario # 8*

Year	Diameter class (cm)						
	10-20	20-30	30-40	40-50	50-60	60-70	70-80
2009	**251.76**	**376.66**	**507.76**	**518.51**	597.73	676.96	756.19
2010	266.28	398.39	537.06	548.42	632.22	716.02	799.82
2011	280.81	420.13	566.36	578.34	666.71	755.08	843.45
2012	295.34	441.86	595.66	608.26	701.20	794.14	887.09
2013	309.86	463.60	624.95	638.18	735.69	833.20	930.72
2014	324.39	485.33	654.25	668.10	770.18	872.27	974.35
2015	338.92	507.06	683.55	698.01	804.67	911.33	1017.98

*AARPC= 5.77%; ARPC= 15.28%

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