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THE TIMBER TRADE AND TROPICAL FORESTS: MODELLING THE IMPACTS OF SUPPLY CONSTRAINTS AND TRADE LIBERALIZATION

John M Perez-Garcia

Bruce R Lippke

Discussion Paper Series

DP 93-03

June 1993

This paper is based on research conducted for the International Tropical Timber Organisation under contract No. PCM(XI)/4, "Economic Linkages Between the International Trade in Tropical Timber and the Sustainable Management of Tropical Forests", October 1992.

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EXECUTIVE SUMMARY

Recent international concern about tropical deforestation highlights the need to examine trends in global timber markets and to investigate the potential impacts of trade policy interventions. Simulation analysis shows that global competitiveness determines the impact of policy alternatives. Sustainable tropical timber management is made economically possible by higher timber prices. Various trade, environmental and timber supply policies will impact regional and global wood supplies and demands affecting timber prices. To evaluate the potential impact of various policies on the setting for tropical timber management, it is necessary to evaluate the impact of changing trade flows from a number of different supply regions to consuming countries, in effect evaluating the changing competitiveness of global trade. The CINTRAFOR Global Trade Model (CGTM) for forest products was used to construct a short-term baseline projection and then examine the impacts of changes from baseline conditions by (i) constraining supply, (ii) introducing trade constraints, and (iii) reducing tariffs and trade barriers as a move toward trade liberalization. A long-term policy scenario was also constructed to illustrate possible implications for sustainable management.

BASELINE CONDITIONS IN THE SHORT TERM SHOW

Shortages exist in tropical timber, not temperate hardwoods The decreasing inventory of tropical timber is beginning to constrain harvests significantly, particularly in Malaysia. There is no comparable shortage of temperate hardwoods which supply large consuming country markets, particularly in the US, Europe and other non-Asian markets. Even with increased sawlog production in Indonesia and Brazil, the two tropical hardwood suppliers with a large inventory, the tropical hardwood share of all hardwoods begins to decline. Tropical hardwood sawlog prices rise steadily reaching levels 60 to 80% above 1990 levels by the year 2000; most of this price increase occurs in SE Asia. Prices in countries with adequate temperate hardwood sources remain more stable.

Strong demand in tropical hardwood producing countries shifts markets away from exports. The expected strong economic growth in tropical timber producing countries without strong demand growth in other consuming countries in conjunction with the declining supply of tropical hardwood logs produces a substantial shift away from export to domestic markets by the tropical hardwood suppliers. Malaysia West becomes an importer; Malaysia East augments processing capacity and decreases log exports to replace markets once held by Malaysia West. Log exports trend downward and are partially replaced by product exports.

Japan's needs are declining but they remain competitive log purchasers. Japan's high-valued, end-use markets continue to import logs to meet their needs, forcing less competitive consumer countries to reduce log purchases. High growth in other Asian consuming countries is filled by increased processed imports, especially in Korea, which has lost much of its processing competitiveness. With very high log prices after the year 2000, Japan decreases log imports substantially.

Product prices are constrained in consumer countries. While product prices are pushed up with rising log prices, the availability of other supply sources in the more developed consuming countries, in conjunction with lower demand growth, constrains their product price increases which in turn squeezes the profitability for processors of tropical timber. Plywood price increases in Japan rise hardly at all. Relatively small price increases are adequate to increase Brazil's sawnwood exports considerably. Temperate region wood processors benefit from increasing availability of wood and gain market share. While tropical hardwood processors also face rising log prices, they at least gain the benefit of rapid domestic demand growth. Other consuming country processors will be further squeezed by softwood and temperate hardwood substitutes. The trend in the more developed-consuming countries is therefore for a reduction in log imports and the processing of imported logs, and increased product imports with more substitution away from tropical products.

Structural changes in the Asia-Pacific Region will result in the near-term as substitutes are not available. In the Asia-Pacific markets, scarcity of temperate hardwoods as well as softwoods will impede substitution of these sources for tropical hardwoods. One can expect significant structural changes in these markets to occur in the short-term as tropical hardwood inventory and harvests decline. Log markets in the Atlantic region are very different from those in the Asia-Pacific region. While African-European tropical log markets are not well differentiated in the model, it is still evident that the increasing availability of temperate hardwoods, both in log and product form, will temper log shortages of tropical timber from Africa to Europe. Even though Africa West log exports has declined historically they should have the opportunity to shift away from European markets to higher prices in Asian markets. However, the structural changes taking placing in Asian markets may result in the consuming countries reducing tropical log exports to the extent that Africa West can not develop a market advantage in the long term.

LONGER-TERM CONDITIONS SHOW SAWLOG PRICES CONTINUE AN UPWARD TREND BUT AT A SLOWER RATE IF TARGETED-SUSTAINABLE-HARVEST RATES CAN BE MAINTAINED

With the available tropical hardwood inventory in several countries declining rapidly by 2000, either harvest levels are reduced quickly to more sustainable levels or they drop even more abruptly just a few years later with the depletion of the inventory. The estimates used for the commercial timber inventory for Malaysia, show that they are near depletion of that inventory. Harvest rates, that some have suggested are sustainable, 4 million m^3 for Malaysia West and 12.5 million m^3 for Malaysia East still result in projected sawlog price increases of 100% by 2010 and 200% by 2020. These targeted-harvest rates may be considered an optimistic policy scenario as they require some harvest of the non-commercial inventory levels in Malaysia given the nearly complete depletion of currently defined commercial inventory. Malaysia West prices will rise higher than other countries; as they become a net importer. Malaysia East log production declines to as low as 6 million m^3 by 2005 as a consequence of low inventory and then is assumed to recover to the sustainable target of 12.4 million m^3 by 2010. Indonesia remains stable at 54 million m^3 beyond 2010, well above the derived 1990 harvest level of 33 million m^3. Even though these harvest rates are likely to be judged as optimistic, they still result in steadily rising prices with demand outstripping supply. Increased harvests by Brazil and Indonesia are not adequate to offset the other harvest declines and also service strong demand growth. Their inventories are sufficiently large that the higher prices produce increasing harvest levels in the model simulation unless harsh harvest constraint are superimposed. Their harvest levels may not be forever sustainable, but they are not close to depletion of the commercial inventory for many years.

The commodity in short supply continues to be tropical hardwood logs, not processing capacity. European markets show no impact of shortages in contrast to SE Asia. With a 30% reduction in supply outside of Indonesia and Brazil, log price increases of 200% above 1990 levels are projected by 2020. Product price increases do not keep up with those cost increases. While consumer countries are forced to accept higher prices and do change their consumption patterns with those high prices, tropical log prices are not likely to flatten out and decline much until the results of increased investment in sustainable forest management can support increased harvest levels. European markets show a tendency for temperate hardwood log substitution for tropical hardwoods.

Much of the pressure on prices derives from the strong growth in demand for the SE Asian region. Substitution by other wood products, and other non-wood materials that may not be adequately characterized in the model, can be expected to constrain these price increases to some extent. It should be noted that the purpose for using CGTM, a global trade model is to allow trade flows to adjust shifts between supply regions and demand regions as conditions change. In comparison to models such as the USFS model of North America, CGTM shows much smaller softwood price increases in response to softwood supply curtailments, as CGTM is able to source as much as 75% of a US supply reduction in world markets. These CGTM simulations of tropical hardwood supply reductions show large increases in sawlog prices in spite of access to global supply sources. The explanation is primarily the large demand growth in SE Asia with few substitute supply regions short of substitution with softwoods which is not incorporated in the simulation.

HIGHER LOG PRICES SHOULD MOTIVATE SUSTAINABLE FOREST MANAGEMENT

The substantially higher log prices over time, even if constrained somewhat by substitutes, should make it possible to economically motivate more investment in sustainable forest management. In particular, while it may not have been economic to manage the current harvest in such a way as to increase the yield of the next harvest given the low prices in the past, these price increases will greatly increase the rate of return for managing forests for more sustainable production. While much of this benefit may take 25 or more years to provide mature inventory and is therefore beyond the forecasting period illustrated, some features such as greater use of waste material and lower-valued species could occur much more quickly and dampen the price increases. Some increase of currently non-commercial timber is already assumed in the sustainable harvest targets used for the long term projections for Malaysia.

SUPPLY CONSTRAINTS PRIMARILY ACCELERATE THE TIMING OF THE IMPACT OF THE DECLINING TREND IN HARVEST

One focus of environmental policy has been to constrain supply in order to preserve tropical forests. Others want to reduce the harvests prior to exhaustion of the inventory to smooth the transition to sustainable harvest levels. In the short term these pressures, if implemented, result in a shift or constraint to supply. With supply constraints, sawlog prices increase even faster and rise to somewhat higher peaks. A 10% supply reduction causes sawlog prices to rise another 15% by 2000. For the most part, since the region is undergoing a supply reduction as the inventory is depleted, the impact of an additional supply constraint is simply to accelerate the impact of shortages and higher prices in time. A supply reduction would constitute a loss in wealth to the tropical timber supply countries to the degree that the reduction is more than required to avoid harvest rates falling below sustainable levels.

TIMBER TRADE CONSTRAINTS REDUCE THE VALUE OF TIMBER, SLOWING DOWN THE MOTIVATION FOR INCREASED INVESTMENT IN SUSTAINED FOREST MANAGEMENT

Since there is a shortage in tropical supply, a reduction in demand from trade constraints might be viewed as restoring a better balance. Such a policy ignores the need for higher prices to motivate sustained management policies. One focus of environmental movements has been to increase the barriers against tropical timber trade to penalize non-sustainable activities. With a 10% increase in tariffs, the CGTM simulation shows tropical hardwood sawlog prices declining by 10-20% by 2000. The largest impact is on log exports, causing consumer countries to reduce their imports more quickly. Indonesian plywood production is also off by almost 10%. While such an impact might have negotiating value, to force the producing countries to change policy, as an economic policy it is counterproductive to motivating sustainable management. The reduction in values reduces the economic return to managing for sustainable growth.

REDUCED TARIFFS AND TRADE LIBERALIZATION INCREASE THE PRICES FOR TROPICAL TIMBER, A WEALTH GAIN FOR THE REGION

Since higher timber prices are viewed as an increasing return for managing forests for sustained-growth, there has been concern that trade barriers that have been introduced largely by consumer countries contribute to low prices and a short-term, non-sustainable management focus. By eliminating tariffs the demand for tropical timber is increased, with increasing returns to managing the forests. While there are both non-tariff barriers and tariff barriers, eliminating the tariff barriers alone has a significant impact.

Reducing transfer costs by 10% as a proxy for reduced tariffs and also eliminating export bans on logs and products in a CGTM simulation of global trade competition results in tropical hardwood sawlog prices rising 20% by 2000. While this demand increase does contribute to a more rapid depletion of the timber inventory, there is a substantial wealth gain by tropical hardwood producers which can support increased investment in sustainable management and higher-growth forests, including the potential for much less damage to the forests from logging activities.

The benefits to consumer countries are also large, with significant declines in log prices as a consequence of open markets. Since the commodity that is in short supply is tropical hardwood logs and the hardwood producing countries have no comparative advantage in processing, they lose some of their processing to the consuming countries. The fact that the economic and product demand growth is higher in the tropical hardwood producing countries than the consuming countries shifts some of the wood flow into Malaysia West, the producing country with the greatest shortage in supply.

OVERALL IMPLICATIONS

These preliminary model simulations suggest that markets will find it difficult to adjust to declining tropical timber supplies even if those countries with large inventory increase their harvest rates to partially offset declines in other countries. With very high economic growth in the tropical hardwood producing region it is doubly difficult to satisfy local demand resulting in a substantial shift away from exports to more local use of the resource. Prices should be expected to rise faster than other wood and non-wood substitutes. This will increase the chances of new forms of substitution to hold down the price increases. More directly it will cause a reduction in log flows into the developed-consuming countries and a less than offsetting increase in product imports. Even with optimistic sustainable harvest targets, substantial sawlog price increases are suggested.

Accelerated reductions in harvests to more sustainable levels, equivalent to a supply constraint would further increase price pressures. The outlook is therefore favorable that log prices will rise enough to significantly improve the motivation for sustainable management.

Decreased trade barriers would increase the demand for sawlogs, raising prices further and adding to that motivation. Increasing tariffs as a means of putting pressure on supply countries to manage forests on a more sustainable basis is counterproductive from an economic perspective, as it decreases the economic motivation for sustainable management.

1. INTRODUCTION

As part of the ITTO Activity entitled "The Economic Linkages Between the International Trade in Tropical Timber and the Sustainable Management of Tropical Forests" the Center for International Trade in Forest Products (CINTRAFOR) at the University of Washington was asked by the London Environmental Economics Centre (LEEC) to assess the impacts of alternative scenarios on tropical timber supply constraints; tropical timber trade constraints; and the global trade liberalization of trade restrictions. These policies necessitate an evaluation of changes in trade flows from a number of different supply regions to consuming countries; in effect, evaluating the changing competitiveness of global trade. Hence, we have used a globally competitive forest products trade model, the CINTRAFOR Global Trade Model (CGTM), to examine the impacts of implementing these policy scenarios.

The three scenarios were selected to simulate the effects of trade policies available to decision makers to promote sustainable forestry practices. The scenario on tropical timber supply constraints simulates the potential effect of implementing sustainable forest management regimes or other constraints on timber harvest in tropical regions. The tropical timber trade constraints simulates the effect of additional tariff barriers being raised against the import of "unsustainable" tropical timber products by northern consumer countries. Finally, the global trade liberalization scenario simulates the likely effect of removing existing barriers to trade in all timber products.

This document reports results using CGTM with recent updates of the data through 1990. The report is organized as follows. The following section describes the methods employed to analyze trade policy impacts. It provides a brief description of the CGTM, and is followed by several sections that describe (i) the data and data limitations; and (ii) methods employed to forecast the key exogenous variables in the model. The next section then describes the reference case output, including a description of future demand for forest products and a description of the key tropical timber producing regions and how they are treated in the model. The final sections describe methods to be employed to implement the scenarios and descriptions of each scenario.

2. METHODS EMPLOYED

The CGTM is a spatial equilibrium model of the global forest sector. It is the result of 11 years of research; five years initially at the International Institute of Applied System Analysis (IIASA) in Vienna, Austria, and six additional years at the University of Washington. The present model is an updated version of the CGTM developed by Cardellichio and others at CINTRAFOR (see Cardellichio, et al. 1988, 1989). Data has been updated to 1990 with additional minor revisions to exogenous forecasts.[1] In the following sections the general modelling approach used in CGTM and the methods used to forecast the key exogenous variables in the model are described.

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[1] Demand forecasts for all regions and timber supply constraints--mainly in the softwood producing regions of the public sector of the US West region--have been revised to reflect their most likely future development.

2.1 The CINTRAFOR Global Trade Model (CGTM)

The CGTM projects production, consumption, prices and trade of ten forest products in 43 regions which comprise the globe. Figure 2.1 presents a flow chart describing the various components of the model. Given the demand and supply for each region, bilateral trade flows between regions, as well as transportation costs, the model solves for an equilibrium price, production, consumption and trade flow. It takes the equilibrium results for a base year and uses them to find equilibrium solutions for subsequent years by considering changes in demand, production and trade levels. These changes are implemented through submodels for timber growth, production capacity, and consumption. A detailed description of the model is presented in Kallio et al. (1987) and Cardellichio et al. (1988, 1989).

2.2 A Short Description of the Model

CGTM utilizes the mathematical programming approach suggested by Samuelson (1952) and incorporated by Kallio et al. (1987) in the IIASA forest sector model. A partial equilibrium solution is found by summing consumer plus producer surplus minus transportation costs. Constraints working on the model are (i) materials balance--in each region for each commodity, consumption equals production minus net trade; and (ii) production capacity--production levels lie within the industrial capacity of each region.

Ten products are considered in the model: Coniferous and nonconiferous sawlogs; coniferous and nonconiferous pulpwood; coniferous and nonconiferous sawnwood; coniferous and nonconiferous plywood; reconstituted panels; and wood pulp. These last two products are defined in the model as inputs to account for pulpwood and processing residual usage.

The regional breakdown in the model is the most complete for a global forest sector model. There are 33 final product demand regions around the globe. A large number of these regions have estimated demand functions for sawnwood and plywood. Final product demand is specified in constant-elasticity form using one of the following equations:

$$Q/I = a*P^b \qquad \text{or} \qquad Q = a*P^b*I^d \tag{1}$$

where:

- Q is the product consumption (million m^3 of product)
- I is an indicator of market activity (for example, GDP or housing starts)
- P is the product prices (real local currency per m^3 of product
- a, b, d are estimated parameters

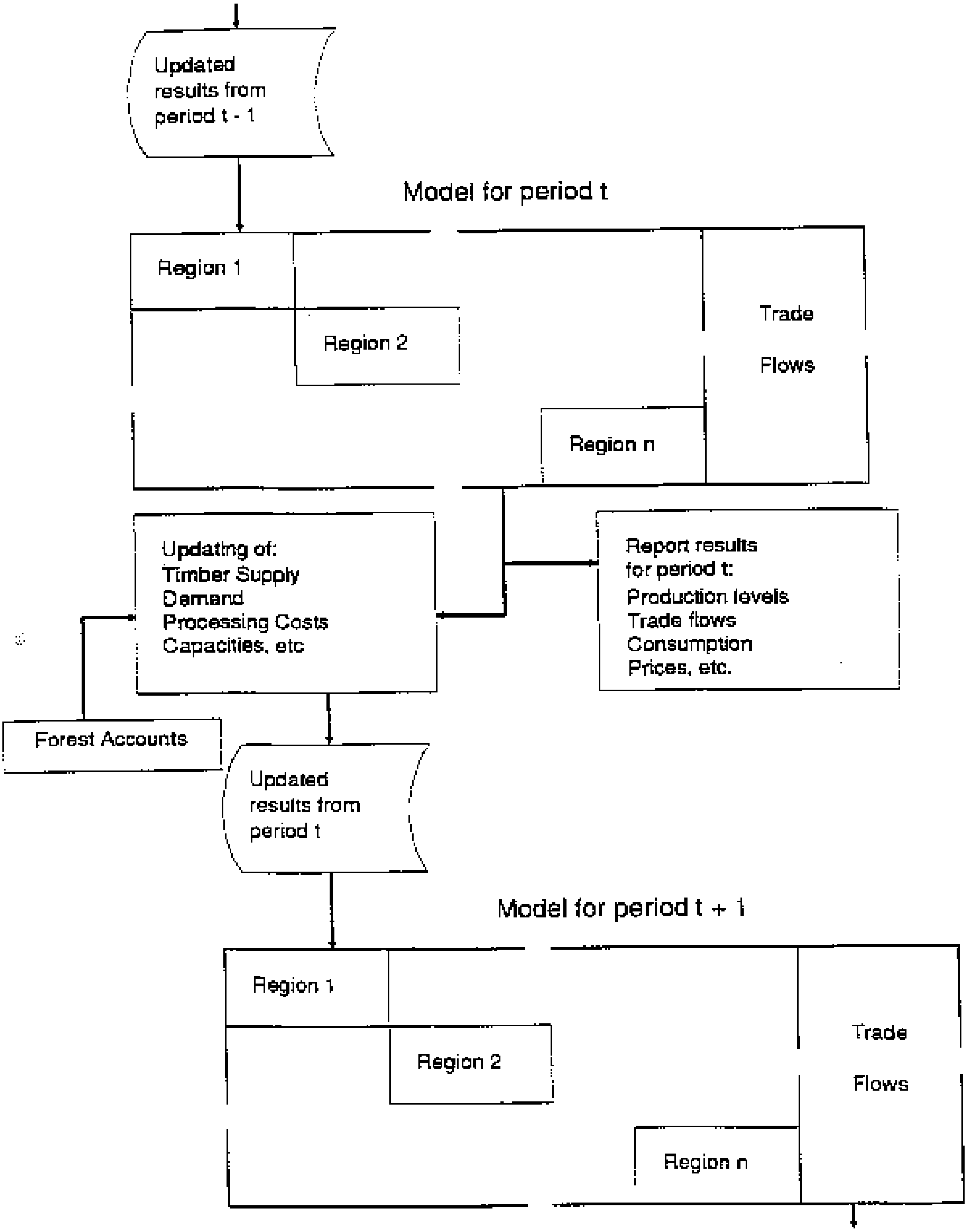
The product supply specification is:

$$P = C + a*U^b \tag{2.1}$$

$$C = (ST + HD)*R_1 + MVMC - CHIPS*R_2 \tag{2.2}$$

$$U = Q/K_{-1} \tag{2.3}$$

Figure 2.1 The CINTRAFOR Global Trade Model



where:

P is the product price (real value per m^3 of product)
C is variable production cost (real value per m^3 of product)
U is capacity utilization
a, b are estimated parameters
ST is stumpage cost (real value per m^3 of log)
HD is log harvest and delivery cost (real value per m^3 of log)
R_1 is an input-output coefficient (m^3 of log used per m^3 of product)
$MVMC$ is minimum variable manufacturing cost (real value per m^3 of product)
$CHIPS$ is the price of wood chips (real value per m^3 of chips)
R_2 is an input-output coefficient (m^3 of product)
Q is product output (million m^3 of product)
K_{-1} is production capacity at the end of the previous year (million m^3 of product)

In most forest sector models the supply specification is fixed proportions: a unit of output requires fixed proportions of inputs. That is to say that timber is assumed to be consumed in fixed proportions to product output.

The supply specification sets the equilibrium price, P, equal to unit cost, C, plus a margin, where the margin is estimated to be a function of the slack in capacity utilization. In CGTM, changes in production capacity are made on the basis of historical profitability. A decision rule is employed to handle capacity expansion and contraction: if capacity is less than optimal, it expands; otherwise it contracts. The optimal capacity level is determined by defining a target capacity utilization.

In CGTM, log cost is defined as the sum of two components: i) the cost of stumpage, or standing timber; and ii) the cost of harvesting the timber and delivering it to a mill. Not all regions have both the stumpage and the harvest and delivery cost structure. The decision on whether to model stumpage or harvest and delivery prices separately depends on their shares of delivered log prices, the availability of data, and the success of estimation.

Stumpage supply is modeled as:

$$P = a(Q/I)^b \tag{3.1}$$

where:

P is the stumpage price (real value per m^3 of wood)
Q is the stumpage quantity (million m^3 of wood)
I is the growing stock volume (million m^3 of wood)
a, b, are estimated parameters

Timber supply in the public sector of the US West is modelled as:

$$P/P_s = a(Q/U)^b \tag{3.2}$$

where:

P_s is a 3-year moving average of past stumpage sales prices
U is uncut volume in public forests.

As expressed in the stumpage supply equation, it is assumed that changes in inventory levels result in a one to one change in stumpage supply (i.e. the inventory elasticity is equal to one).

The timber supply dynamics include an update of the inventory term using a growth-drain relationship:

$$I_{t+1} = I_t + G_t - H_t \tag{4}$$

where:

G is timber growth (million m^3 of wood)
H is timber harvest (million m^3 of wood)

These dynamic elements of CGTM allow model solutions to be linked between time periods, but do not imply an optimal inter-temporal market equilibrium solution. The dynamic structure in the model, although a simple procedure, captures many of the important adjustments that would be expected in a more complete representation of the forest sector.

3. DATA REQUIREMENTS AND LIMITATIONS

Data are required to estimate the supply and demand equations (1) through (3). Behavioral equations of demand and supply were not re-estimated, having been developed with the historical period ending in 1987. In addition, since timber demand is represented by recovery ratios and the production of finished wood products, data are required for the input/output coefficients associated with sawmilling/plywood processing, pulp and reconstituted panel manufacture. Finally, one needs information on transportation cost measures and prices. Trade data are necessary to account for additions and subtractions to the available timber used in processing finished products and the consumption of these finished products.

In accumulating the data needed to estimate the equilibrium conditions in the model, several data problems became evident. Data problems with timber harvest occur when under/over-reporting of harvest levels are recorded, and perhaps less seriously, when inventory measures is poor or not available. Problems also exist with timber trade data and production data on sawnwood and plywood.

These data problems have an impact on the equilibrium solution. Errors in the measurement of timber production and trade affect the equilibrium production, consumption, trade and prices of both the timber and finished products. Measurement errors in inventory have an effect on future levels of production. Trade data problems also have been identified during the process of calibrating the model solution to 1990. Net trade affects the available timber supply for a region. Hence, measurement errors in net trade, either in imports or exports, also affect the model solution for the production, consumption, trade and prices for the period. Errors in the measurement of the production of the finished products have similar consequences. In constructing the data sets for the model, we have developed a data checking procedure to identify where data reporting inconsistencies occurred.

As an example of the data checking procedure, consider the following example. Define apparent consumption as the sum of timber harvests and net trade of timber products. For Japan, harvest of nonconiferous sawlogs in 1990 was reported as 2.063 million m³ (FAO, 1991). Imports of hardwood sawlogs were 12.5 million m³ as reported by import data. Apparent consumption, therefore,is 14.563 million m³.

Actual consumption of coniferous logs is calculated by multiplying the production of hardwood sawnwood and plywood by their respective recovery ratios. In the case of Japan, recovery of sawnwood from nonconiferous logs was 70%; for plywood it was 65%. Production of nonconiferous sawnwood was estimated to be 3.361 million m³ and 6.738 million m³ for plywood. Actual consumption of logs is estimated at 15.196 million m³. There is a difference of 0.633 million m³.

Since supplemental information on the Japanese data is available through various sources, it is possible to check these data inconsistencies. In this manner, where the data exists, we have proceeded to check it for consistencies in reporting timber production and net trade of timber products.

In practice, there are a number of inconsistencies in the real historical data that must be resolved to avoid inconsistencies in the projections. Reconciling these inconsistencies in favor of one historical data series versus another is not always possible or practical given limited time. It is frequently less damaging to allow the inconsistency to remain and understand the implications in the projections. Otherwise we may be increasing the inaccuracy of the projections by making arbitrary adjustments in the data. Most inconsistencies will impact the balance of supply and demand and therefore impact prices, resulting in a potential step shift between historical data and projected data. We always show the last historical data point as an overlap with the first projection point to demonstrate such differences.

To make the price series transfer smoothly from the historical period to the projection period, it is customary in many models to add a constant so that no step shift between history and the projection is observed. That is, the rate of change of prices is linked to the historical series, either to the last historical data point or some average of the last several data points or alternatively, an autocorrelation adjustment is provided to smooth out the transition. Both of these procedures mask the reality of data inconsistencies and calibration problems.

We have not attempted to correct the historical data for inconsistencies except where there was at least strong evidence to support the adjustment. Any adjustment to the historical data can appear to an analyst familiar with that data to be an inconsistency in the model. Similarly, not making an adjustment will make the projected price series show a shift between the historical period and the projection that would appear to be a model inconsistency instead of a data problem.

One may choose to disregard a step shift in prices by concentrating on the rate of change in projected prices. Whether or not any step shift in prices beyond the rate of change should be considered may depend upon the nature of the inconsistencies in the historical data. The same can be said for historical versus projected volumes. All data used in this analyis are presented in separate statistical appendices, which are available on request from LEEC.

4. FORECAST OF KEY EXOGENOUS VARIABLES

4.1 Timber Harvest Levels

Two large tropical timber producers Brazil and West Africa are modeled exogenously. These two regions are treated differently in the model. Brazil, with its vast inventory of timber, is able to expand its marginal frontier unconstrained i.e. , there is no constraint placed on harvesting timber in Brazil. Brazil does not become the major producer of logs for the globe however, because log demand is constrained to its domestic needs, *i.e.* , the log trade is not a significant economic activity. The ability for Brazil to provide sawnwood exports to other markets allows it to expand its domestic production--constrained by profitability, rather than its supply of logs. Brazil does increase sawnwood exports as other suppliers are constrained.

West Africa, on the other hand, with significant log trade has production projections of timber harvest levels. These projections were made based on historical production trends while reflecting expected increases from plantations after 2000. The lack of structural detail for these regions limits the information that can be gained about their future behavior under the various policy scenarios. One could test the sensitivity of the assumptions or attempt to more fully structure these regions in the model. Either approach requires extensive effort and time beyond the scope of this study.

4.2 Exogenous Forecasts of Product Demands

Consumption of sawnwood and plywood products for exogenous regions are also reported in Appendix II. Forecasts for the exogenous regions are provided in Appendix III. Consumption of sawnwood products were forecast using GDP per capita estimates and measures of income elasticities. Plywood consumption for these regions were determined by noting the trend in plywood to total wood-based panel consumption (which also includes reconstituted panels) and forecasting the total wood-based panel consumption, again based on GDP per capita and income elasticities.

4.3 Demand Shift Forecasts

Demand shifts for those regions with endogenous demand functions were projected using forecasts of end-use indicators. For the Southeast Asian regions, the more important end-use indicators were GDP per capita, housing starts, and construction activities. These demand shift forecasts were implemented for the following countries as follows:

For Malaysia, Indonesia and the Philippines, the demand forecasts were based on GDP per capita growth and an income elasticity measure. Forecast of GDP per capita are presented in the following table. An income elasticity measure of 2.50 was used to reflect the changes in demand associated with per capita income growth.

Table 4.1: GDP per capita forecasts for Malaysia, Indonesia and the Philippines
(in percent per year)

Period	Malaysia	Indonesia	Philippines
1990-1994	3.63	3.63	3.00
1995-1999	4.13	4.13	3.51
2000-2005	5.05	5.05	4.41

Demand growth in hardwood products is projected to double for Malaysia East, Malaysia West, and Indonesia and 65% for the Philippines for nonconiferous sawnwood by 2000. Plywood consumption is also expected to double in Indonesia by 2000. Hardwood sawnwood consumption is expected to increase by 10% in Europe West by 2000.

For Japan, Korea, Taiwan-Hong Kong and West Europe, end-use indicators were total floor area for housing starts (HSA), total floor area for all construction starts (BSA), and real value of furniture production (FRN). Table 4.2 gives the region, the end-use indicator by product and the assumed elasticity for these regions. Demand growth for Europe West was estimated using a GDP per capita forecast of 1.99 for the forecast period and an elasticity measure of 0.63.

A list of the most notable demand growth assumptions might include: (i) demand for wooden homes in Japan stops declining although at the lower levels experienced over the last several years. Wooden homes have lost market share, an important loss in demand for a major consumer, given a stable housing outlook. (ii) demand growth in the tropical hardwood producing countries is very strong, especially for SE Asia with substantial growth in Africa. (iii) with little population growth, demand in Europe is weak. Collectively these provide a shift in demand away from the historically strong economically developed-consuming countries to the developing-producing countries.

Table 4.2: End-use indicators for demand and elasticities for Japan, Korea and Taiwan-Hong Kong and West Europe

Region	Product	Indicator	Elasticity
Japan	nonconiferous sawnwood	HSA	1.00
Japan	nonconiferous plywood	BSA	1.00
Korea	nonconiferous sawnwood	BSA	1.00
Korea	nonconiferous plywood	BSA	1.00
Taiwan-HK	nonconiferous sawnwood	FRN	1.00
Taiwan-HK	nonconiferous plywood	BSA	1.00
West Europe	nonconiferous sawnwood	GDP	0.63
West Europe*	nonconiferous plywood	GDP	0.63

* Demand forecast for West Europe for nonconiferous plywood is exogenous. Projected consumption levels were determined based on GDP growth and the income elasticity measure of 0.63.

5. BASE CASE REFERENCE FOR THE SHORT TERM (TO THE YEAR 2000)

The short term here is defined as the ten-year period from the first projection year of 1990 to the year 2000. For periods so short, assumptions on inventory growth can be assumed to be relatively independent of price performance, i.e. , there will be little feedback between prices and the consequences of forest management. Since the model does not directly incorporate feedback between sawlog prices and the growth of inventory, the analysis of short term projections has been separated from longer term projections where such feedback as well as other assumptions become more difficult. Another reason for separating the discussion on long term projections is that the declining inventory of commercial timber in several producing countries becomes acute beyond the year 2000 requiring additional policy and technological assumptions regarding sustainable harvest rates. Short-term projections of the behavior of the hardwood forest products markets for key regions have been developed. The following subsections discuss these projections.

5.1 Timber Producers in the Southeast Asia Region are an Important Source of Raw Materials

Hardwood sawlog production for the regions of Malaysia East (MAE, includes Sarawak and Sabah), Malaysia West (MAW, includes Peninsular Malaysia), Indonesia (IDN) and the Philippines (PHL) are depicted in Figure 5.1. With the exception of Indonesia, the model predicts the historical harvest levels well.[2] For Indonesia, forecast harvests for 1990 (the first projection period) are nearly 23% greater than the historical level of 27 million m^3. This is largely a data problem which will be discussed in more detail. Both Indonesia and Malaysia East show an increase in harvest levels in the short term; with harvest levels declining in the latter part of the decade for Malaysia East. Harvest levels for Malaysia West decline during the short term. The Philippines maintains a harvest level of about two million m^3 per year. By 2000, these regions provide over 40% of the tropical hardwood harvest (see Table 5.1). India's production, while significant, serves domestic markets only

[2] Preliminary analysis of the data revealed several discrepancies in hardwood production, trade and consumption data. See the section on Data and Data Limitations for a discussion of these problems. For Indonesia, one can estimate the harvest levels by converting sawnwood and plywood production into sawlog requirements. Sawnwood and plywood production are estimated at 9.000 and 9.306 mmcm in 1990. Recovery ratios for sawnwood and plywood are 50 and 48 percent respectively. Sawlog consumption is equal to sawlog production since net trade is very small (about 0.2 mmcm of log exports): 37.356 mmcm. Reported harvest levels are 27.000 mmcm (FAO, 1991). This step increase between the historical data and forecast is evident in Figure 5.1.

FIGURE 5.1: HARDWOOD SAWLOG PRODUCTION

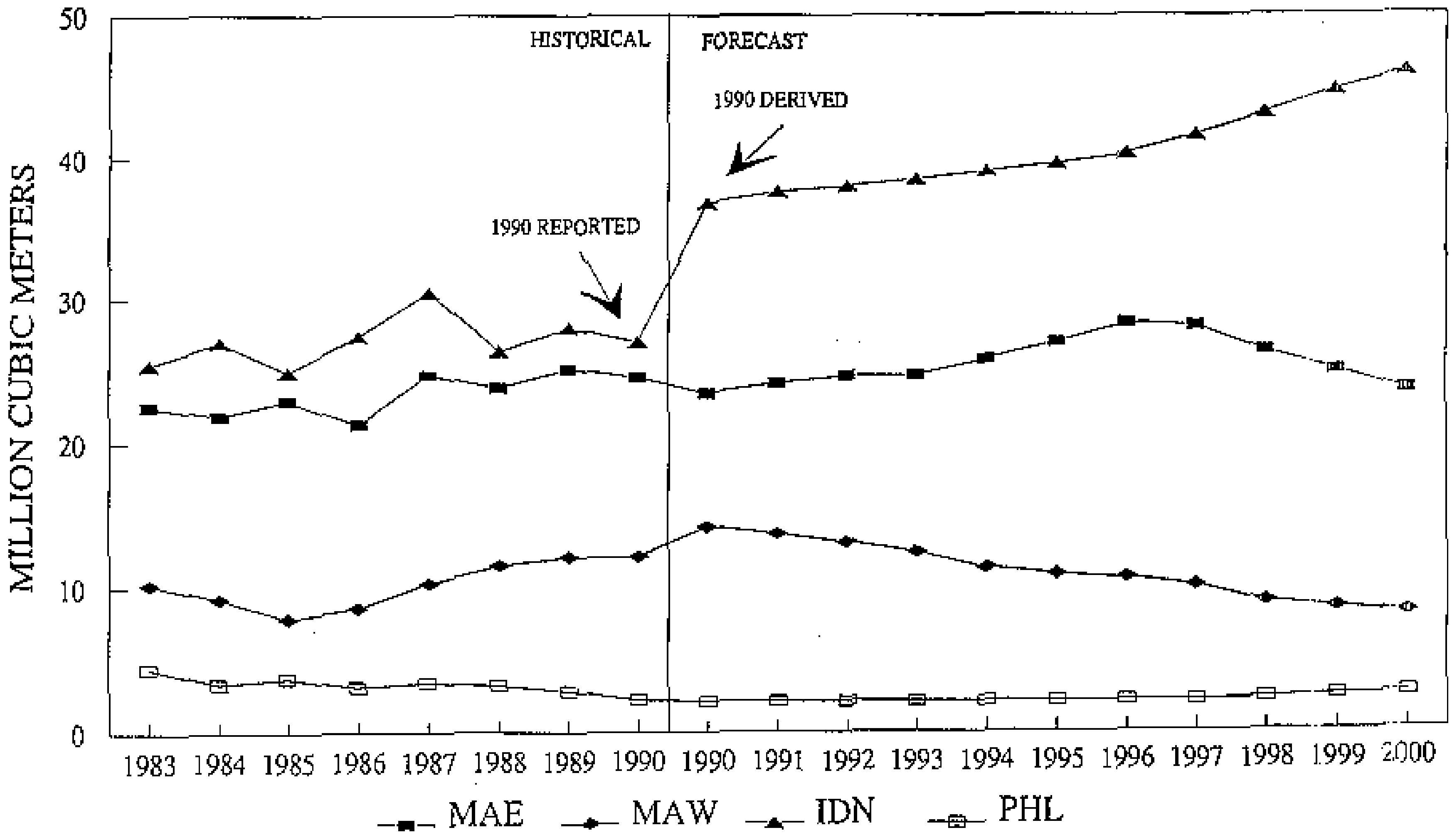


Table 5.1: Harvest projections for the year 2000 by major tropical hardwood producing regions (million m³)

Malaysia East	22.0
Malaysia West	8.3
Indonesia *	36.6
Philippines	2.2
Papua New Guinea	2.6
Indochina	6.1
India	41.1
Africa West	15.0
Brazil	23.1

* unadjusted harvest level

Since we have some confidence in the log-to-product recovery ratios used to compute the hardwood sawlog production projection for Indonesia, the projected harvest volumes should be more reliable than history. We have not chosen to scale the historical data up to be consistent with the projection as the historical data is the international published series. Such a step increase is evident in Figure 5.1.

The harvest projection trends reflect a growing scarcity of timber in each region. Indonesia, with a growing stock of nearly 3 billion m^3 of commercial timber, reduces its inventory by 375 million m^3 in the short term, a 13% reduction. Given the large timber stock, Indonesia may be expected to maintain its harvesting trend into the future. Malaysia East, with a stock of commercial timber estimated at 326 million m^3 reduces its inventory by 40% during the first half of the decade--a period of somewhat expanding harvests--and 67% during the remaining half of the decade, when timber harvest rates decline. Inventory in Malaysia East drops to 65 million m^3 by 2000, approximately 17% of the 1990 growing stock level. Continued harvests at historical levels will quickly eliminate any available inventory. Reduced timber inventories in Malaysia West force timber harvest levels to decline in the short term. An estimated 116 million m^3 of hardwood growing stock is reduced by three-quarters by 2000.

The projections provide a reasonably consistent view of the regions' potential for the short-term. Planning authorities may choose to reduce the harvest to sustainable levels more quickly, or to maintain a high harvest level in the short - term. This last option, however, will cause an abrupt fall in harvest as the inventory declines more quickly. Substantial changes in prices could induce structural changes that might alter harvesting techniques and the amount of volume removed per hectare, thereby increasing the volume removed in comparison to the historical experience, which would result in some downward pressure on prices. Such a structural change is not characterized directly in the model but could be juxtaposed based on technological considerations.

Harvest levels in Brazil are unconstrained by a large inventory and increase 21 % over the decade. Harvest levels in Africa West were assumed to remain at historical levels, rising in trend after 2000 (an exogenous assumption, not a model driven supply response).

5.2 Timber Consumption in the Southeast Asia Region Depends on Trade

Trade of hardwood sawlogs in the region and across the globe is heavily restricted by trade barriers. There are log export bans in place in Indonesia, the Philippines, Malaysia West and several African countries. The effect of these bans is to increase the consumption of logs in those domestic markets. In Southeast Asia, only Malaysia East provides a significant amount of hardwood logs to the international market, choosing not to impose any log trade barrier. The share of East Malaysian timber in international markets is displayed in Figure 5.2. Figure 5.2 also illustrates the amount of log exports originating from Malaysia East and the total export of hardwood logs (both temperate and tropical) in the world. There is a decline in the level and share of the hardwood log export market for Malaysia East. Log exports decline from 20.8 million m^3 in 1990 to 15.1 million m^3 in 2000. Export logs from Malaysia East decline due to decreasing timber inventories and increased domestic sawnwood production. The world demand for sawlogs remains strong with world hardwood production growing 10% by 2000. In contrast, log exports decline by 4%.

Timber consumption in major Southeast Asian consuming markets relies heavily on log imports from Malaysia East. Figure 5.3 illustrates the trend in log imports for Japan (JPN), Korea (KOR), China (CHN) and Taiwan-Hong Kong (THK). Log imports for these regions show a declining trend with the exception of Taiwan-Hong Kong, which shows a constant level of imports. Without a suitable substitute source of hardwood logs, these regions are forced to consume fewer logs in their sawmilling and plywood manufacturing processes.

Figure 5.4 illustrates hardwood sawlog consumption for the major regions in the area. Hardwood log consumption declines in Japan and Korea, while consumption levels are maintained in Taiwan-Hong Kong and consumption increases in China. Higher domestic production to meet demand requires China to increase its consumption of hardwood logs and sustain imports.

Hardwood suppliers outside of Southeast Asia include Brazil and Africa West. Brazil's production increase is channelled to sawnwood exports, since their log export levels have been small. Africa West's declining trend in exports results from weak demand and declining prices in Europe. In addition US temperate hardwood suppliers are competitive in European markets. Given the shortage in Asian markets the assumed downward trend in their log exports might be reversed by a shift away from European markets to Asian markets. Since Africa West production is an input, a detailed analysis of distribution costs would be required to determine their export potential to SE Asia.

Given the greater scarcity of tropical hardwood logs in the consuming markets of Japan, Korea, and China, and the limited number of potential suppliers, the possibility exists for greater substitution of softwoods for hardwoods, especially in the large Japanese plywood market, which might allow a more rapid decline in Japan's hardwood sawlog imports. While some might argue that this shift should be defined as a certainty and part of a BASE CASE, others have pointed out that the curtailments of softwood harvest already underway in the US Pacific Northwest and future declines expected in Canada are so large that they could easily counteract much of the potential substitution of softwood for hardwood plywood.

FIGURE 5.2: HARDWOOD SAWLOG EXPORTS

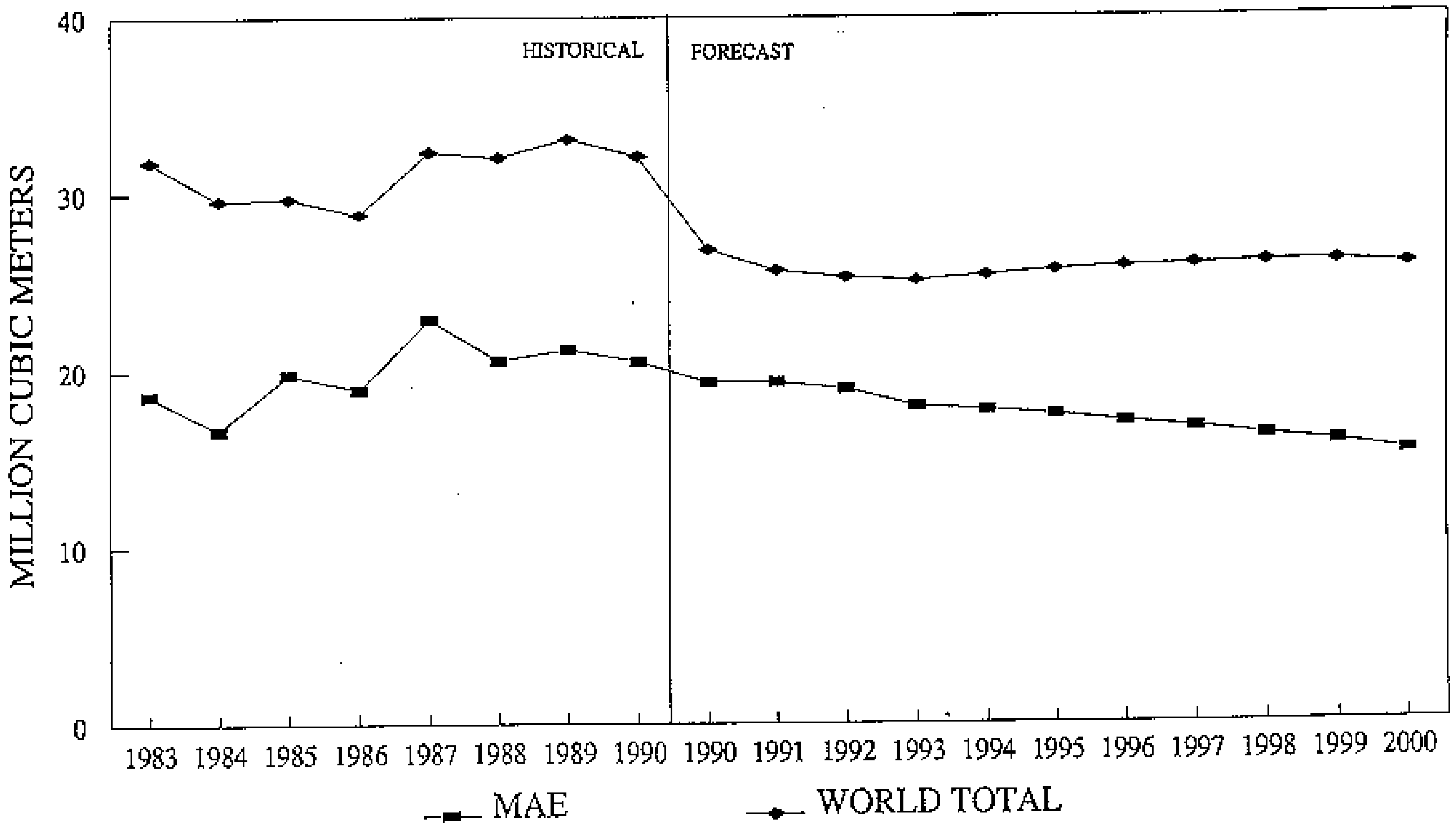


FIGURE 5.3: HARDWOOD SAWLOG IMPORTS

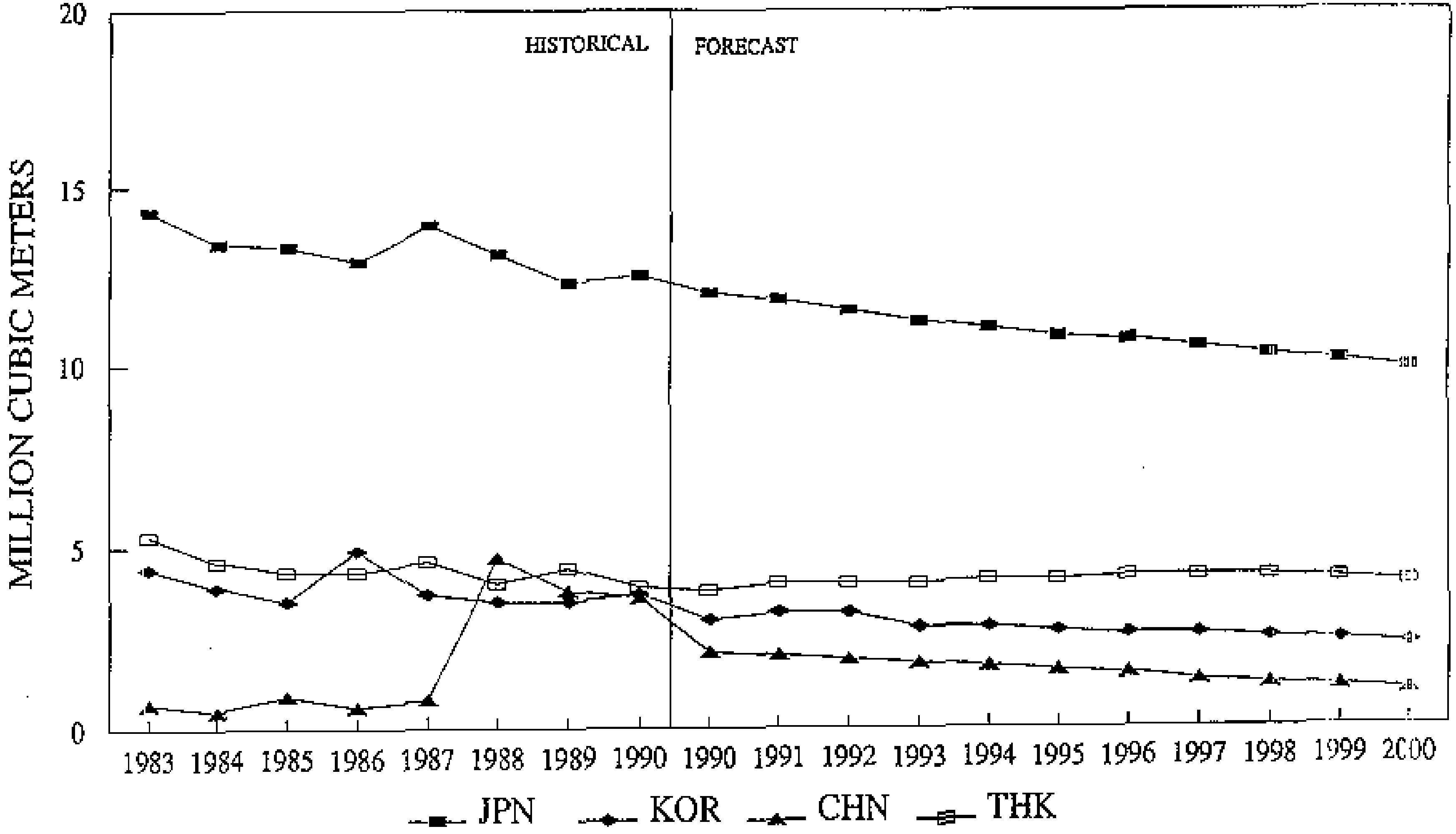
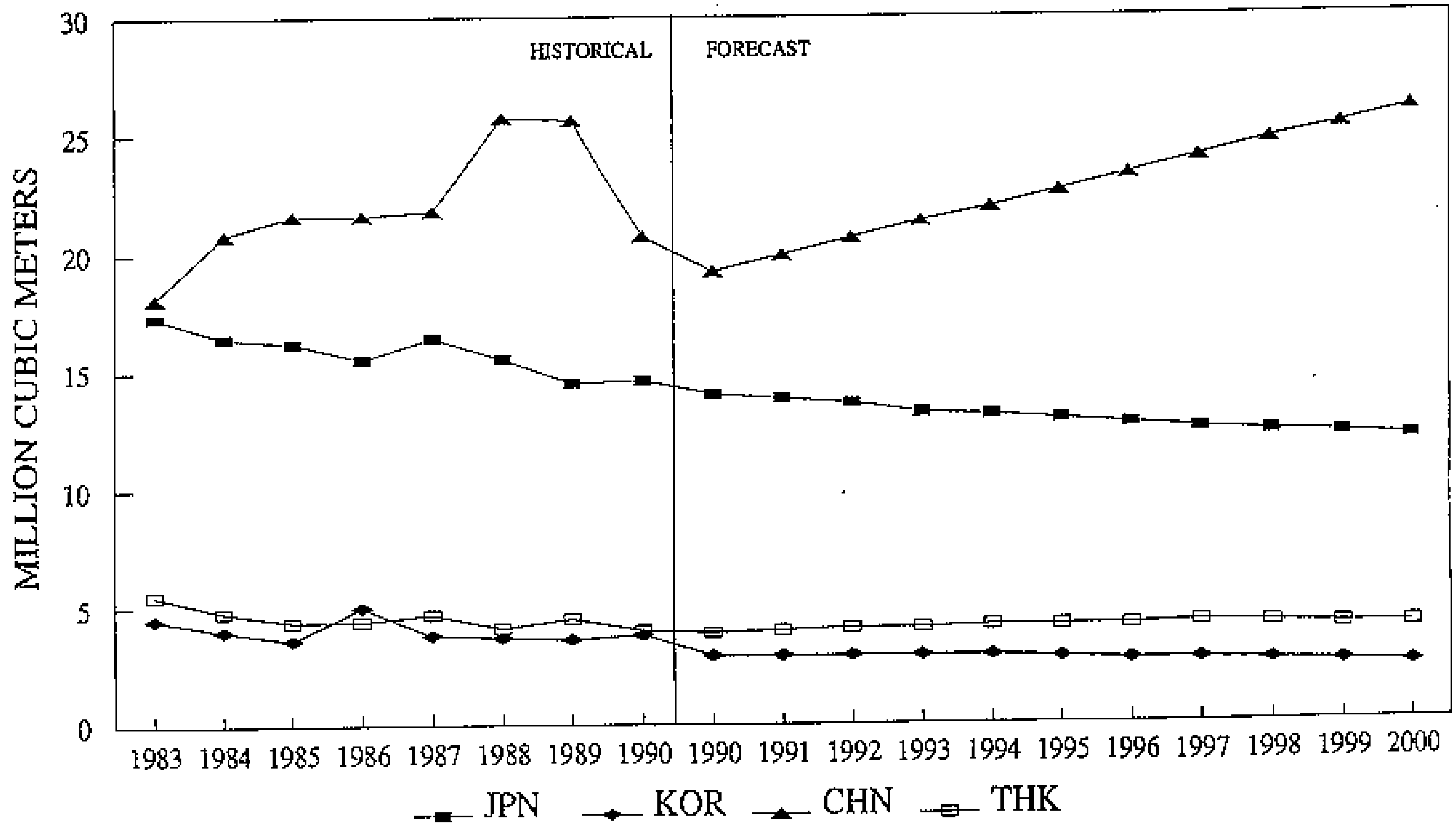


FIGURE 5.4: HARDWOOD SAWLOG CONSUMPTION



5.3 Temperate Hardwood Sources Reduce the Impact of Tropical Hardwood Producing Countries Marketing in Europe

Unlike the Southeast Asian region, log markets for tropical Africa and their connections to Europe are not well differentiated in the model. It is difficult to distinguish the temperate and tropical log uses directly without knowledge of bilateral trade flows. Even with access to such information, it would be hard to estimate the amount of temperate-tropical log substitution that would take place. Such a detailed analysis of substitution is beyond the scope of this study. Temperate-tropical substitution is assumed by the model where both sources exist. With the lower demand growth in Europe and the US, and the increasing inventory in temperate forests, there is no scarcity of hardwoods in these countries. While countries like Africa West might be expected to shift their exports to Asian consumers, their assumed production levels eventually fall short of local demands. Brazil, however, does increase its exports in sawnwood.

5.4 Hardwood Sawlog Prices Increase as Log Scarcity Grows

Log price behavior plays a critical role in sustainable forest management. All other things being constant, rising log prices imply increasing returns to stumpage, which should allow for higher levels of forest management investments. Figures 5.5-5.7 depict log price behavior in the major producing countries of Southeast Asia. The full world (temperate and tropical) weighted average price for all hardwood sawlogs is shown as FWA. The log shortage and rising prices being experienced in tropical hardwood countries is not shared by temperate hardwoods which as a consequence, show a much slower rate of price increase. The weighted average price for hardwoods in temperate regions is lower and not increasing compared to the increasing trend of tropical log prices in S.E. Asia.[3]

Growth rates of log price vary from 3.22% per year for the first half of the decade for Indonesia to 10.32% for the second half of the decade for Malaysia West. These projections imply a steady increase in the log price, and hence returns to stumpage. Table 5.2 reports the rate of price increase for several producing and consuming regions. Log price increases are greatest in Malaysia West, where severe log shortages occur. A portion of the price increase for Indonesia in Figure 5.5 can be related to the data discrepancies on volume that were described earlier. These show up as a substantial price increase from 1990 historical to 1990 projected. The price rate of change Table 5.2 excludes this discrepancy. Since there is probably not a comparable error in the historical price data, one could apply the rate of change projection for prices to the last 1990 price data point for an alternative price projection at least partially adjusting for the data discrepancies. These price projections have been provided as Figures 5.8 to 5.10, "Adjusted ... price projections."

[3] As a consequence, there is an increase in substitutes in European markets where temperate hardwoods are more readily available.

FIGURE 5.5: HARDWOOD SAWLOG PRICE PROJECTIONS

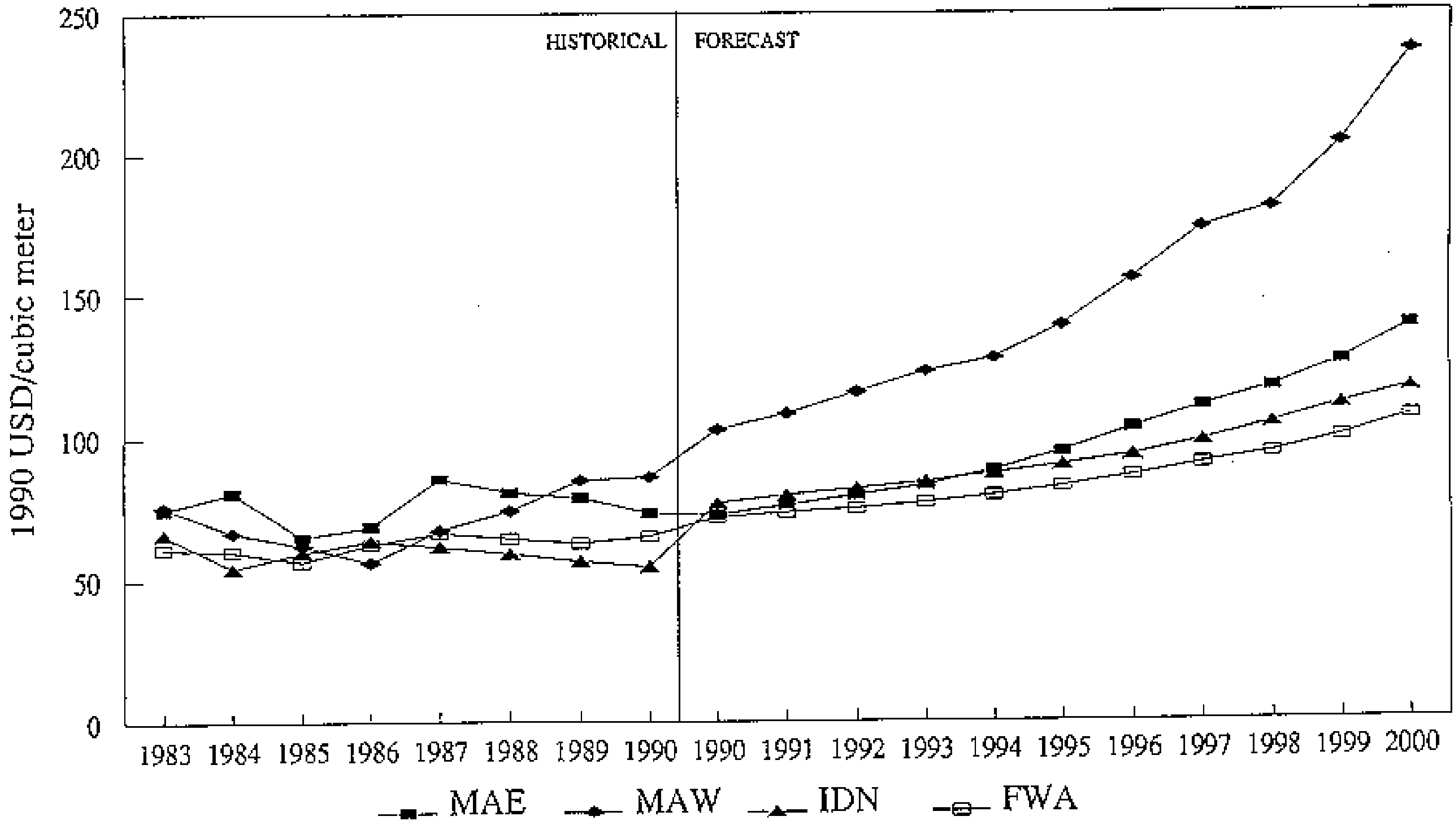


FIGURE 5.6: HARDWOOD SAWLOG PRICE PROJECTIONS

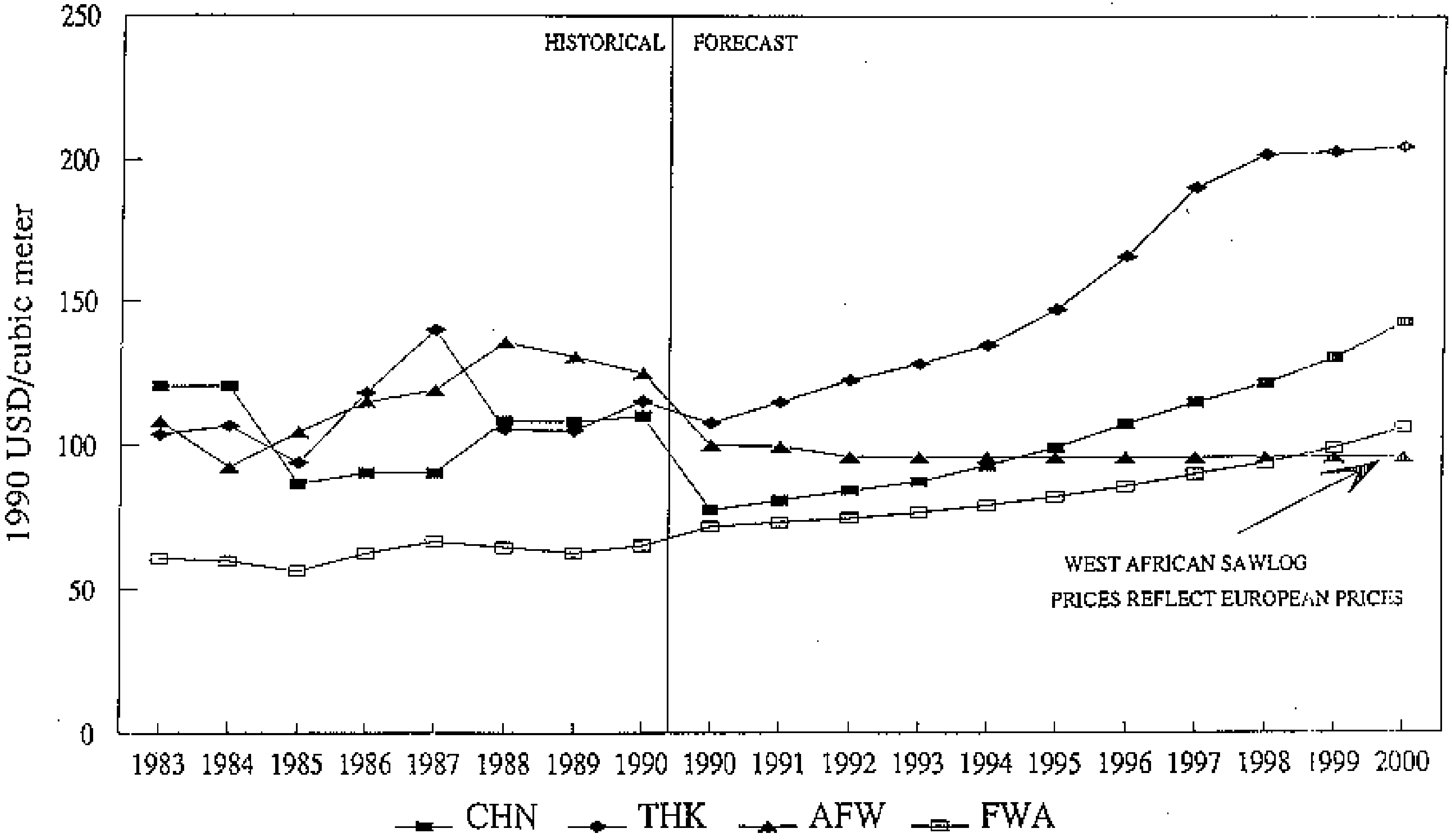


FIGURE 5.7: HARDWOOD SAWLOG PRICE PROJECTIONS

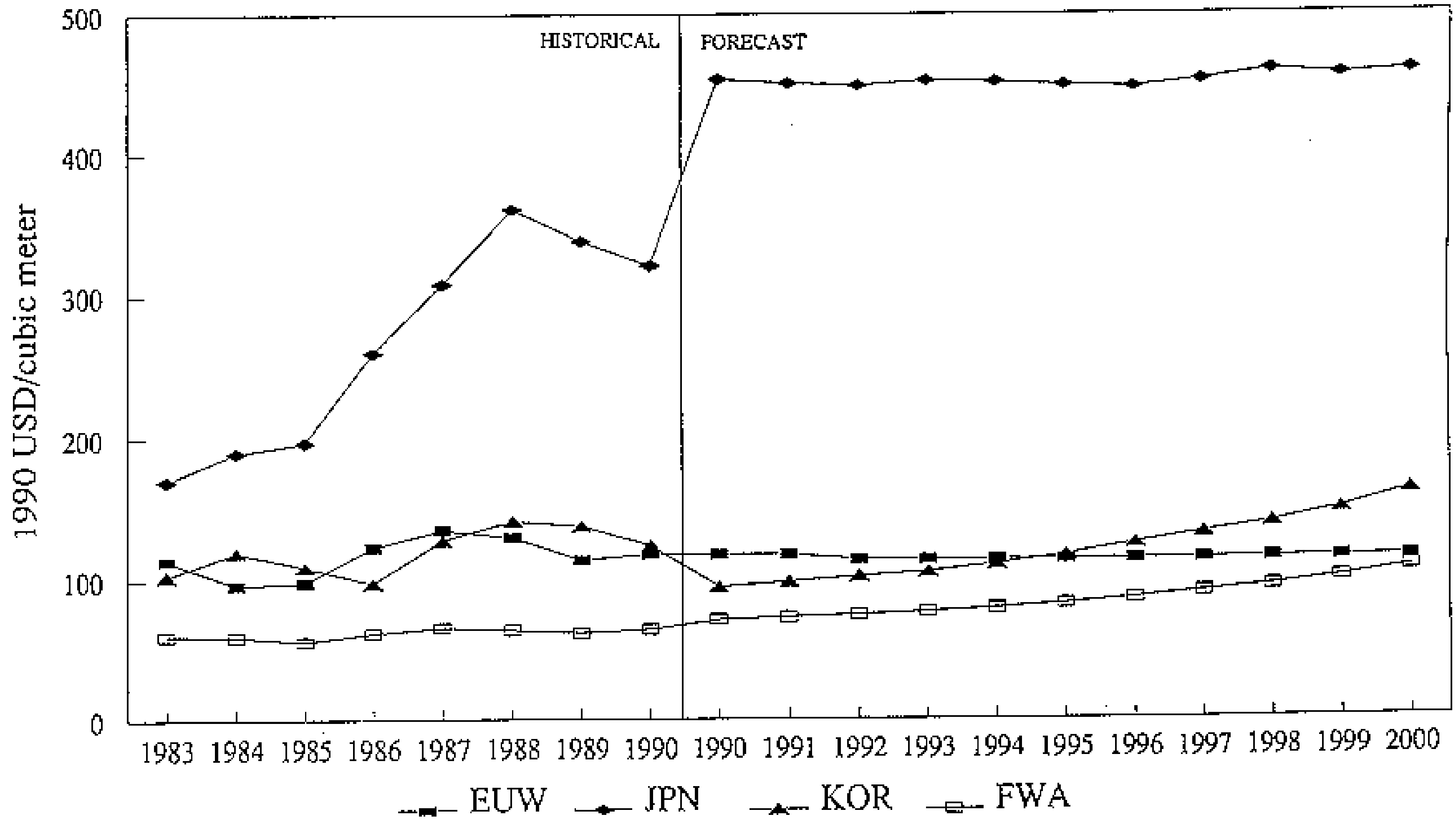


FIGURE 5.8: ADJUSTED HARDWOOD SAWLOG PRICE PROJECTIONS

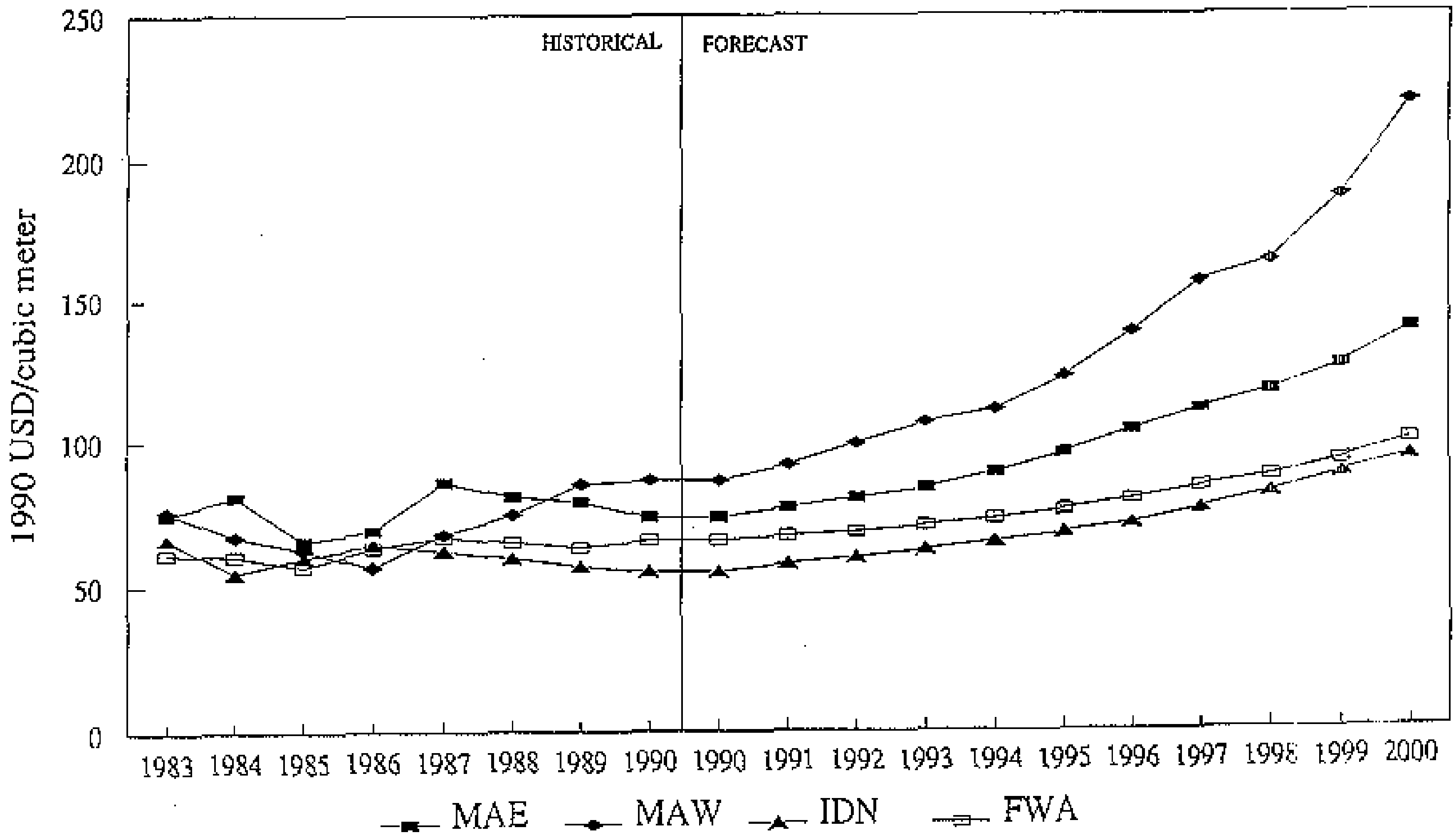


FIGURE 5.9: ADJUSTED HARDWOOD SAWLOG PRICE PROJECTIONS

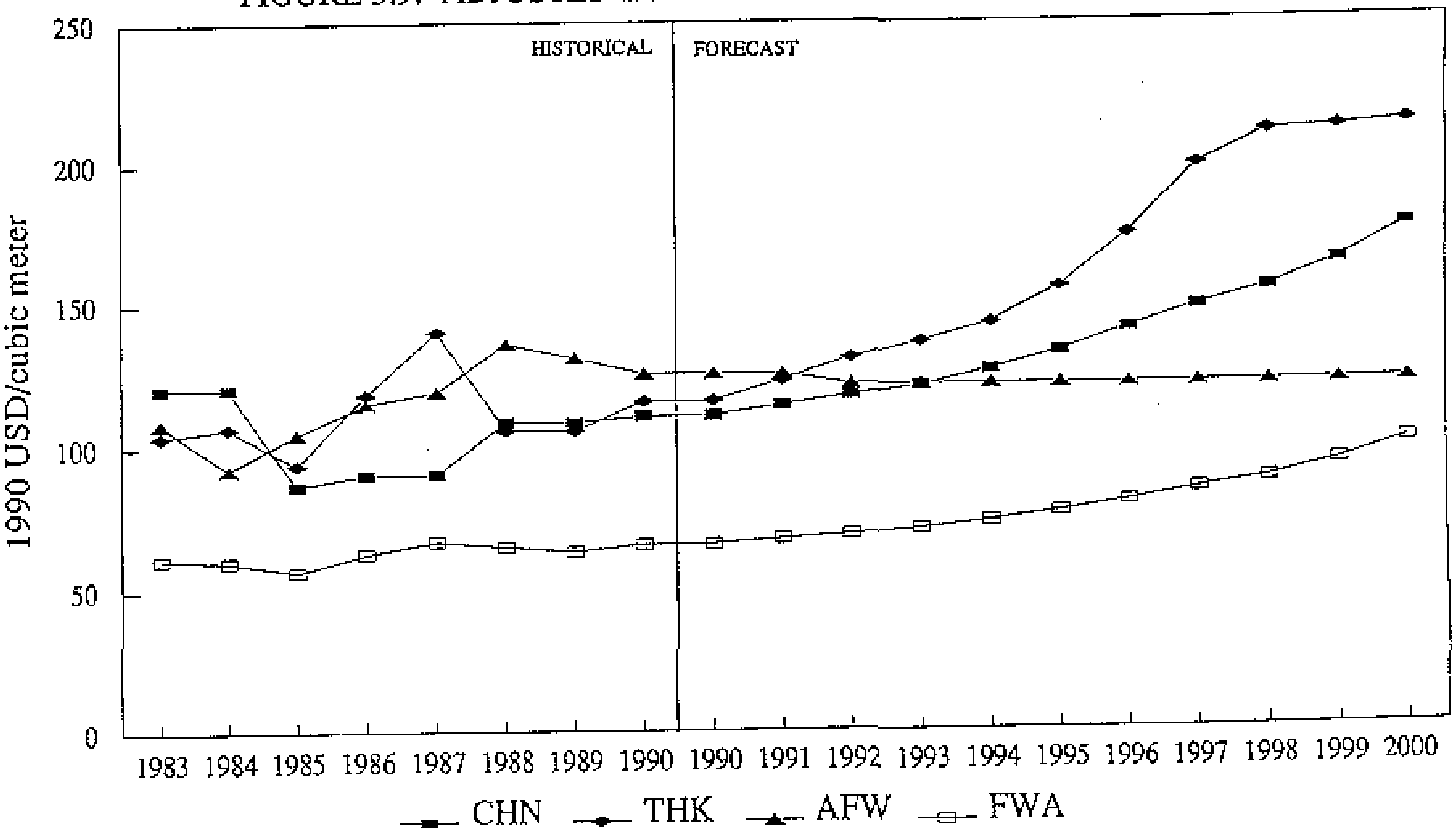


FIGURE 5.10: ADJUSTED HARDWOOD SAWLOG PRICE PROJECTIONS

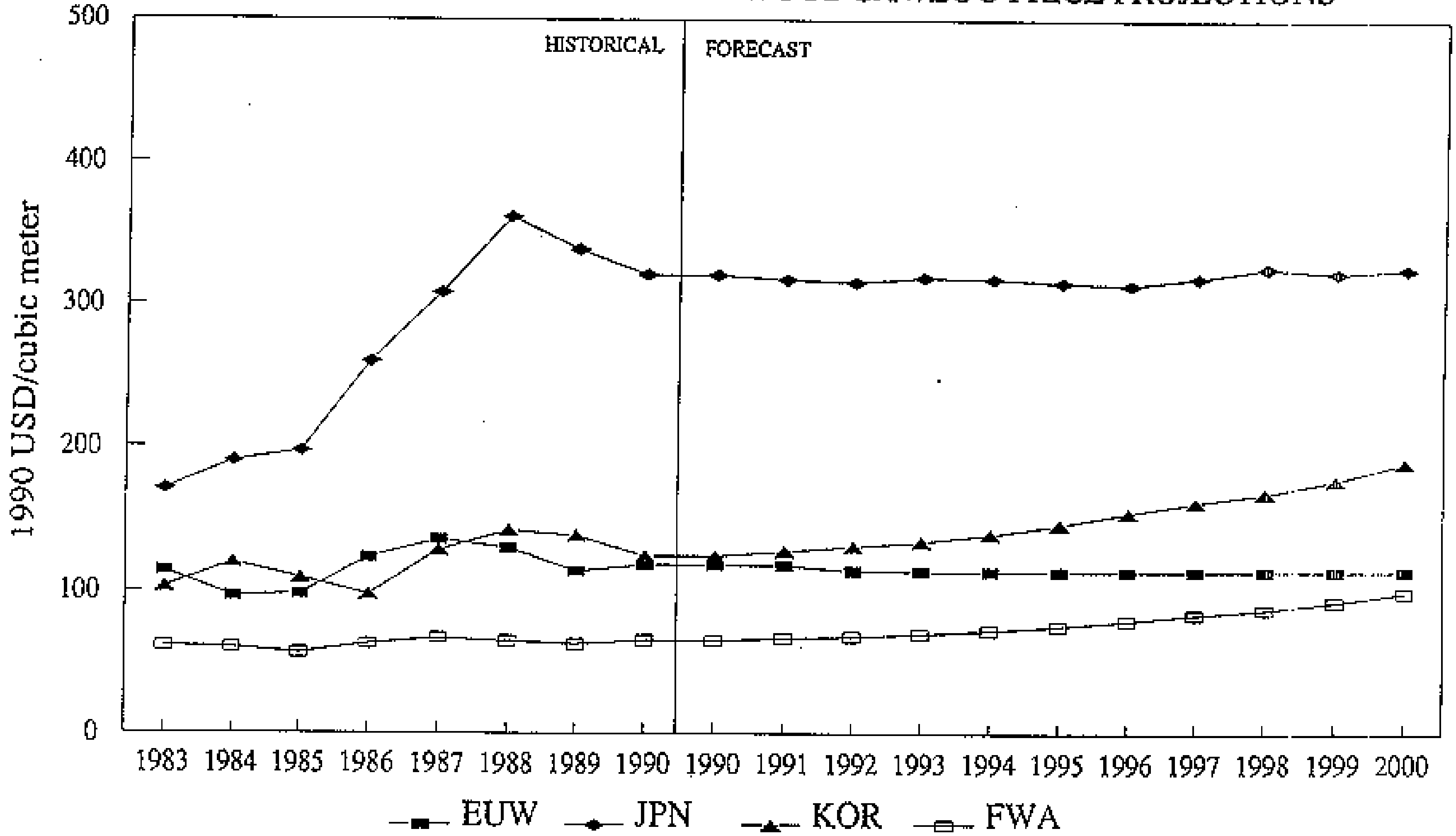


Table 5.2: Rate of hardwood log price growth for selected regions (in percent)

Region	1991-1995	1996-2000
Europe West	-6.60	0
Japan	-0.15	0.25
Korea	3.86	6.57
China	4.64	7.59
Taiwan-Hong Kong	6.74	7.04
Malaysia East	4.91	7.93
Malaysia West	6.28	10.32
Indonesia	3.22	4.81
Philippines	0.09	3.42
Africa West	-0.78	0

The extreme price increase for Malaysian West derives from rapidly rising demand for logs in international markets related to its rapidly declining inventory. Alternative trade channels might be developed to diffuse such a large price increase, such as log or product imports from countries other than Malaysia East. However, effective trade restrictions in place for Indonesia have reduced substantially the available quantities of logs on the international market. The model depicts the Malaysian West market as almost closed, with rapidly declining supply. In reality, prices will not rise as rapidly as projected, consequent to the need to make structural changes that open up the channels of trade.

Log prices in consumer countries increase in those Asian countries especially dependent upon tropical hardwoods. Much lower price increases occur in Europe with rising inventories of temperate hardwood substitutes. As a consequence there would be little upward pressure on tropical hardwood log prices from Africa West (AFW).

China sawlog prices increase in response to their steady growth in demand and sawlog consumption. Taiwan-Hong Kong's somewhat higher-priced and probably higher-quality logs also move up rapidly in price with nearly flat consumption. Japan's sawlog prices remain flat with declining consumption. Korean prices rise somewhat more than in Japan with smaller declines in consumption. Since all prices are reported in US dollars, the cross-country price differences include the impacts of potential currency biases as well as quality differences and distribution channel differences.

These price increases have an implication for sustainable forest management investments. First, if harvest and delivery cost increases are comparable to the historical period and rise more slowly than log prices return to stumpage should also increase. With constant real harvest and delivery costs, stumpage prices would grow with log prices. Thus, there is an opportunity to increase the rent capture from higher log prices through the application of higher royalty fees, or change the contractual arrangements to pay for more expensive logging in order to support sustainable forest management production agreements.

5.5 Production of Finished Products

5.5.1 Plywood

Production of hardwood sawnwood and plywood occurs in both the timber producing countries--such as Indonesia--and major timber consumers, such as Korea and Japan. Indonesia has been able to substitute exports of plywood for its earlier export logs. Indonesia now surpasses the production levels of Japan as the major producer of hardwood plywood. Figure 5.11 illustrates hardwood plywood production forecast for Indonesia, Japan and Korea under the BASE CASE. Hardwood plywood production levels remain relatively constant throughout the short term, with Korea showing a decline in production.

With no domestic source of wood, declining competitiveness from increases in labor costs, and a strong currency, Korea is faced with a more severe erosion in processing competitiveness and a greater dependence upon product imports. Figure 5.13 shows their rapid shift from plywood surplus to shortage made up by imports. Through log export bans, Indonesia has become the major exporter of hardwood plywood. Figure 5.12 demonstrates no discernable change in the level of plywood exports for the short-term forecast. This figure also illustrates the nature of trade data inconsistency problems. Total world exports for plywood in 1990 are reported as 14.2 million m^3 whereas importers report a total of 20.4 million m^3 in 1990.

The forecast for growth in the demand for plywood in Japan indicates a drop in plywood consumption. Demand declines by 13% by 1993 and remains constant to 2000 in Japan. With a sufficient supply of tropical logs, mainly from Malaysia East, Japan reduces its imports of plywood to zero in the short term as domestic production is able to fill demand.

Projections of increased construction activity in Korea, on the other hand, show the demand for hardwood plywood increasing by 50% by 2000. Since there is no growth in log imports into Korea, a projected increase in the consumption of hardwood plywood is met by increased levels of imports. These trends in hardwood plywood imports are illustrated in Figure 5.13. Import levels of Taiwan-Hong Kong and China are also illustrated but do not show a comparable increase. Korea is shown as the major importer of finished product as a consequence of its declining competitiveness in processing. Taiwan-Hong Kong maintains its level of log imports and does not need to increase plywood imports. Demand growth in China supports some increase in plywood imports as well as active log imports.

There are problems with the historical price series for plywood, which was derived from export value and volume data. We have not attempted to resolve the discrepancy but do believe the price changes in the projection period are still reflective of changing supply and demand conditions.

Price behavior for the plywood markets is illustrated in Figures 5.14-5.16. With the exception of Malaysia West, there is only a modest gain in the price for plywood in the various markets. The rapid rise of plywood prices in Malaysia West occurs because demand growth is much greater than supply; hence there is no way for Malaysia West to substitute supply from other regions for its domestically produced plywood. Allowing imports would reduce the Malaysian plywood price increase and constrain sawlog price increases as well.

FIGURE 5.11: HARDWOOD PLYWOOD PRODUCTION

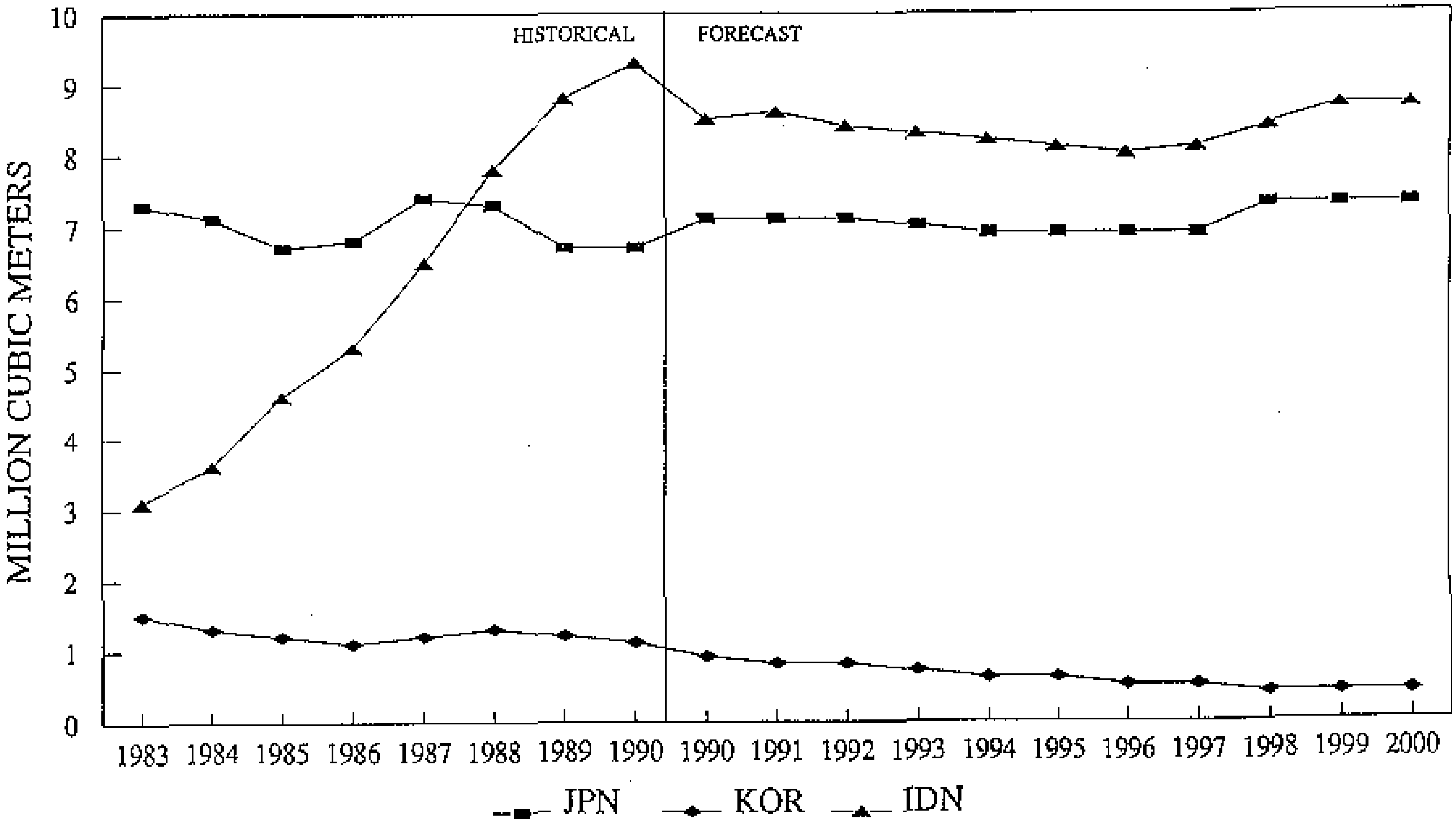


FIGURE 5.12: HARDWOOD PLYWOOD EXPORTS

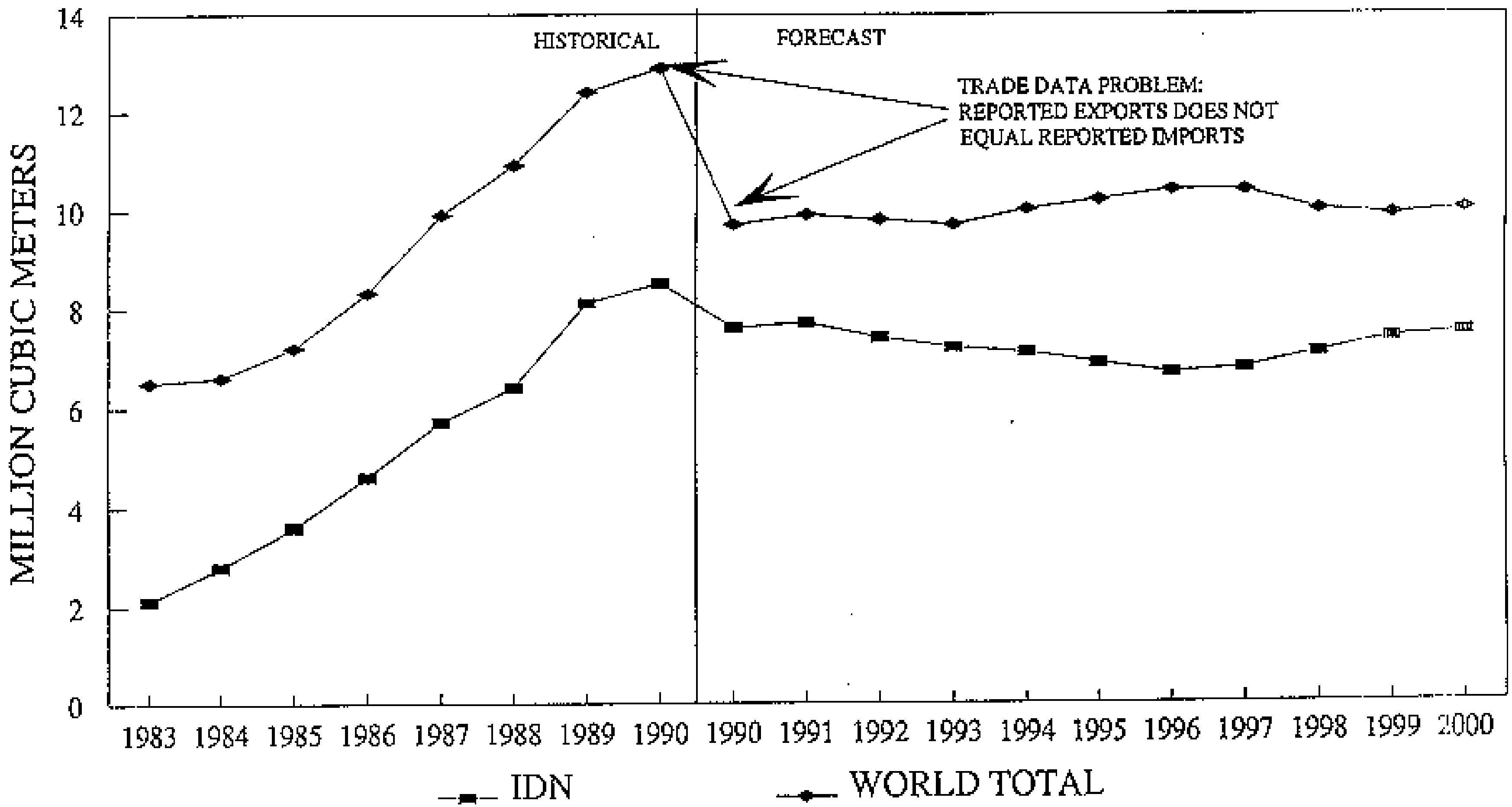


FIGURE 5.13: HARDWOOD PLYWOOD IMPORTS

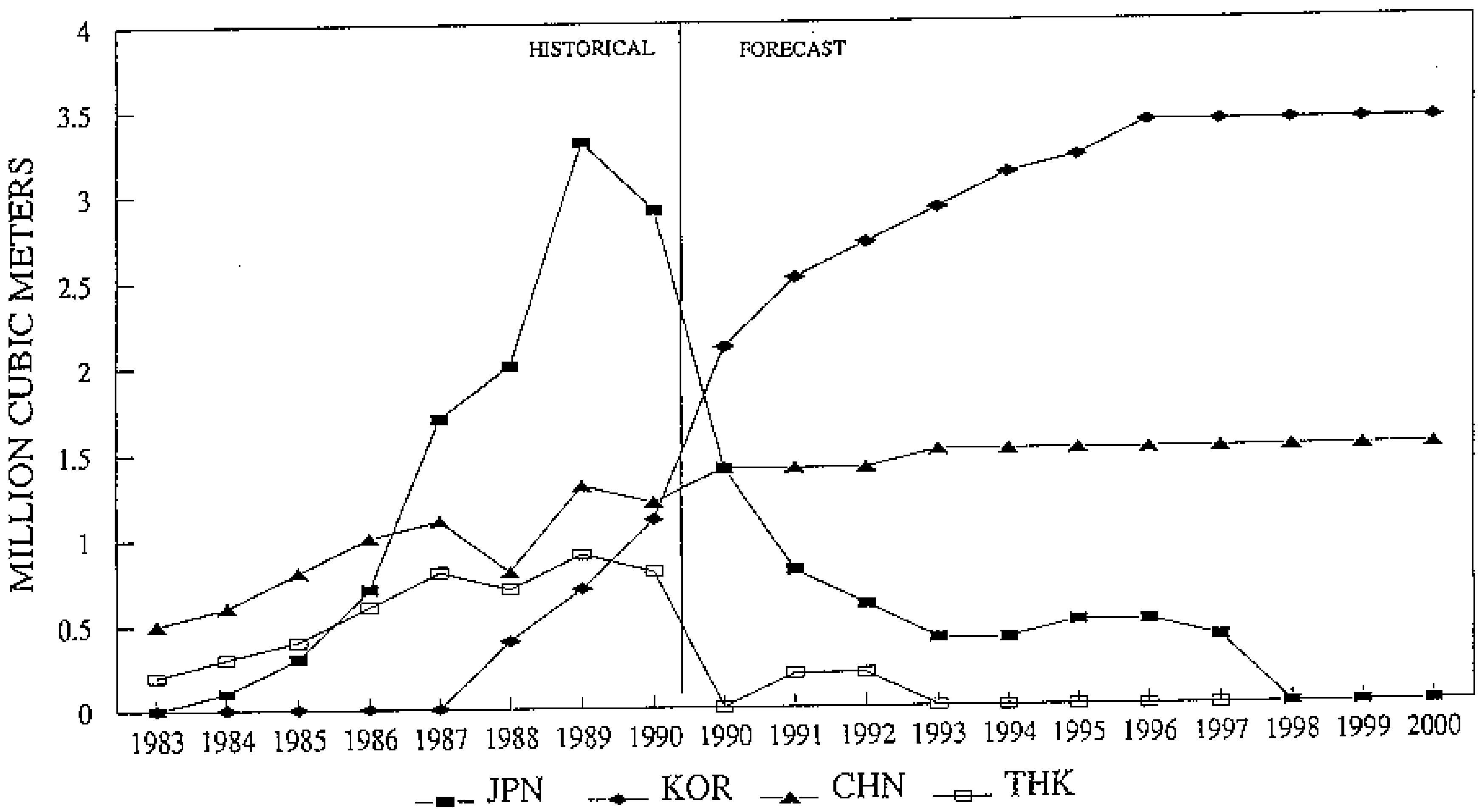


FIGURE 5.14: HARDWOOD PLYWOOD PRICE PROJECTIONS

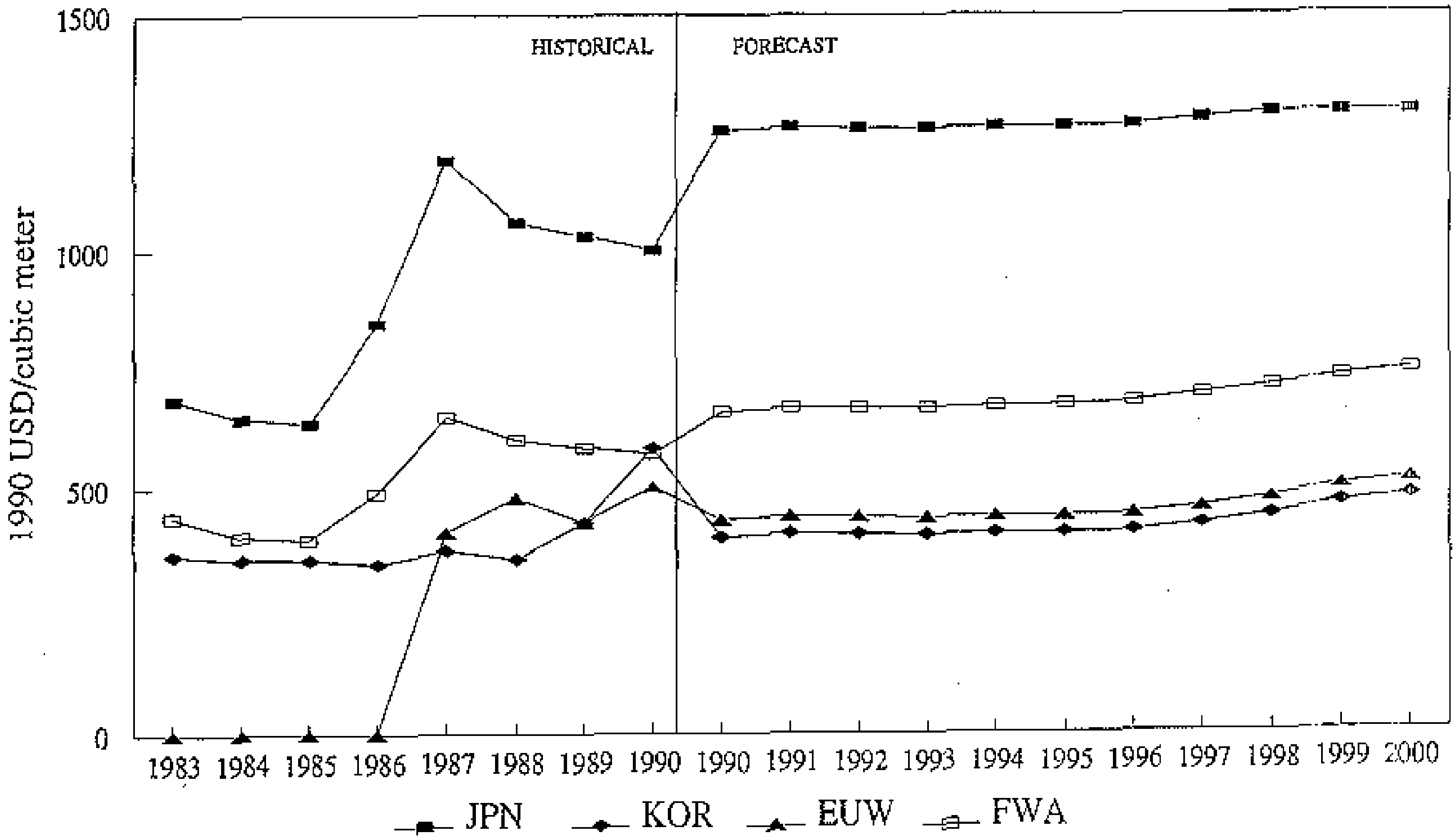


FIGURE 5.15: HARDWOOD PLYWOOD PRICE PROJECTIONS

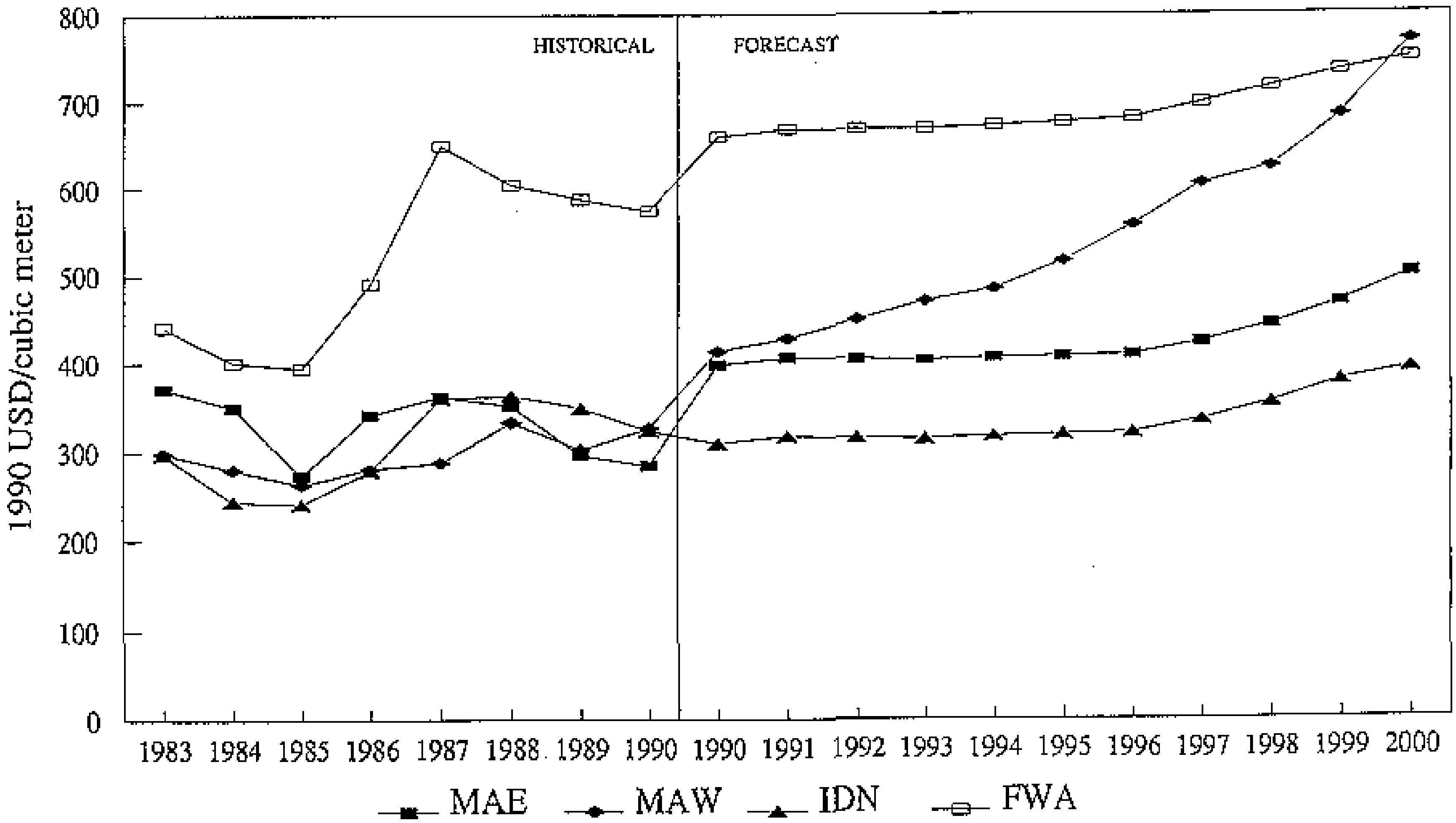
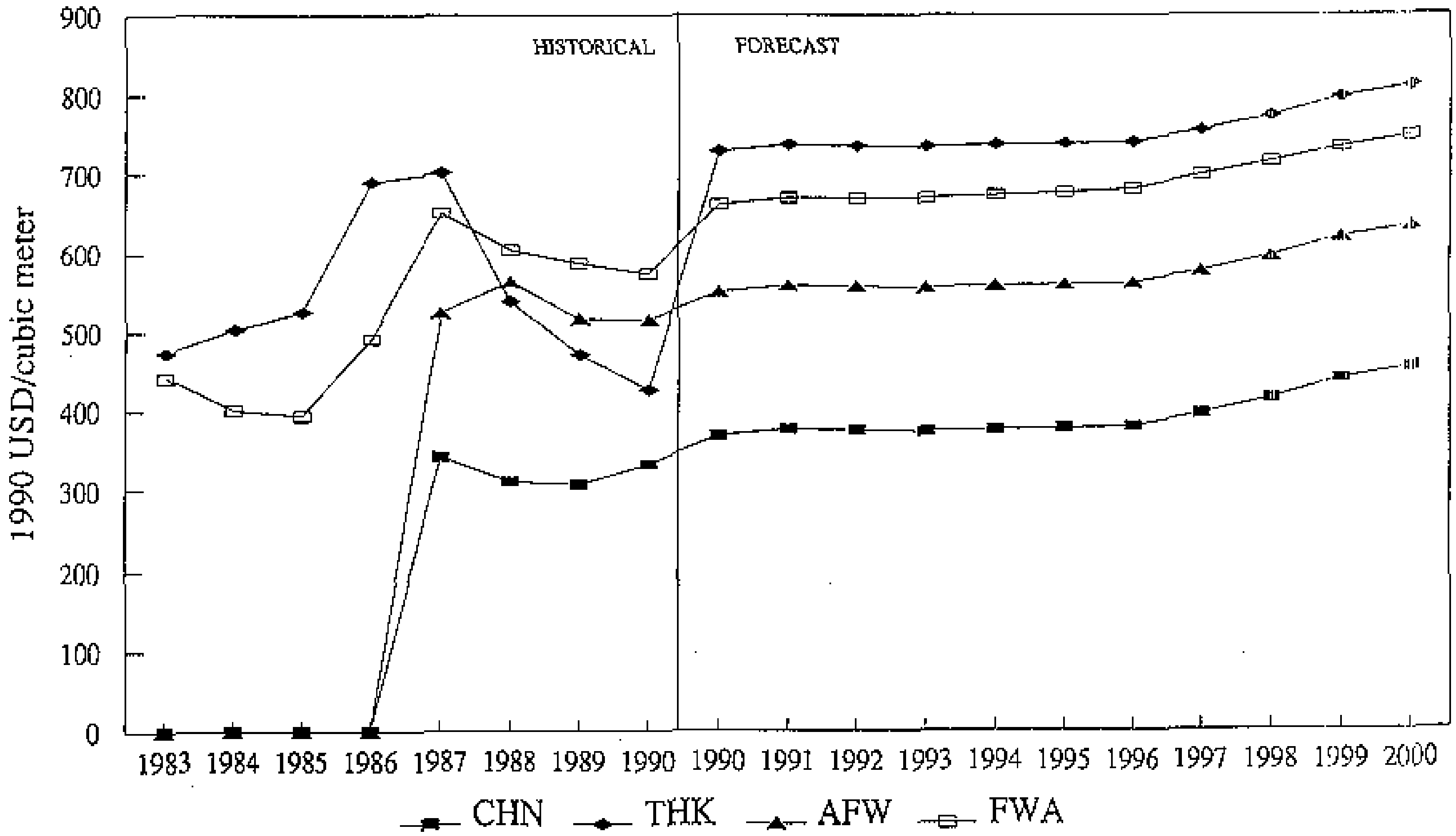


FIGURE 5.16: HARDWOOD PLYWOOD PRICE PROJECTIONS



It should be noted that imports to Malaysia West are zero under the BASE CASE. The rate of changes in prices is listed in Table 5.3.

The fact that plywood prices are not rising rapidly and production levels are flat suggests that the sawlog price increases are largely driven by declining supply. Plywood mill margins are therefore under great pressure with a shift in profits from the processing stage to timber production in the forest.

Table 5.3: Rate of hardwood plywood price growth for selected regions (in percent per year)

Region	1991-1995	1996-2000
Europe West	0.41	2.43
Japan	0.14	0.40
Korea	0.44	2.64
China	0.48	2.83
Taiwan-Hong Kong	0.24	1.49
Malaysia East	0.44	3.72
Malaysia West	4.50	7.70
Indonesia	0.57	3.32
Philippines	0.50	2.95

5.5.2 Sawnwood

Sawnwood markets behave differently than the plywood markets. First, domestic sawnwood production in Indonesia and the Philippines is primarily used to meet domestic demand. Only Malaysia West and Malaysia East export any significant amount of sawnwood; exports of sawnwood from Indonesia have dropped significantly by 1990 due to the imposition of an export tax in 1989. Second, Malaysia West has been the primary exporter of sawnwood in the past, through the imposition of a log export ban. Nevertheless, with decreasing timber harvest levels and increasing domestic demand for sawnwood, Malaysia West steadily reduces its exports of sawnwood from 4.2 million m^3 in 1990 to only 0.1 million m^3 by 2000. Malaysia East, with sufficient log supplies, increases its exports of sawnwood to capture the market previously held by Malaysia West. In total, however, exports drop from 6.0 million m^3 in 1990 to 4.2 million m^3. These trends are illustrated in Figures 5.17 and 5.18 for hardwood sawnwood production and consumption. Brazil provides 1.6 million m^3 of increased exports by 2000 making up for a portion of the Asian deficit.

Japanese import levels of sawnwood, however, are maintained in the short term. Imports are maintained at about 3.5 million m^3. Imports by Korea, China and Taiwan-Hong Kong decline as a consequence of reduced availability. These trends for the short term are illustrated in Figure 5.19.

Price projections for sawnwood increase steadily in Malaysia East and Indonesia. As in the plywood market, sawnwood prices in Malaysia West increase at a very rapid rate. These price projections for the three regions are shown in Figure 5.21. Similar trends in the price projections for the Japanese, Korean and European markets are illustrated in Figure 5.20.

FIGURE 5.17: HARDWOOD SAWNWOOD PRODUCTION

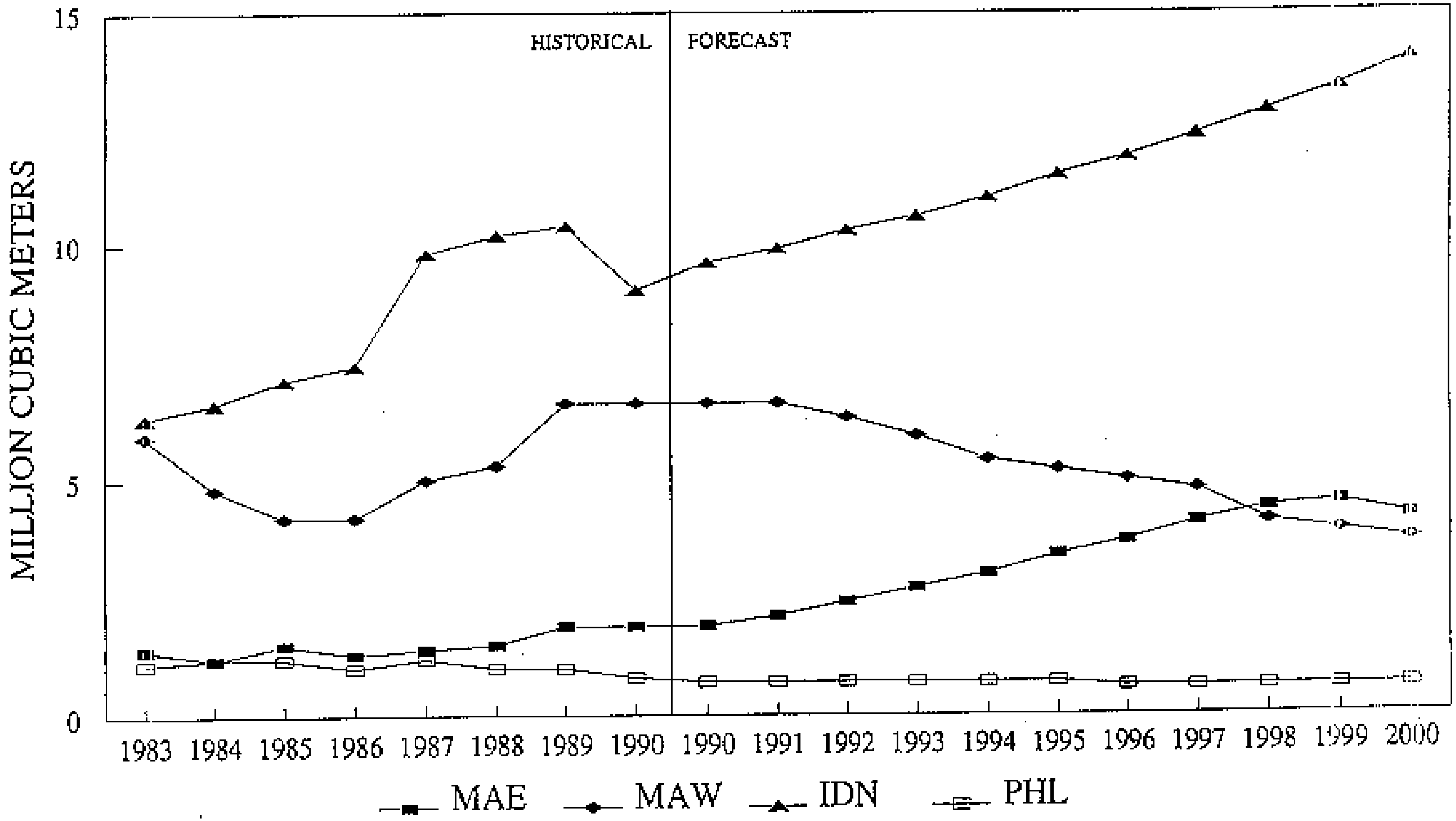


FIGURE 5.18: HARDWDOOD SAWNWOOD CONSUMPTION

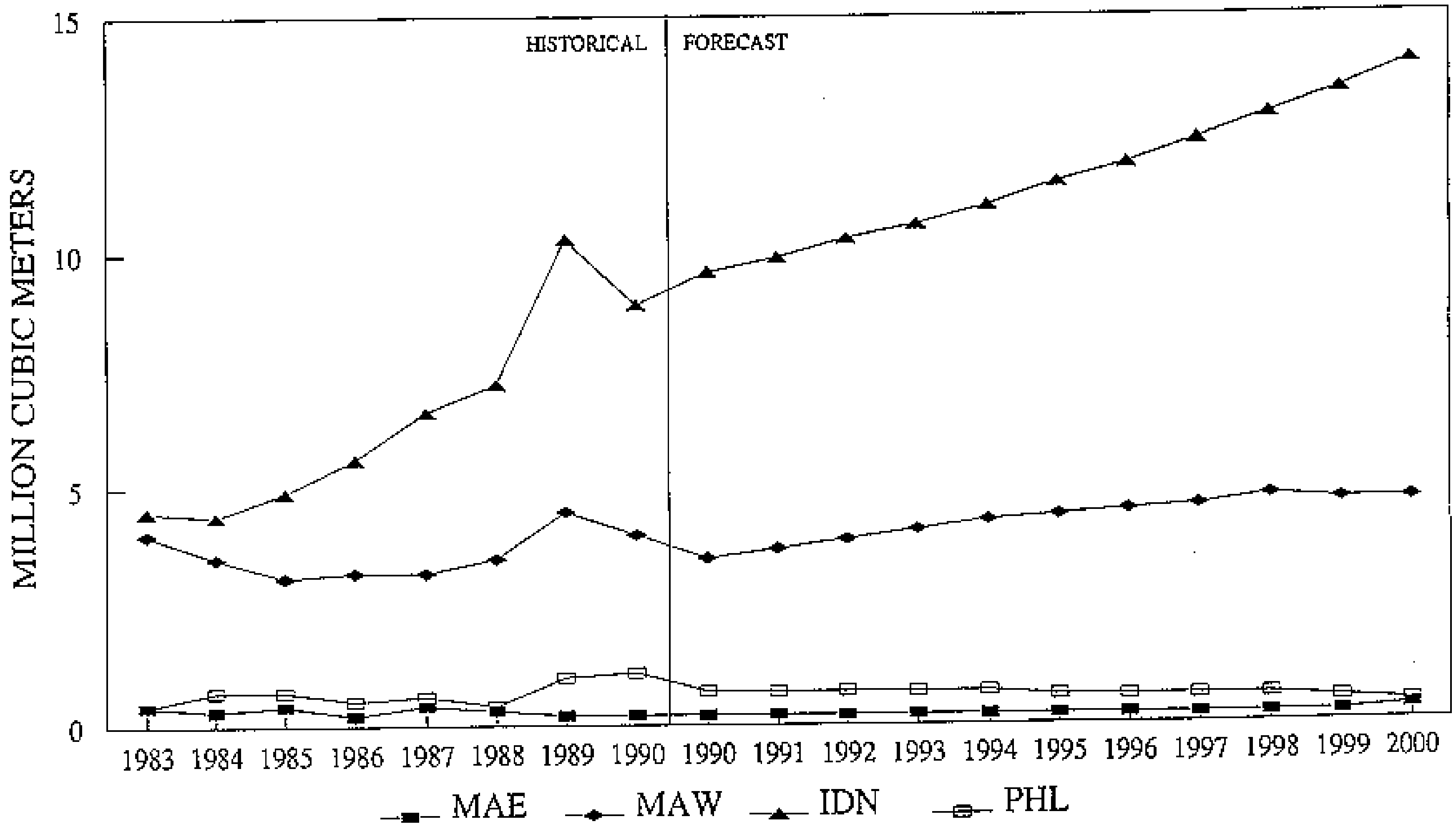


FIGURE 5.19: HARDWOOD SAWNWOOD IMPORTS

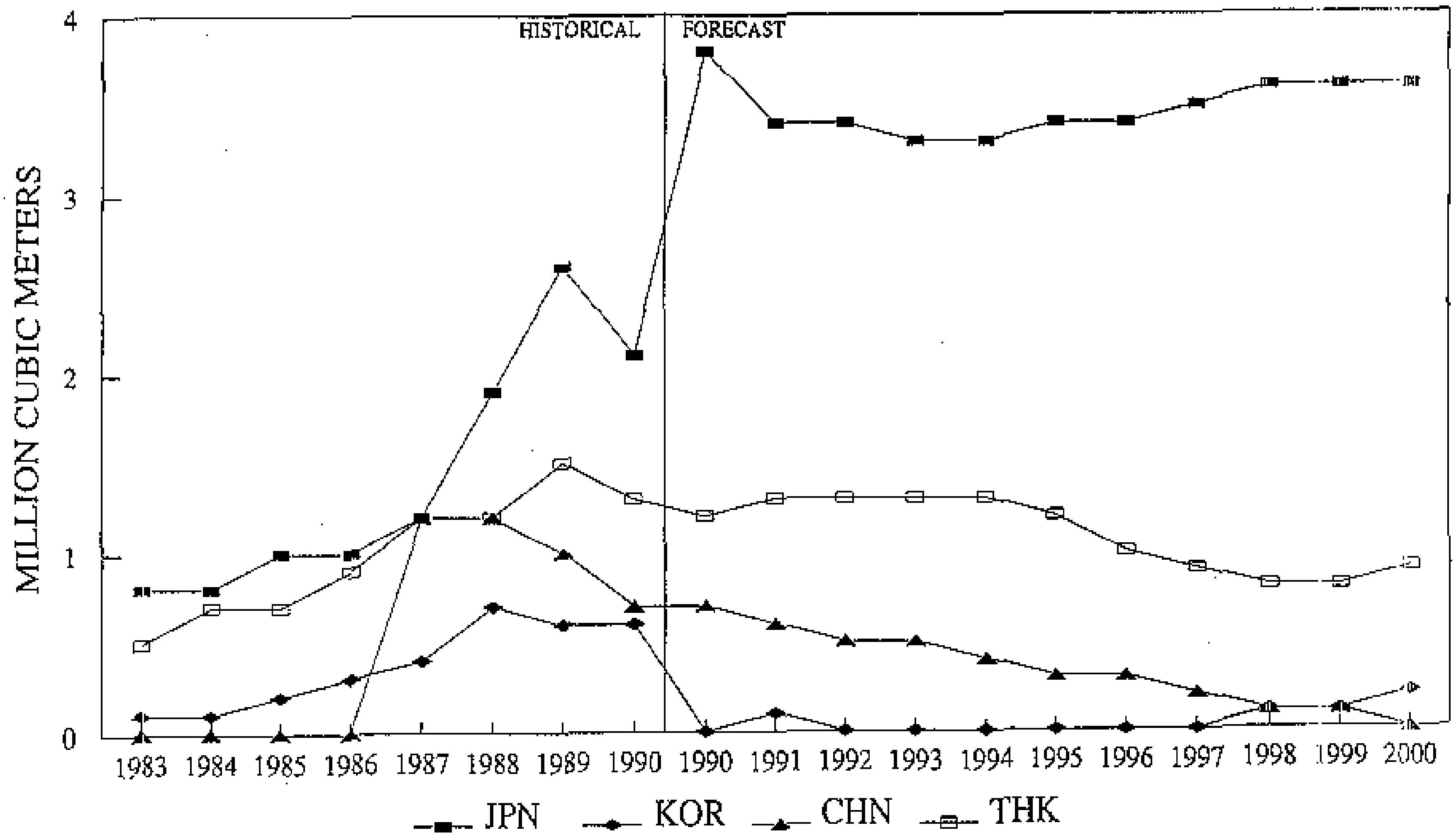


FIGURE 5.20: HARDWOOD SAWNWOOD PRICE PROJECTIONS

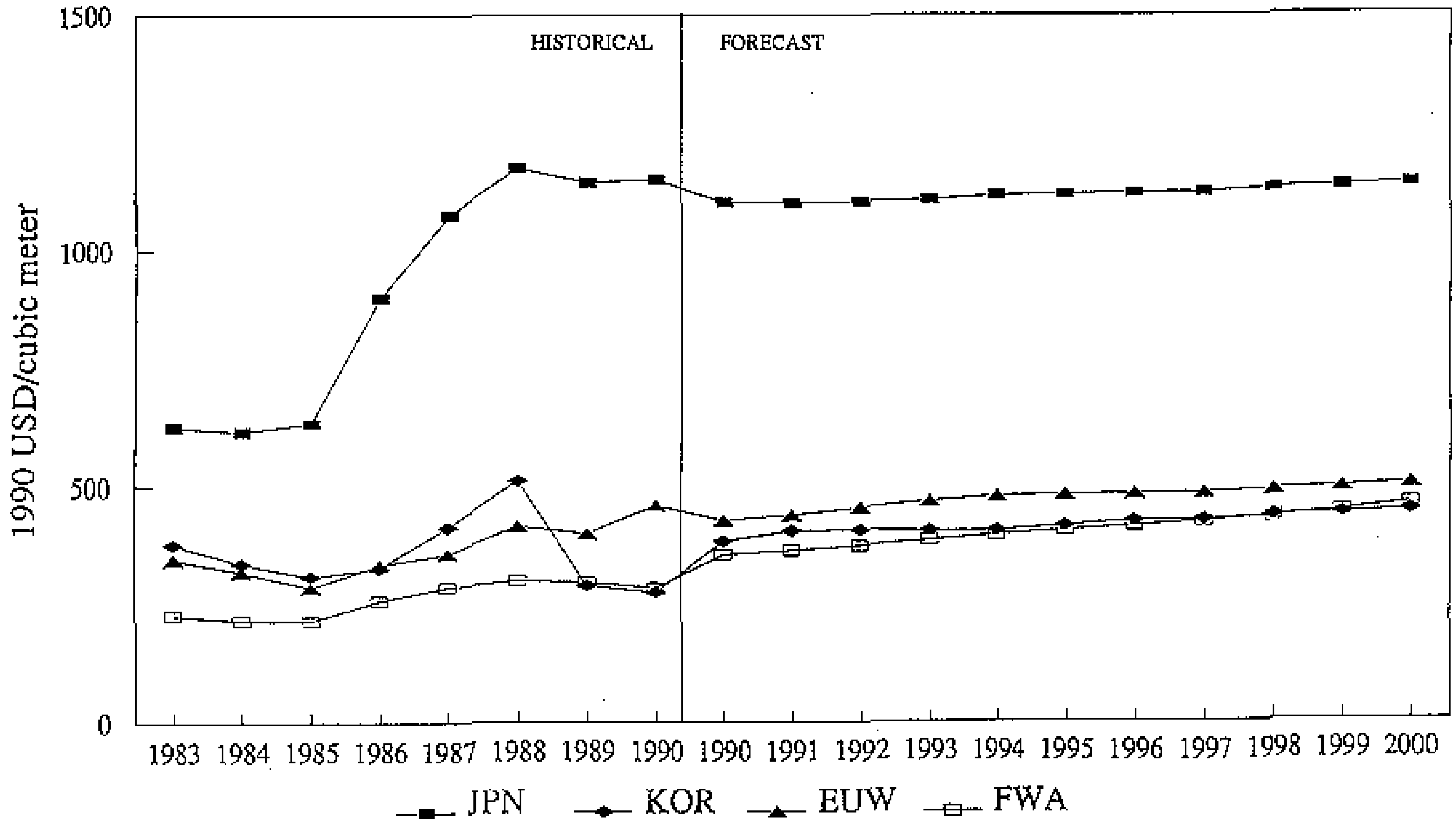
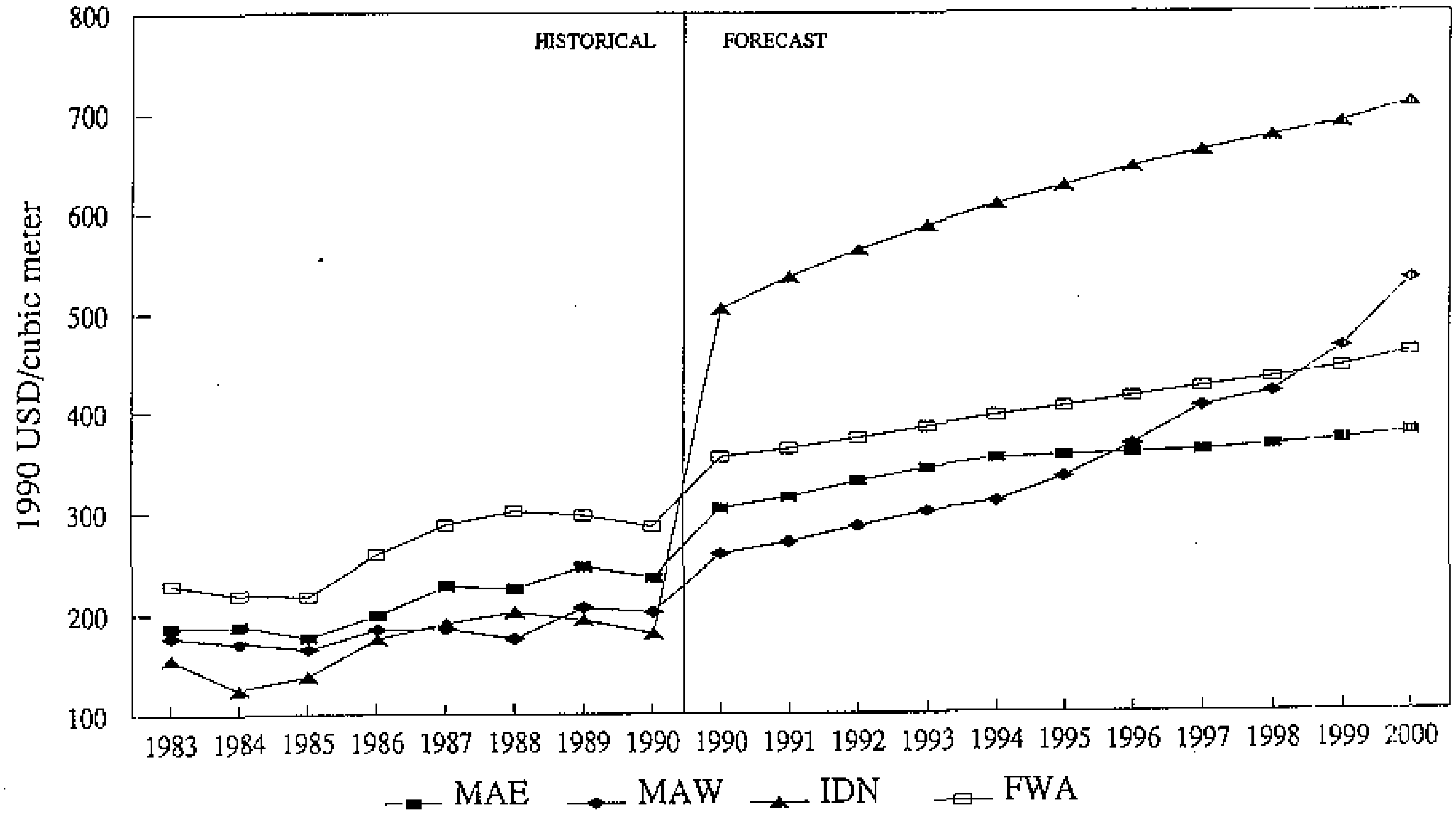


FIGURE 5.21: HARDWOOD SAWNWOOD PRICE PROJECTIONS



Finally, rates of price growth are provided in Table 5.4. It takes little price growth in Brazil to support increased exports. Africa West price growth is largely dictated by stable European markets.

Table 5.4: Rate of hardwood sawnwood price growth for selected regions (in percent)

Region	1991-1995	1996-2000
Europe West	2.53	0.74
Japan	0.38	0.32
Korea	1.55	1.61
China	3.60	3.60
Taiwan-Hong Kong	5.45	5.56
Malaysia East	3.49	0.99
Malaysia West	5.23	9.05
Indonesia	4.41	2.62
Philippines	3.91	7.38
Africa West	3.06	0.88
Brazil	1.20	0.01

The higher price structure of Japanese sawnwood allows Japan to maintain its volume of imports at the expense of other countries. In reality, if they do not accept a broader range in quality their share of imports may not increase as rapidly, since the lower -quality wood might continue to flow to other countries. The model does not distinguish these quality differences directly.

5.6 Summary of BASE CASE:

Shortages exist in tropical timber, not temperate hardwoods.

The decreasing inventory of tropical timber with declining harvests in Malaysia, Indonesia and the Philippines dominates the projection period to the year 2000. There are not sufficient alternative sources of tropical timber to offset these declines. Africa West's declining trend in log exports was assumed to continue even though the shortages projected in Asian markets would suggest that they could reduce exports to Europe and increase exports to Asian consumers. There is no shortage of temperate hardwoods, allowing the substitution of temperate hardwoods for tropical hardwoods, particularly in the US, Europe and other non-Asian markets.

Strong demand in tropical hardwood producing countries shifts markets away from exports.

With a strong growth in domestic demand in the tropical hardwood supply countries, and without a strong growth in demand in the other consuming countries, there is a substantial shift from exports to domestic consumption of tropical sawnwood and declines in log exports. The supply reductions are greatest in Malaysia West resulting in Malaysia East lumber production increasing as their log exports decline in order to help fill markets once held by Malaysia West.

Japan's needs are declining but they remain competitive log purchasers.

The highest-valued end-use markets in Japan continue to import even as demand declines. Improving domestic supply and continued losses in the share of wooden housing reduces the Japanese need for products. Japan's ability to sustain its imports drives down Korea's and China's imports, given the limited excess supply. Korea's high growth in demand can only be made up by increasing their product imports such as plywood. If Japan's strong preference for quality does not decline somewhat, they might not purchase most of the available logs, leaving somewhat more for Korea, Taiwan and China.

Southeast Asian sawnwood exports also decline.

Brazil increases sawnwood exports to offset a portion of the shortage experienced by Asian producers.

Plywood prices are constrained in consumer countries.

Plywood prices only increase substantially late in the decade after timber prices have risen considerably. Without strong overseas demand for plywood the squeeze will be on mills for profits as their profits are shifted back to the timber resource, the resource in shortest supply.

This of course is not so in temperate forests where supply is more plentiful, hence temperate processing will grow while the economic signals for tropical production will favor the tropical forest plantation rather than processors.

Malaysia West supply limitations are most severe, requiring new channels for imports.

The shortage of supply in Malaysia West is so severe that their prices tend to rise much faster than other regions. New import channels are likely to be developed that would prevent the full price lift for West Malaysian logs. The BASE CASE does not assume substitute sources beyond the immediate hardwood producing region, East Malaysia. Indonesia maintains and even increases harvest levels and production for part of the period but barely keeps up with domestic needs.

International data problems remain significant.

Several significant data problems are apparent. Indonesia's historical harvest appears to be understated given the usual assumption that the production of products data is more reliable and the analysis of recovery data is reasonably accurate. The step shift increase in volume from the historical reported data period to the computed demand for logs in the projection period is therefor unlikely as is the step increase in prices that corresponds with that volume increase. But these data problems are probably not seriously affecting the projected rate of change in prices.

Higher timber values will support more sustainable forest management.

Overall there is a much improved outlook for tropical timber prices. These higher values for timber should go a long way toward motivating more investments in the sustained management of timber, which in the longer term could support increases in supply. While there is the risk of substitution of softwoods, yield increases from technological advances and other new sources not included in the model to provide enough supply to dampen the projected price increases, these structural changes would likely occur as a response to rising prices rather than to prevent rising prices.

6. LONG-TERM POLICY PROJECTIONS: HARVESTS DECLINE TO SUSTAINABLE LEVELS

The objective of including long-term forecasts is to observe how resource markets behave given a demand outlook and a deteriorating supply outlook. Of particular interest are the shifts in harvest levels and subsequent effects on available inventory for the tropical timber producer. The Southeast Asian tropical timber producers are likely to experience large structural changes within the next two decades. These will have direct impacts on forest products markets. This scenario provides some insight into how these changes might develop, driven by the changing resource availability.

Projecting both a demand future for the globe and resource outlook is a risky task, however. Any model outcome will be quite sensitive to the future outlook in demand, excess production of other regions, and inventory growth. We have made no direct attempt to adjust inventory levels for possible feedbacks from more intensive management in sustainable production. However, as the available commercial inventory has approached depletion, we have modified the harvest levels to reflect targets that have been described as potentially sustainable. Given the low level of commercial inventory remaining in several countries at that point in time, one can infer that some of the targeted-harvest would have to derive from either what is considered the currently non commercial inventory or other technology improvements.

At the demand end, it is also difficult to project substitution effects directly. With these cautions in mind to constrain the framework of what information can be gained from long term projections, the assumptions for demand and resource development are described first, followed by a brief analysis of the scenario results.

6.1 Key Exogenous Forecasts

6.1.1 Demand

Demand forecasts are greatly simplified for the period 2000-2040 by observing GDP per capita growth and projecting product consumption.

6.1.2 Resource Development

As described in the BASE CASE, the inventory of commercial timber in Malaysia is approaching the zero level given harvest rates that are based on historic supply response behavior. The inventory level for commercial timber used in the BASE CASE is almost 1/2 of the total inventory estimated in these countries. Specifically it was noted that estimates of the commercial inventory being used in the World Bank study (*Tropical Deforestation in Asia and the Market for Wood*) were only 1/2 of the inventory data that had been developed in the research phase of the development of the model. Hence, the inventory was redefined to be a commercial inventory for the BASE CASE projection. Depletion of the commercial inventory does not imply depletion of all wood in the forest. But since the non-commercial inventory is largely left behind after harvesting of the commercial inventory, depletion of the commercial inventory appeared to be the more consistent modeling approach.

As the commercial inventory becomes depleted a problem develops. Will the harvest decline to levels no greater than the estimated growth per acre, or will a portion of the non-commercial inventory become commercial? And at some point will more sustainable management techniques and technology contribute some increase to the sustainable harvest rate?

While there may not be adequate data to develop a highly reliable basis for projections, some insights on the transition from harvesting the remaining commercial inventory to potential sustainable harvest targets can be gained. If the inventory is simply depleted and the harvest levels decline to near zero, the model behavior would produce results much like those observed for Malaysia West in the BASE CASE as it approaches very low inventory with harvest rates declining rapidly. Prices rise dramatically as supply falls short of even domestic demand and prices rise to keep the production out of the export markets. Since there will be structural changes in the markets given such extreme shortages, this long term projection assumes a conversion to lower harvest levels that have been suggested by others as potential targets for sustainable harvests. The sustainable harvest levels are phased in between the year 2000 and 2005.

Given the continued increase in the harvest levels of Malaysia and Indonesia, what is the impact of imposing sustainable levels of harvests in these two regions? Recent efforts by International Tropical Timber Organisation to implement sustainable timber harvest levels for Malaysia and Indonesia have yielded estimates of sustainable log productions. Log production levels for Malaysia West are expected to decline from 11.0 million m^3 to 4.7 million m^3 per year by 2000. Log production levels decline from 27.6 million m^3 to 12.4 million m^3 by 2000 in Malaysia East. Indonesian sustainable log production has been suggested to be around 25 million m^3, down from an estimated 30.5 million m^3 in 1990. This long term projection assumes these sustained harvest levels are implemented for Malaysia between 2005 and 2010. Harvest levels prior to that time are driven by the available inventory. Malaysia falls below the sustainable harvest levels, implying some degree of over-cutting. The sustainable harvest level also exceeds estimates of forest growth suggesting some of what has been defined as non-commercial inventory is being harvested. Since the suggested sustainable target for Indonesia implied a harvest of only 1% of the commercial inventory per year it did not seem appropriate to force a large reduction in the harvest rate for Indonesia. Instead it was prevented from further increases in harvest levels after 2010 even if prices increase. This projection therefore primarily demonstrates the impact of declining harvest levels in Malaysia East and West until 2005 when sustainable levels are phased in reaching the target levels of 4 million m^3 for Malaysia West and 12.5 million m^3 for Malaysia East by 2010.

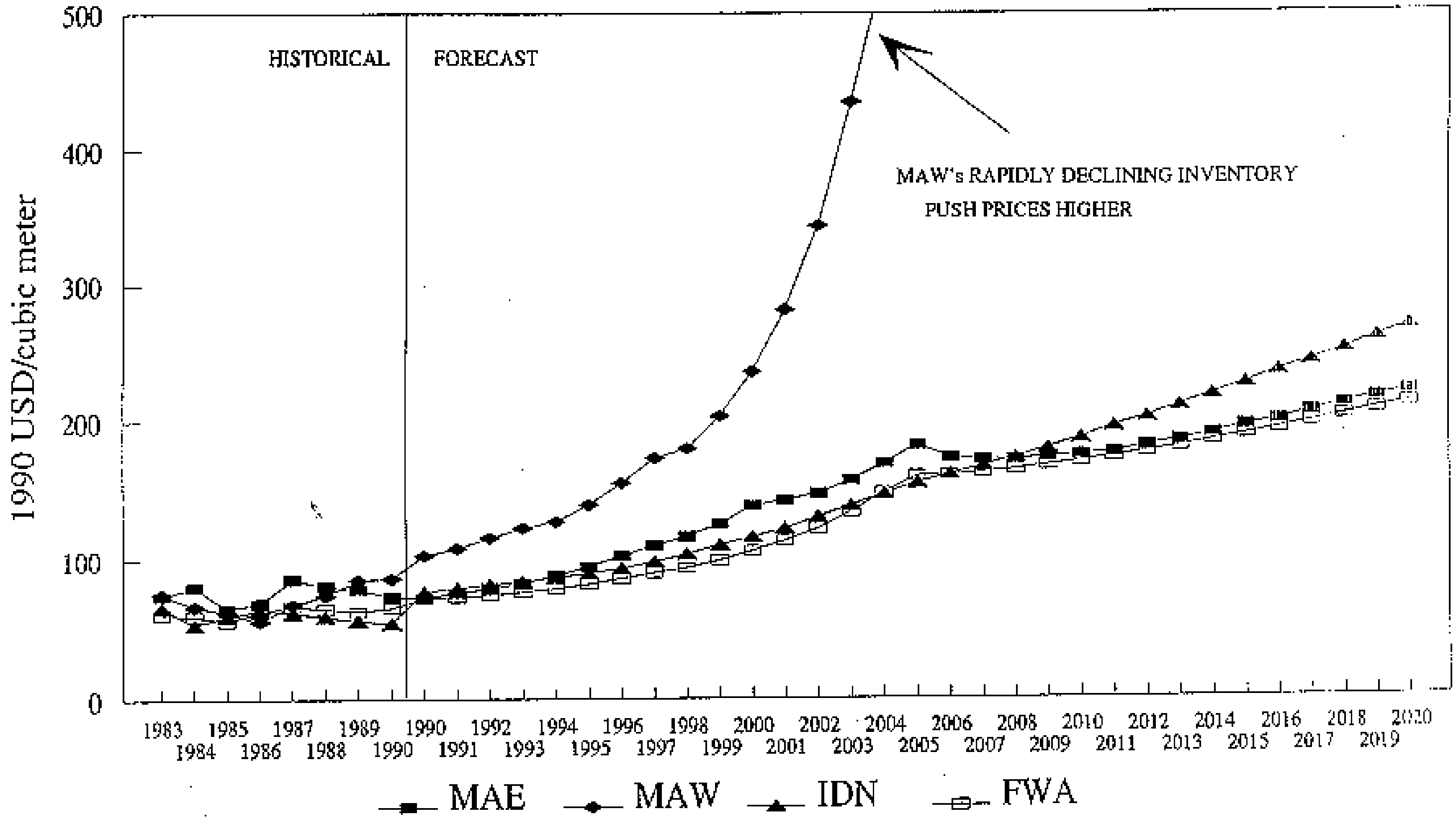
6.2 Long Term Outlook Issues

6.2.1 Sawlog prices continue an upward trend

Figure 6.1 illustrates the sawlog price projections for tropical hardwood suppliers beyond the year 2000. The shortage of wood in Malaysia West becomes virtually complete by 2005. The price increases are essentially unlimited although with very low volume, but are capped in the simulation as harvest is increased to the targeted sustainable harvest levels after 2005. This issue was already identified in the short term outlook. Alternative import channels will no doubt be developed to relieve the Malaysia West shortage including non-wood substitutes.

Of greater importance is the continued upward trend in sawlog prices in all regions, which will provide even greater support for sustainable forest management. Malaysia East log prices move up more rapidly by the year 2000 as their production drops with depletion of the timber inventory. By 2005 prices are \$20 per m^3 above the world price and the Indonesia price. By 2010 their production has increased to sustainable levels, which are above the low point; thus, price increases slow down and fall below the increases shown for Indonesia. By 2020 the Indonesia price is about \$50 per m^3 above the world price and the Malaysia East price. The slowdown in price increases after 2005 results from the harvest to the targeted sustainable levels that are higher than the low harvest point just prior. If the harvest transition was less abrupt, without a dip, the price lift prior to 2005 would have been muted. If the sustainable harvest level has been overestimated, prices would be expected to continue to increase with lower harvest rates.

FIGURE 6.1: HARDWOOD SAWLOG PRICE PROJECTIONS



The higher prices begin to change the usage of wood in other countries. With declining wood demand in Japan, for example, the higher prices by 2005 cause imports of logs to decline. Figure 6.2 shows this decline in Japan's log imports as prices peak. Figure 6.3 shows consumer countries' log prices peaking as imports start to decline.

6.2.2 Plywood prices in producer countries rise slightly faster than world prices

International plywood prices do not rise as rapidly as do the prices in tropical producer countries with weaker demand and alternative supply sources. Tropical producer prices are therefore pushed up by log prices, squeezing plywood processor margins. The Malaysia West wood scarcity shows up again as an out of control price spiral in order to keep all volume for domestic consumption. The impact is capped by 2005 with the introduction of sustainable harvest levels as described above. These price trends are illustrated in Figure 6.4.

The decline in plywood price trends in other regions after 2005 is largely the result of shifting to sustainable harvest levels, reversing the declines in harvest.

6.2.3 Sawnwood prices rise more slowly than log prices unless domestic demand exceeds capacity

While the data problems with Indonesia supply and sawnwood prices are severe, the trends in sawnwood prices are evident. Malaysia West sawnwood prices spiral out of control for the same reasons described above for plywood. Without an alternative supply, prices attempt to keep the declining supply for domestic consumption.

Malaysia East, with a surplus in wood above domestic needs, shows a continuing upward price trend in sawnwood but slower than world markets and more importantly, slower than log prices. These price trends are illustrated in Figure 6.5.

6.3 Summary of key long term issues: The commodity in short supply is tropical hardwood logs, not processing capacity

Log prices rise faster than product prices. The highest value return is for logs. Processing margins will be squeezed until there are increases in harvest from investment in sustainable forest management. This outlook scenario does not attempt to characterize what time frame will be required to see that impact. The sustainable harvest levels imposed after the year 2010 do not include the impact of improved management but they do infer harvesting more than what has currently been defined as commercial inventory for Malaysia. While consumer countries are largely forced to accept higher prices, they do begin to change their usage to reduce the impact of price increases. Japan, the major importer, reduces its imports of logs. There are many other substitutes not characterized in the model that might be expected to increase their share, reducing the rate of price increases. The domestic demand in the tropical hardwood producing countries becomes a much more important part of their overall market.

Even with sustainable harvest target rates that might be considered optimistically high sawlog price projections rise by 100% over 1990 levels by 2010 and almost 200% by 2020. While there are many possible impacts not considered in this simulation to slow the increase in

FIGURE 6.2: HARDWOOD SAWLOG IMPORTS

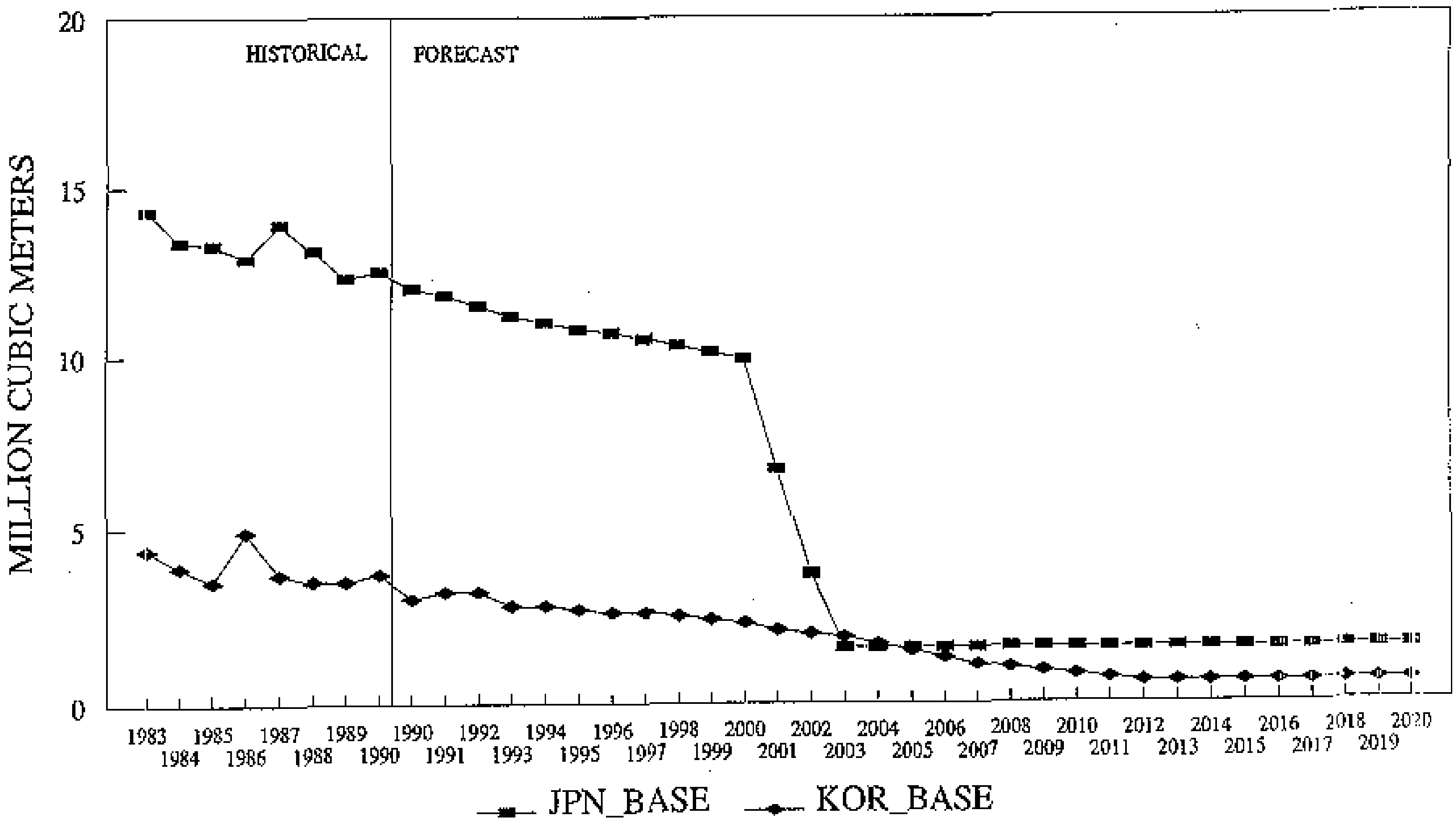


FIGURE 6.3: HW SAWLOG PRICE PROJECTIONS

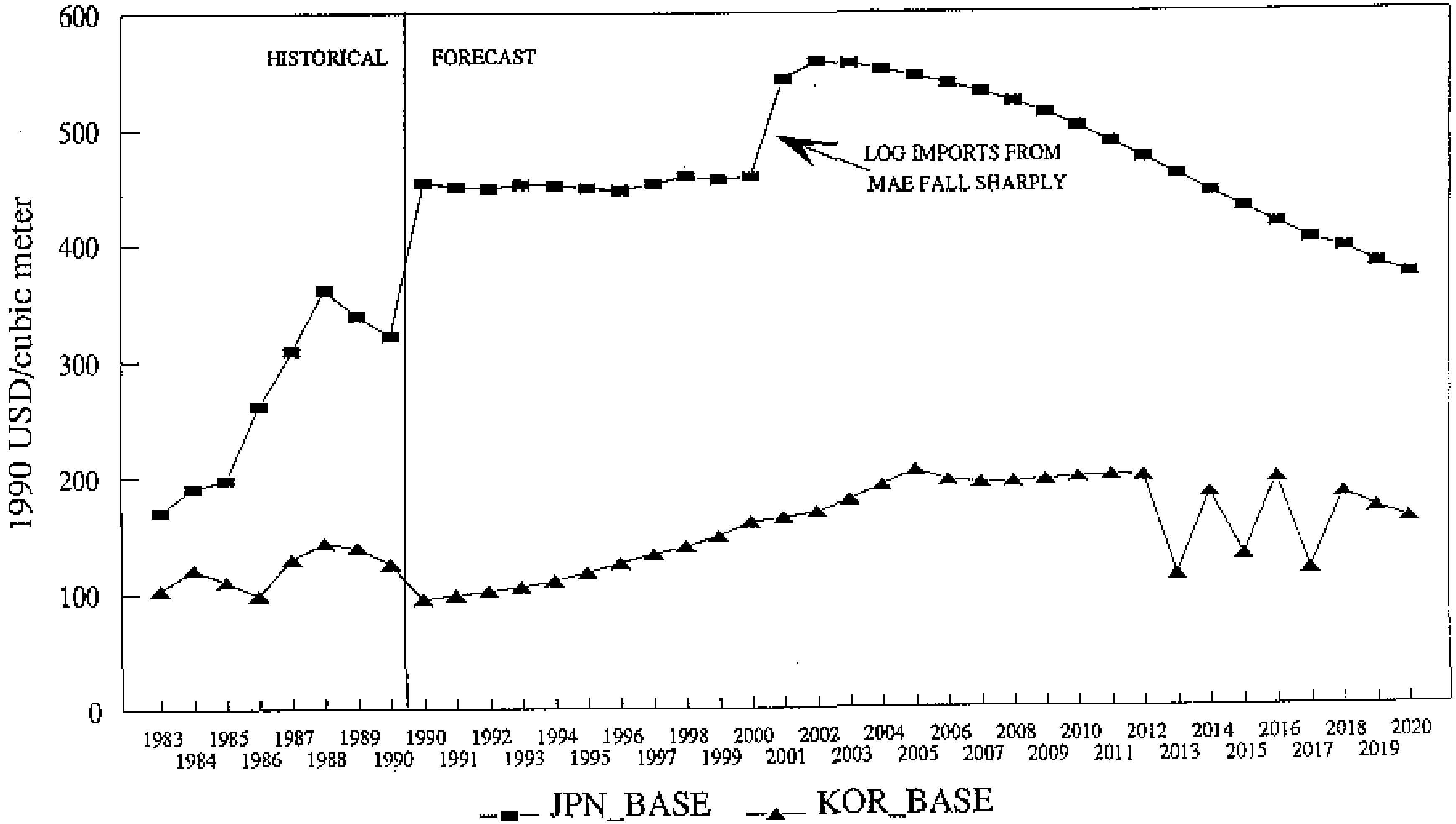


FIGURE 6.4: HARDWOOD PLYWOOD PRICE PROJECTIONS

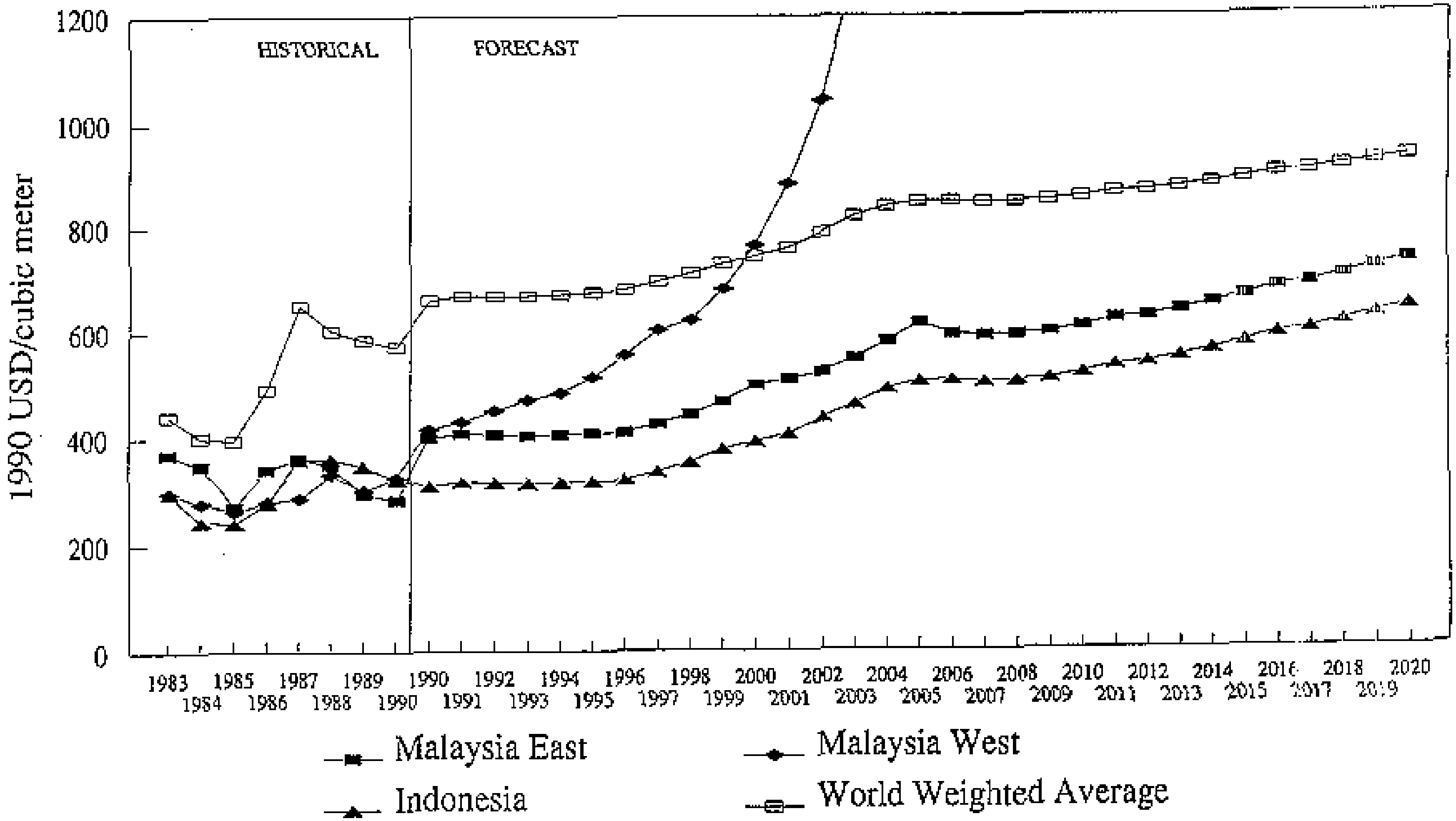
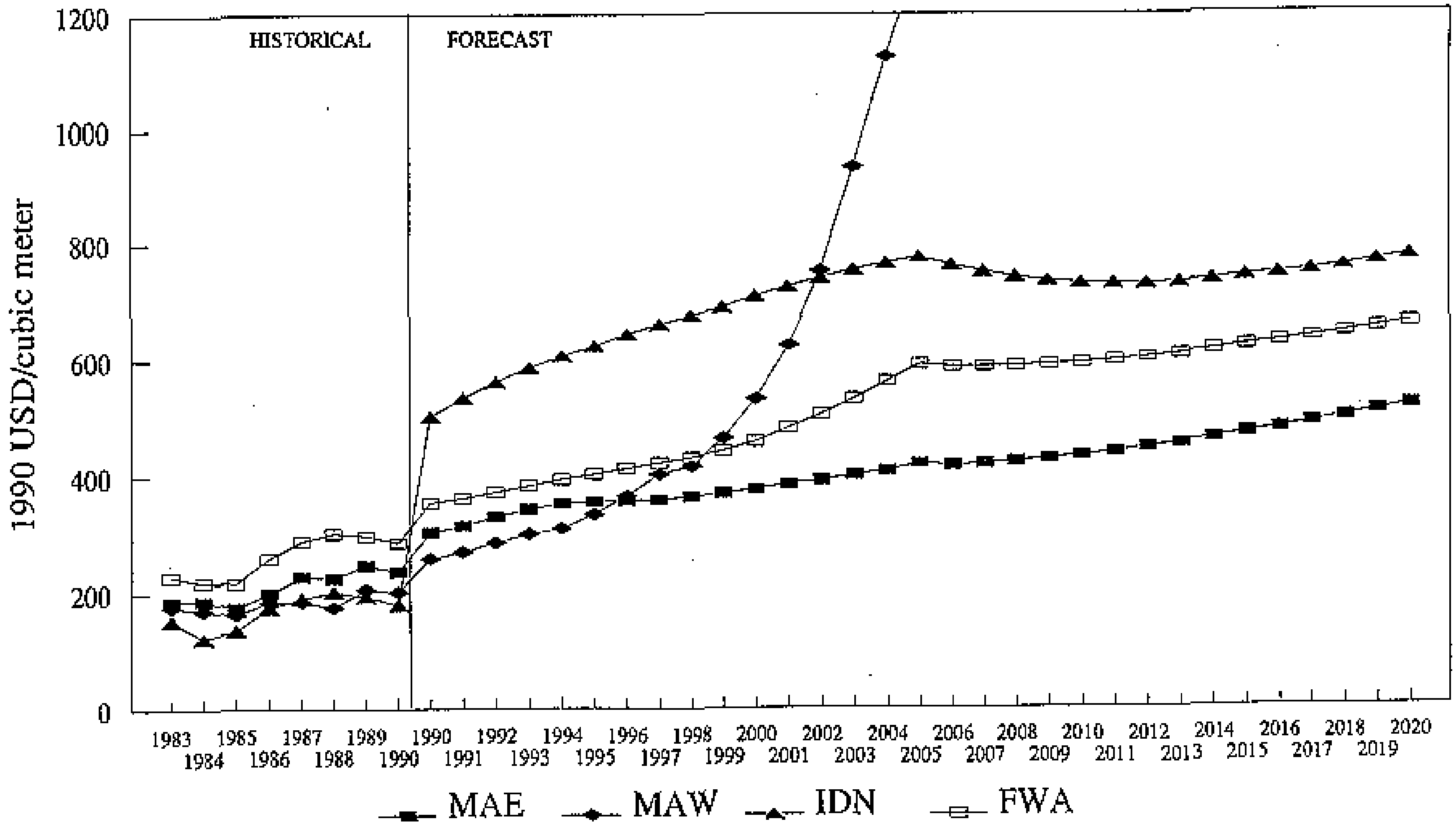


FIGURE 6.5: HARDWOOD SAWNWOOD PRICE PROJECTIONS



prices, such as increased supply from new sources, substitution with softwoods and technology impacts, these will all occur as a result of high prices and merely slow down the price increase, not eliminate it. These price increases should go a long way to motivating sustainable management investments to reduce the damage from harvesting in order to gain the benefits from the second growth harvest with much higher rates of return than in the past.

7. TROPICAL TIMBER SUPPLY CONSTRAINTS

There are two thrusts toward reducing the supply of tropical hardwoods. One recognizes that the rapid liquidation of the inventory will require lower harvests sooner or later. If the harvests are reduced sooner, sustainable levels can be reached without falling below those levels to wait for the inventory to rebuild. Alternatively, set-asides may be mandated to preserve natural stands. During the first few years there will not be much apparent difference between these two approaches. Over the longer-term, permanent set-asides would not support as high a level of sustainable harvest.

The reduced supply scenario merely shifts the supply curve back 10% for all tropical hardwood regions much like set-asides. Inventory is reduced by 10% to cause the harvest to reduce by 10% as though it was set aside and no longer available. Timber supply curve shifts were implemented by reducing inventory in Malaysia East, Malaysia West, Indonesia, Philippines and Papua-New Guinea by 10%. These shifts are provided in Table 7.1.

Table 7.1 Inventory Shifts in Tropical Hardwood Producing Countries (million m³)

Region	Base Inventory	Reduced Inventory
MAE	325.7	293.1
MAW	116.5	104.8
IDN	2955.3	2659.8
PHL	347.1	312.4
PNG	846.4	761.8

7.1 Short term impacts of 10% supply reduction

As summarized in Figure 7.1, sawlog prices increase even faster than in the base scenario. Malaysia East production declines several years sooner. Figure 7.2 shows sawlog production declining rapidly, falling below the previously identified sustainable target levels before recovering. The impact on consumer countries is felt more in the countries that were noted in the BASE scenario to be somewhat less competitive. Korea reduces log imports even more.

7.2 Long term impacts of 10% supply reduction

Generally there is little that could be considered surprising in that a 10% supply decrease is simply a movement forward in time of the trend supply reductions expected in the base scenario. By reducing the available supply, harvest levels fall more rapidly in Malaysia East, falling to levels of only 20% of the previous trend by 2002. As such, the major impact of a supply reduction is felt before 2010. Volumes are returning closer to base scenario levels by 2020 only because the same transition to sustainable targets defined in the previous case was assumed after 2010.

In the longer term, after Malaysia's inventory is largely depleted, and targeted sustainable harvests are used as in the long term simulation discussed in section 6, there is no way to

FIGURE 7.1: HARDWOOD SAWLOG PRICE PROJECTIONS
SCENARIO: 10% SHIFT IN TIMBER SUPPLY CURVE

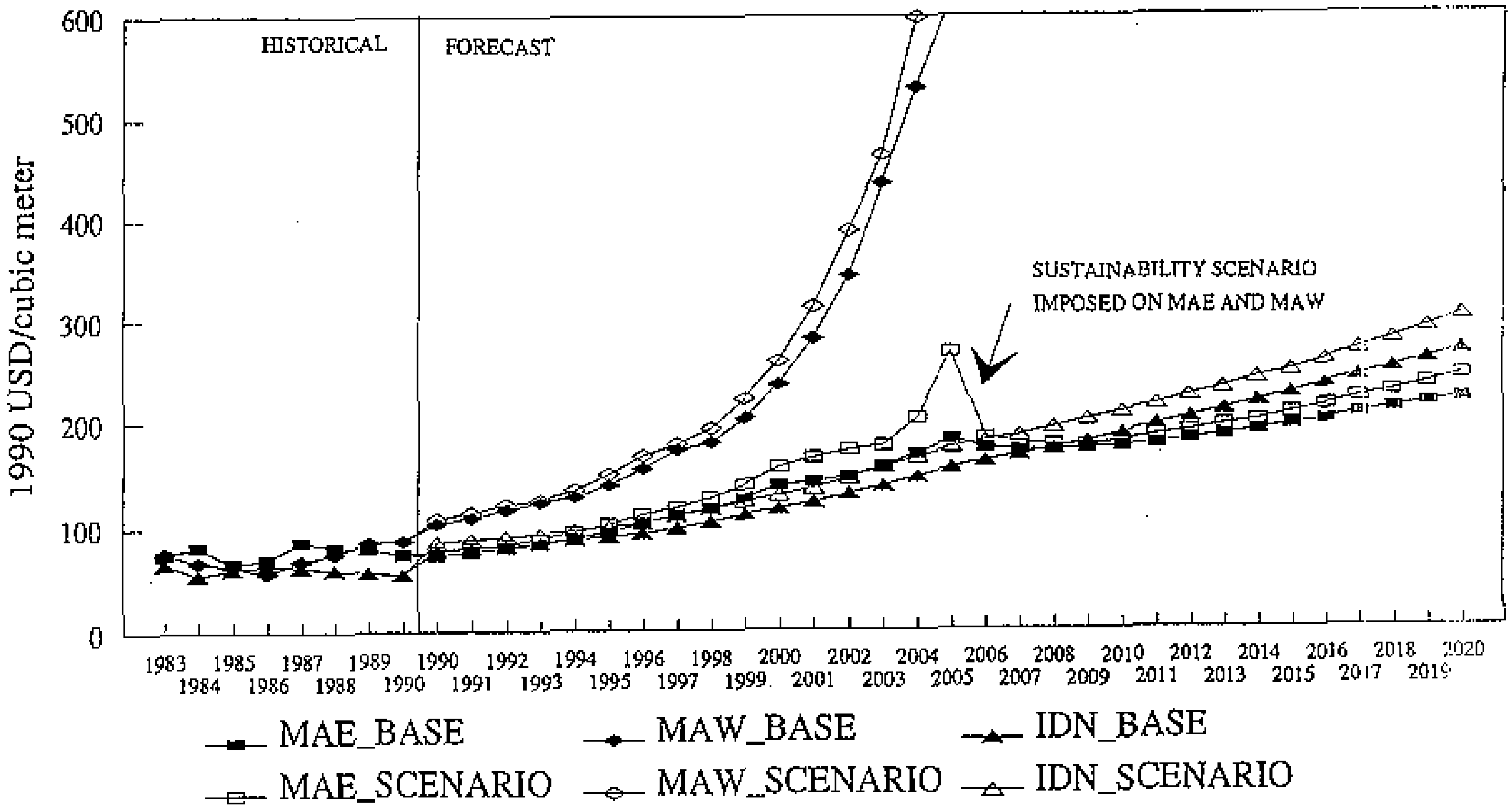
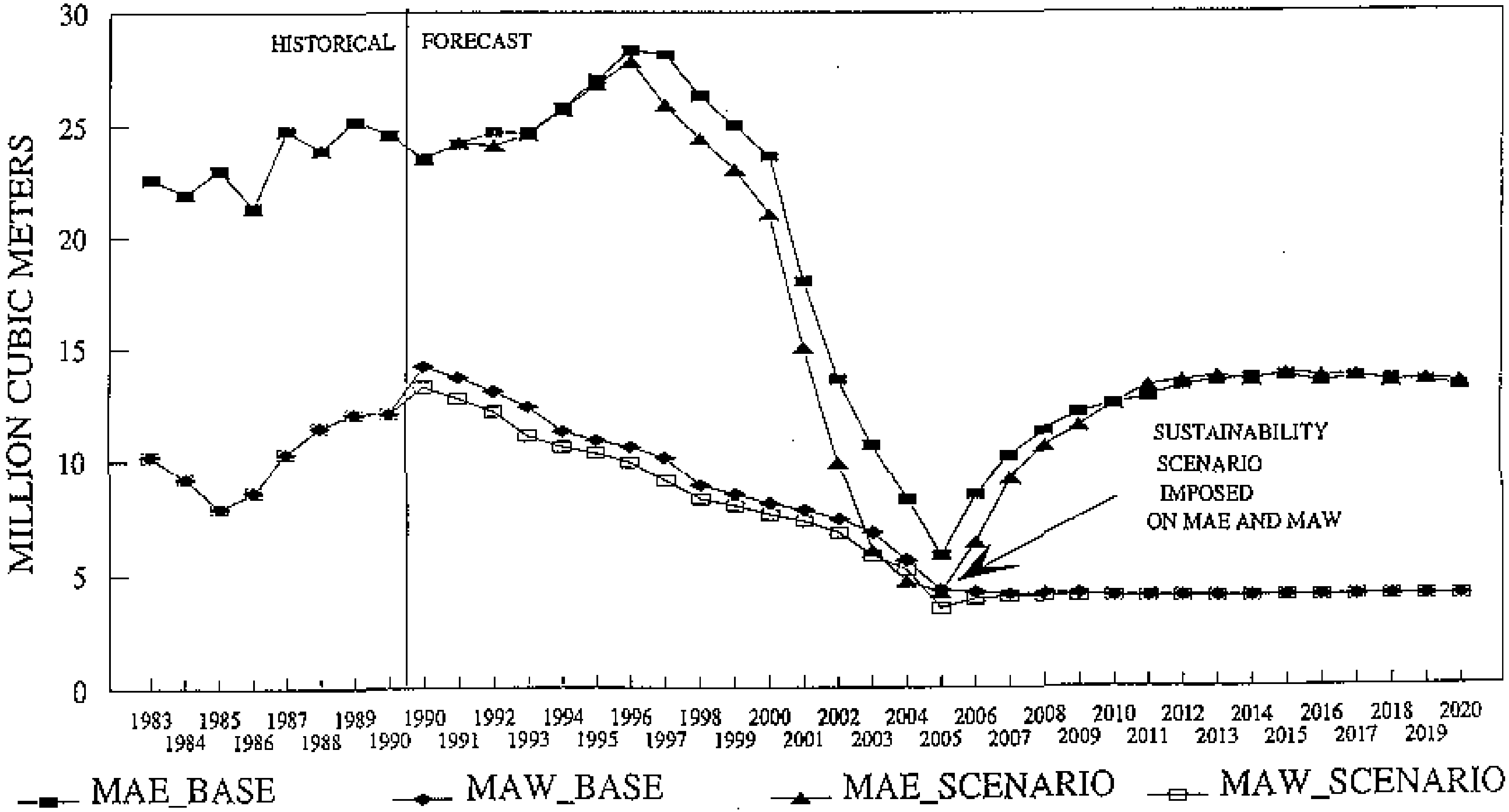


FIGURE 7.2: HARDWOOD SAWLOG PRODUCTION SCENARIO: 10% SHIFT IN TIMBER SUPPLY CURVE



shift the supply curve for Malaysia. Hence the long term portion of this simulation does not reflect a supply shift, especially for Malaysia.

8. TROPICAL TIMBER TRADE CONSTRAINTS

8.1 Key Assumptions in Increasing Trade Constraints

The environmental movement is pushing tropical hardwood import bans and tariffs as a policy to penalize non-sustainable tropical harvesting, with the goal of reducing the harvest of tropical forests. Trade barriers have also been erected by developed countries to protect their domestic processing. The economic impact of increasing such trade constraints has been simulated by applying a 10% increase to product prices for products reaching destination countries in the CGTM. Some product exports can be expected to be driven out in competition with domestic supplies. Table 8.1 summarizes the revenue generated from increased tariffs.

8.2 Sawlog Production Declines

All tropical hardwood suppliers suffer a decline in production. Indonesia production declines up to 2 million m^3 as shown in Figure 8.1. Malaysia East declines by as much as 4 million m^3 prior to 1996 as shown in Figure 8.2 but, because of the rapid decline in harvest forced by inventory depletion, they are able to make up for some of that decline between 1995 and 2005. Since most log exports were already non-economic after the year 2000 under baseline conditions, the impact of increased tariffs is not as great beyond the year 2000.

8.3 Log Trade Declines

As a consequence of the tariff, consumer countries such as Japan and Korea reduce their import of logs from Malaysia as shown in Figure 8.3. There is a 3-4 million m^3 reduction in log exports from Malaysia East prior to the year 2000. With the decline in harvest near the year 2000 which produces higher prices, most log imports by Japan are curtailed.

8.5 Sawlog Prices Decline

Sawlog prices decline by as much as 20% for Malaysia East reducing to less than 10% declines after 2005. Indonesia sawlog prices decline less than 5%. These price impacts are illustrated in Figure 8.4. In the consumer countries, especially Japan, log prices are driven up by the reduced availability by about 10% as shown in Figure 8.5. After the year 2000 with a much reduced level of log exports the impact on sawlog prices is much smaller.

FIGURE 8.1: HARDWOOD SAWLOG PRODUCTION
SCENARIO: 10% INCREASE IN TRANSFER COSTS

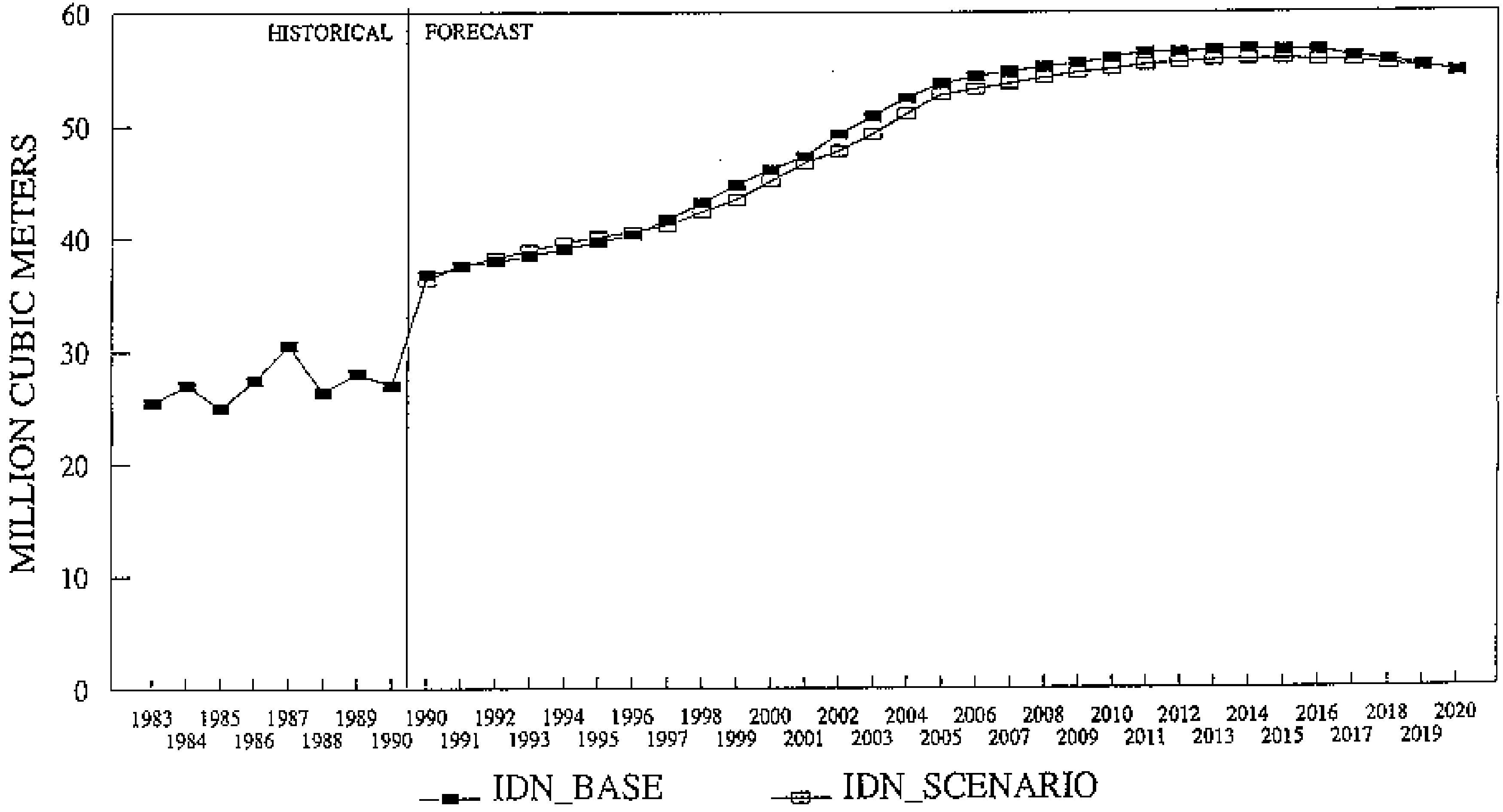


FIGURE 8.2: HARDWOOD SAWLOG PRODUCTION
SCENARIO: 10% INCREASE IN TRANSFER COSTS

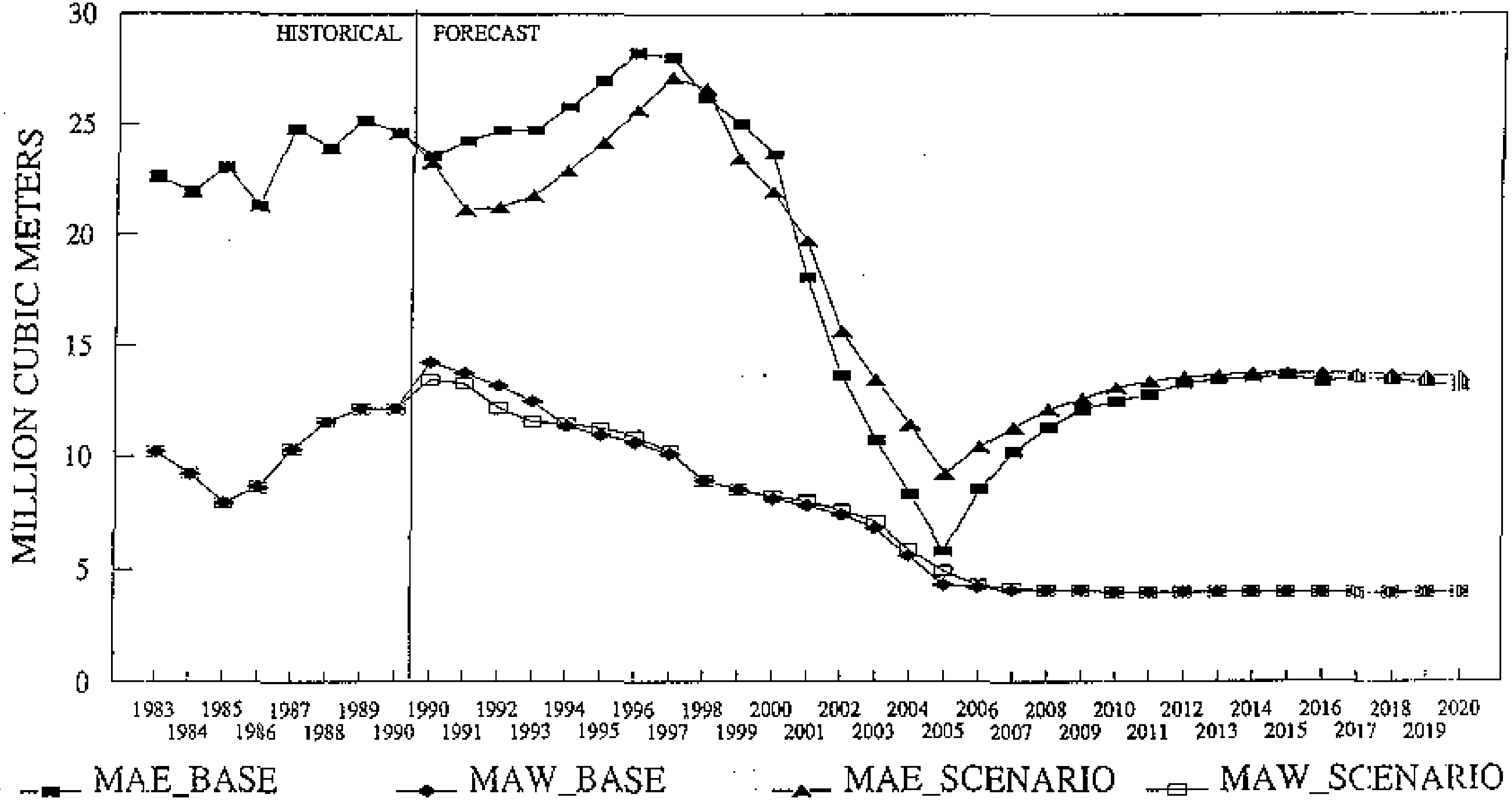


FIGURE 8.3: HARDWOOD SAWLOG TRADE
SCENARIO: 10% INCREASE IN TRANSFER COSTS

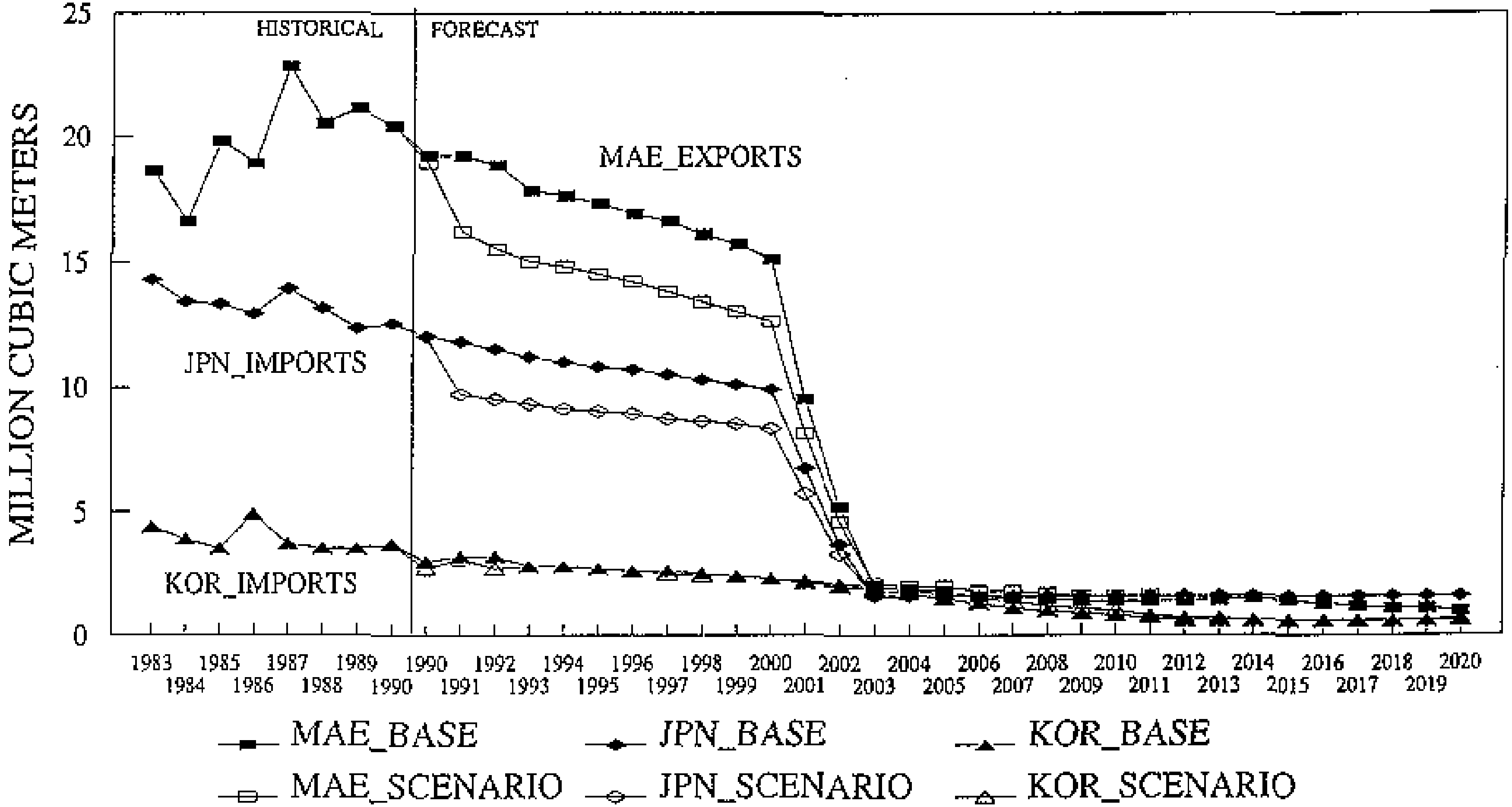


FIGURE 8.4: HARDWOOD SAWLOG PRICE PROJECTIONS
SCENARIO: 10% INCREASE IN TRANSFER COSTS

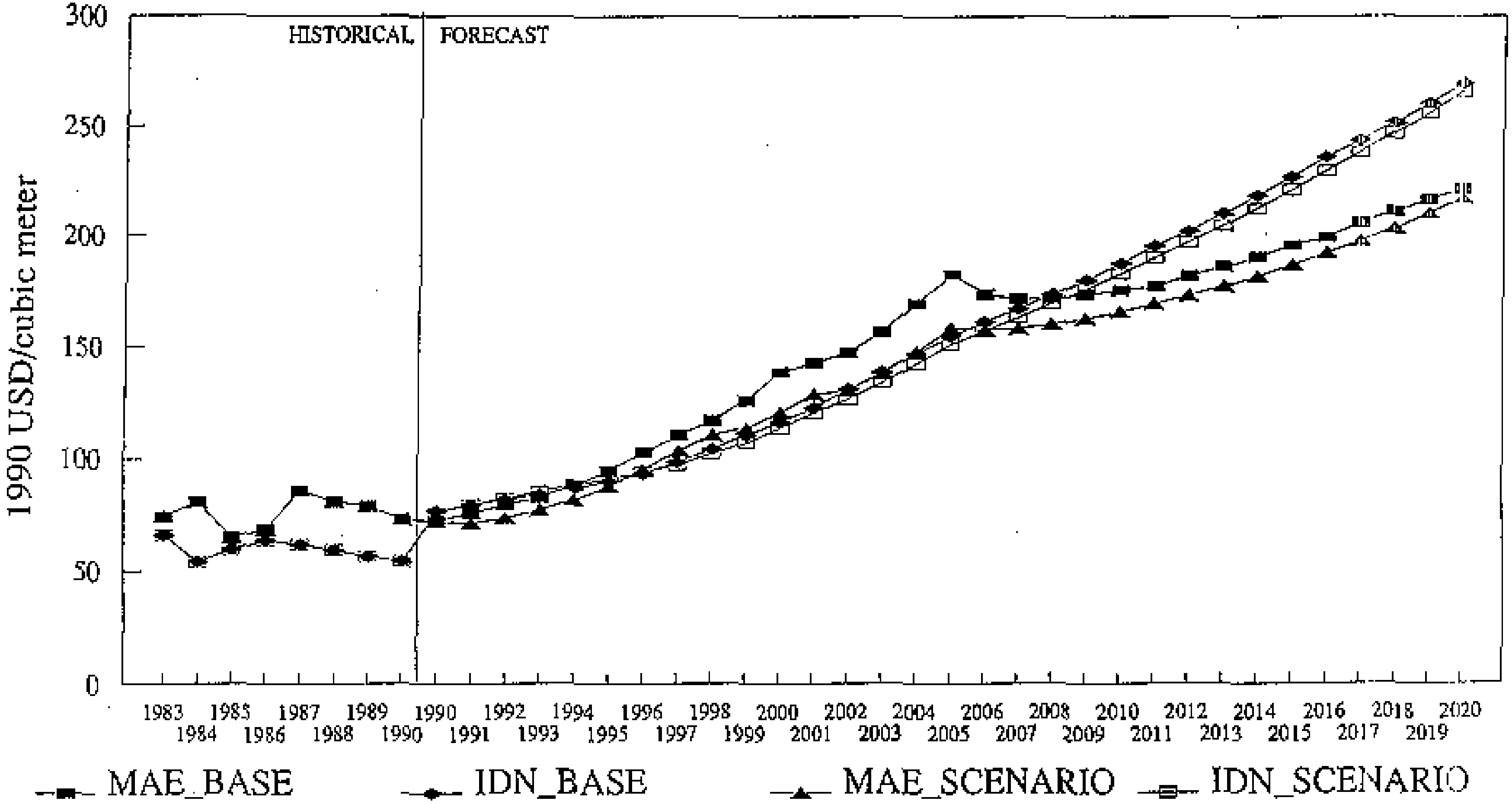


FIGURE 8.5: HARDWOOD SAWLOG PRICE PROJECTIONS
SCENARIO: 10% INCREASE IN TRANSFER COSTS

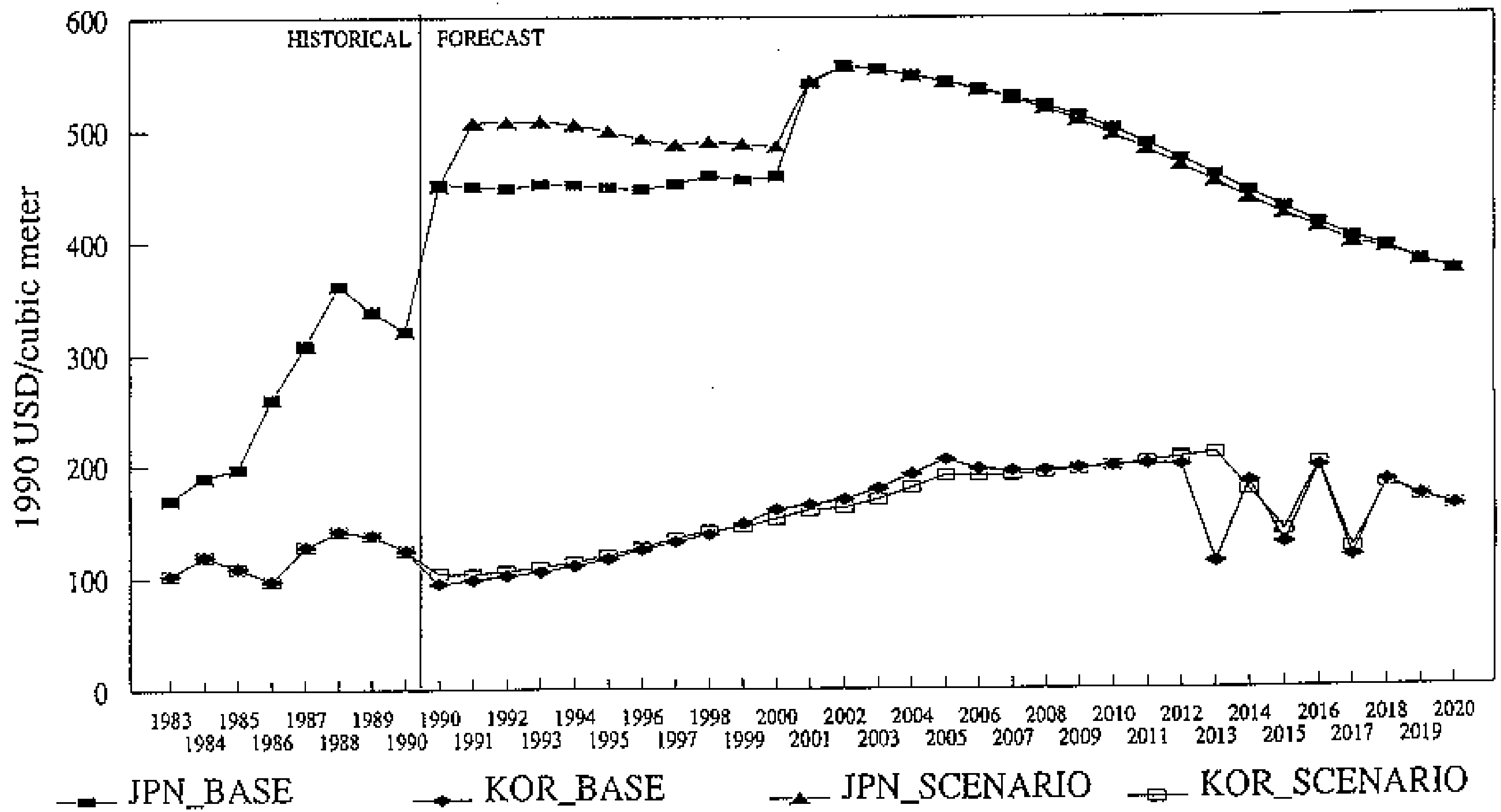


Table 8.1 Revenues Associated with Transfer Cost Increase Scenario

Product a/	Region b/	Tariff c/ (US$)	Imports(mmcm) 1990	Imports(mmcm) 2000	Revenue (US$ mm) 1990	Revenue (US$ mm) 2000
Logs	West Europe	11.81	3.5	0.0	41.4	0.0
	Japan	45.32	14.5	12.9	657.1	584.6
	Korea	9.71	2.9	2.5	28.1	24.3
	China	7.97	2.1	1.0	16.7	8.0
	Taiwan/Hong Kong	10.77	5.1	4.2	54.9	45.2
Sawnwood	US West	44.2	0.3	0.3	13.3	13.3
	US South	20.26	0.1	0.1	2.0	2.0
	US North	20.06	0.3	0.3	6.1	6.1
	Canada	39.51	1.0	1.9	39.5	75.1
	West Europe	42.74	4.7	8.4	200.9	359.0
	Japan	111.01	3.8	3.9	421.9	433.0
	Korea	38.35	0.0	0.2	0.0	7.7
	China	38.82	0.7	0.0	27.2	0.0
	Taiwan/Hong Kong	24.75	1.1	1.2	27.2	29.7
Plywood	US West	48.02	0.2	0.2	9.6	9.6
	US South	40.00	0.8	0.6	32.0	24.0
	US North	41.63	0.3	0.0	12.5	0.0
	Canada	42.75	0.1	0.1	4.3	4.3
	Central America	49.18	0.1	0.1	4.9	4.9
	West Europe	44.13	1.8	1.8	79.4	79.4
	Japan	126.29	1.4	0.0	176.8	0.0
	Korea	40.49	2.1	3.4	85.0	137.7
	China	36.85	1.4	1.5	51.6	55.3
	Taiwan/Hong Kong	72.74	0.0	0.0	0.0	0.0
TOTALS		na	48.3	44.6	1,992.5	1,903.0

a/ Non-coniferous (hardwood) from tropical producer countries.
b/ Regions as defined in the CGTM.
c/ Tariff equals 10% of baseline product price in destination regions.

8.6 Product Distribution Changes

Product distribution is also impacted. Plywood exports from Indonesia are off almost 10% after 1995 as shown in Figure 8.6. In the early period prior to 1995 when there was a decline in log exports, plywood exports were slightly increased. With such a large impact on log exports, the consuming country needs for products increases, resulting in a small increase in plywood exports. In the first few years, Malaysia West increases its share of plywood exports before being constrained by log scarcity.

8.7 Summary of Impacts from Increased Trade Constraints

This scenario demonstrates the expected impacts from imposing trade barriers. Sawlog production declines in producing countries, log trade declines as transfer costs increase, and sawlog prices fall. There will be less motivation to manage the forests given the lower prices and there is a reduced revenue from which to consider such investments.

9. GLOBAL TRADE LIBERALIZATION

9.1 Key Assumptions in Reducing Trade Barriers

Trade barriers exist in consumer countries to protect their processing industry. The demand for tropical timber increases by eliminating tariffs, with increasing returns for sustainable management of the forests. While there are many non-tariff barriers as well as tariff barriers, eliminating the tariff barriers alone would have a significant impact.

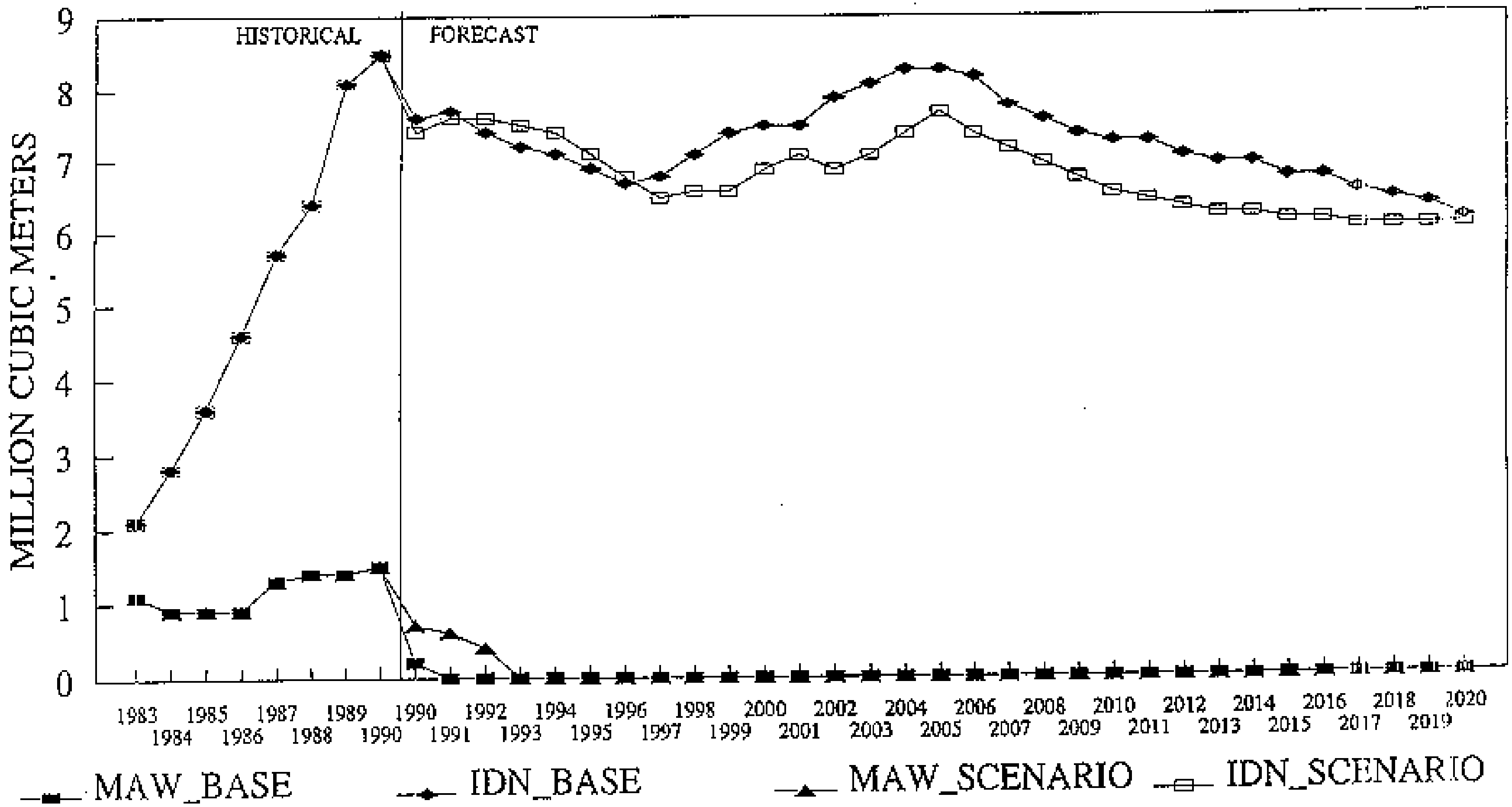
Tropical timber producing countries have introduced log export bans and even primary processing product export bans in order to encourage more high valued domestic processing. While these policies may increase processing employment, many studies have shown that they also result in income and wealth losses to the region (see list of references under Literature Cited). That is, they reduce the economic welfare of the producing countries, rather than increasing it. They are largely designed to counteract the impact of consuming countries' tariffs which are designed to protect processing operations in consuming countries.

Trade liberalization in this scenario includes both the reduction of product tariffs and the removal of export bans. Most products have tariffs of 10% or more. The trade liberalization scenario reduces transfer costs by 10%. The scenario also includes lifting the restriction on log exports from Malaysia West, Indonesia, Philippines, Papua New Guinea, and West Africa. Several routes for which there existed no log exports were opened, including log exports from Indonesia to Japan and Korea.

9.2 Sawlog Production Increases

With trade liberalization, Indonesia and Malaysia West increase sawlog production significantly for a number of years. Indonesia's harvest is up almost 5 million m^3 until 2000 and then runs just slightly below the base projection. Malaysia East also increases harvest by over 5 million m^3, which accelerates the depletion of their inventory resulting in harvest

FIGURE 8.6: HARDWOOD PLWOOD EXPORTS
SCENARIO: 10% INCREASE IN TRANSFER COSTS



levels below the base from 1996 to 2000. Malaysia West's remaining inventory is so low and their domestic needs so high that they reduce harvest and import logs of lower cost from Malaysia East. These sawlog production changes are illustrated in Figure 9.1.

It should be remembered that even in the base projection, and the long term policy simulation the rapid reduction in Malaysian East inventory resulted in a decline below the targeted-sustainable levels for a few years just after the year 2000 before settling down with the targeted harvest levels. The increased demand from trade liberalization accelerates the inventory decline with harvest levels dropping below the base projection in just 5 years. During the periods of shortest supply in Malaysia East their prices will rise significantly.

9.3 Sawlog Prices Increase

The increased demand on tropical hardwood suppliers increases sawlog prices for the producers even as log prices decline considerably in the importing consumer countries. The availability of import logs that had been banned drives down prices in the consumer countries. The reduction in prices in consumer countries are considerably larger than the increases in tropical hardwood supplier countries.

As illustrated in Figure 9.2 sawlog prices in both Indonesia and Malaysia increase by 20% during the first few years when they are both producing more than they were under baseline conditions. Once the Malaysia East inventory is near depletion their prices rise substantially, remaining about 25% higher than in the baseline projection. As Indonesia production falls back beyond the year 2000, just as in the baseline projections, their prices return to levels not much above the baseline. However because the markets are more open under trade liberalization, the Malaysia West price level converges with the Indonesia price level instead of staying below it as was the case in the baseline projection. In effect a large part of the cross-country price differences is a consequence of barriers in trade flows.

Under the baseline, Japan, Korea and other consumer countries were denied access to log imports from many countries. With the removal of these barriers their log prices decline by 20 to 40% as illustrated in Figure 9.3. In dollar amounts the decline in consumer country log prices is much larger than the gain by producer countries due to the much higher cost structure in these countries which includes freight and distribution as well as higher cost domestic timber.

9.4 Product Distribution Changes

As shown in figure 9.4, Malaysia East and Indonesia both increase their log exports significantly although in the longer term domestic demand with high sawlog prices brings an end to Indonesian log exports.

With these lower log costs, Japan imports 2 million m^3 more in logs for the first 10 years and does not stop importing by 2000, in contrast to the baseline when they were forced out of the market once Malaysia East harvest levels declined from inadequate inventory. By 2010 they are importing almost 10 million m^3 more in log form with trade liberalization. While log exports remain on a declining trend in all consumer countries as log prices rise,

FIGURE 9.1: HARDWOOD SAWLOG PRODUCTION
SCENARIO: GLOBAL TRADE LIBERALIZATION

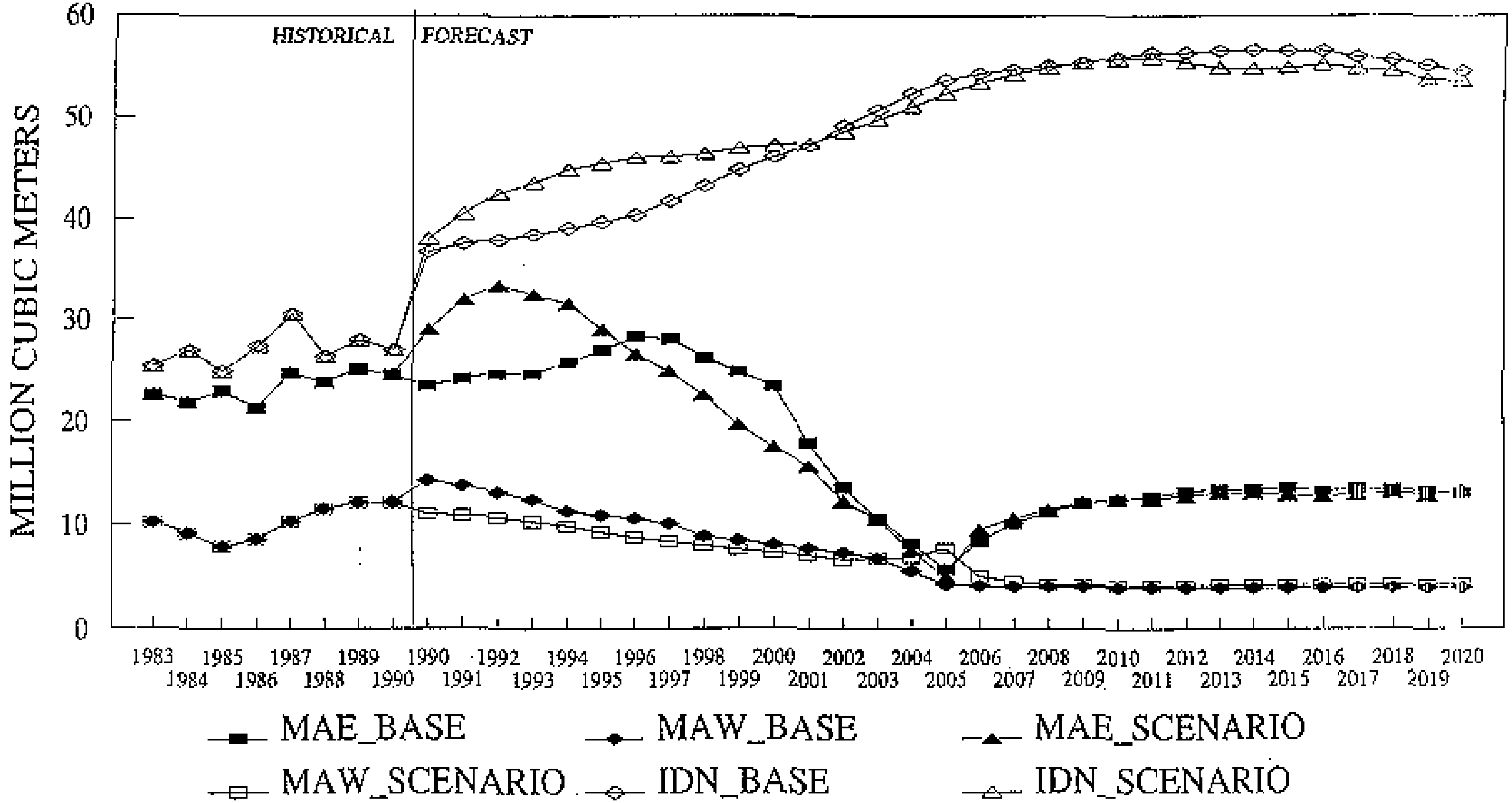


FIGURE 9.2: HARDWOOD SAWLOG PRICE PROJECTIONS
SCENARIO: GLOBAL TRADE LIBERALIZATION

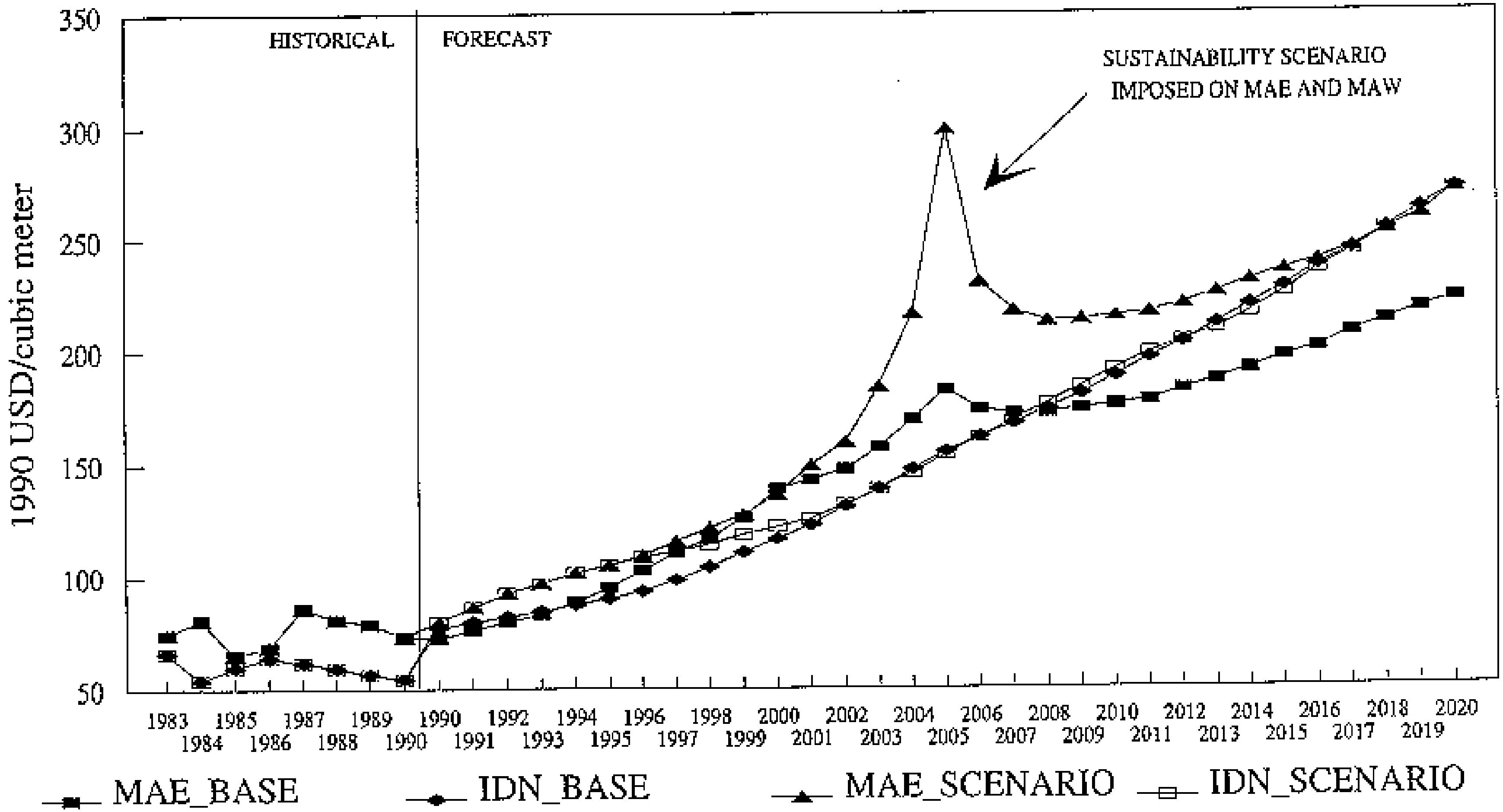


FIGURE 9.3: HARDWOOD SAWLOG PRICE PROJECTIONS
SCENARIO: GLOBAL TRADE LIBERALIZATION

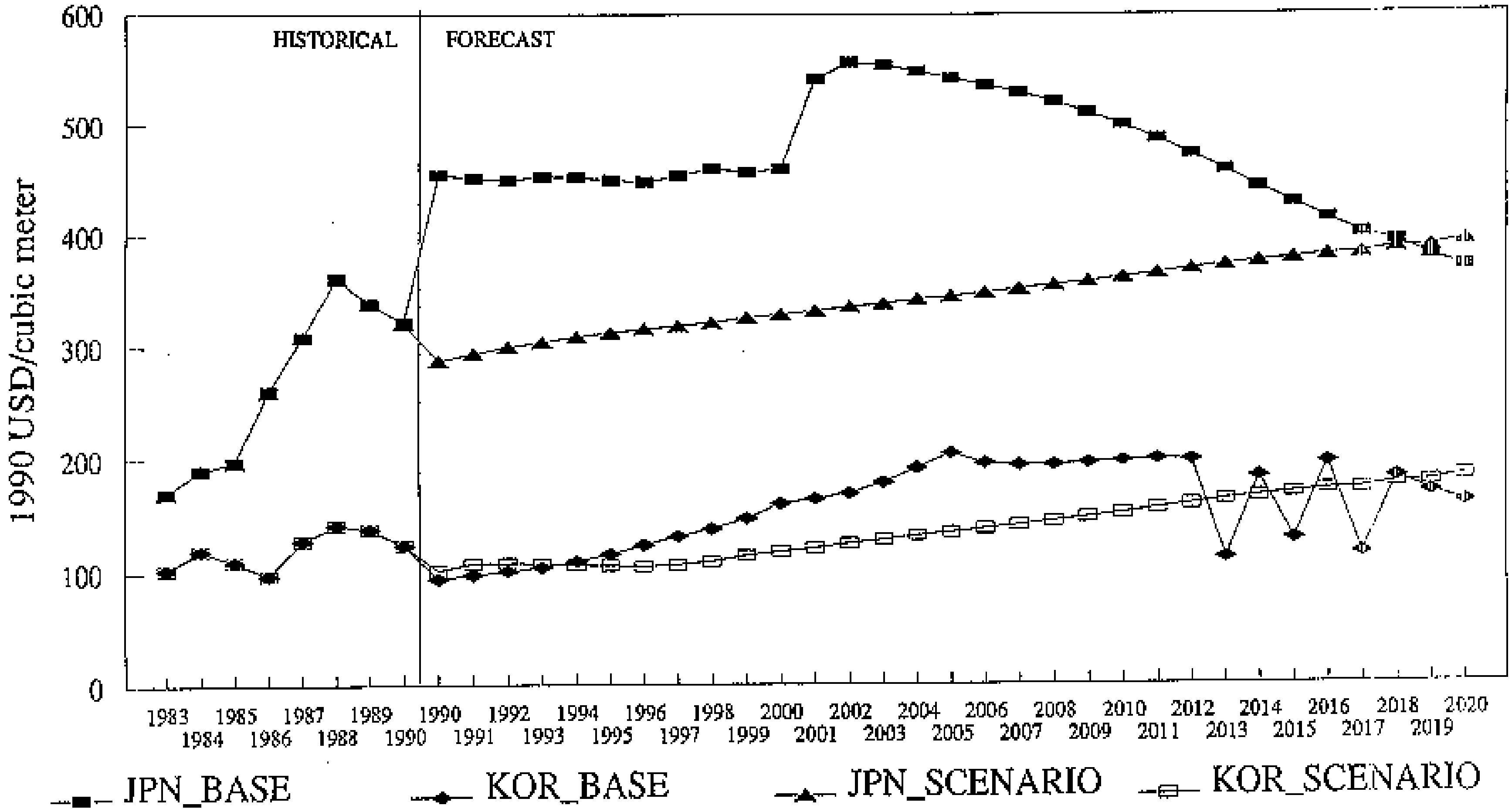
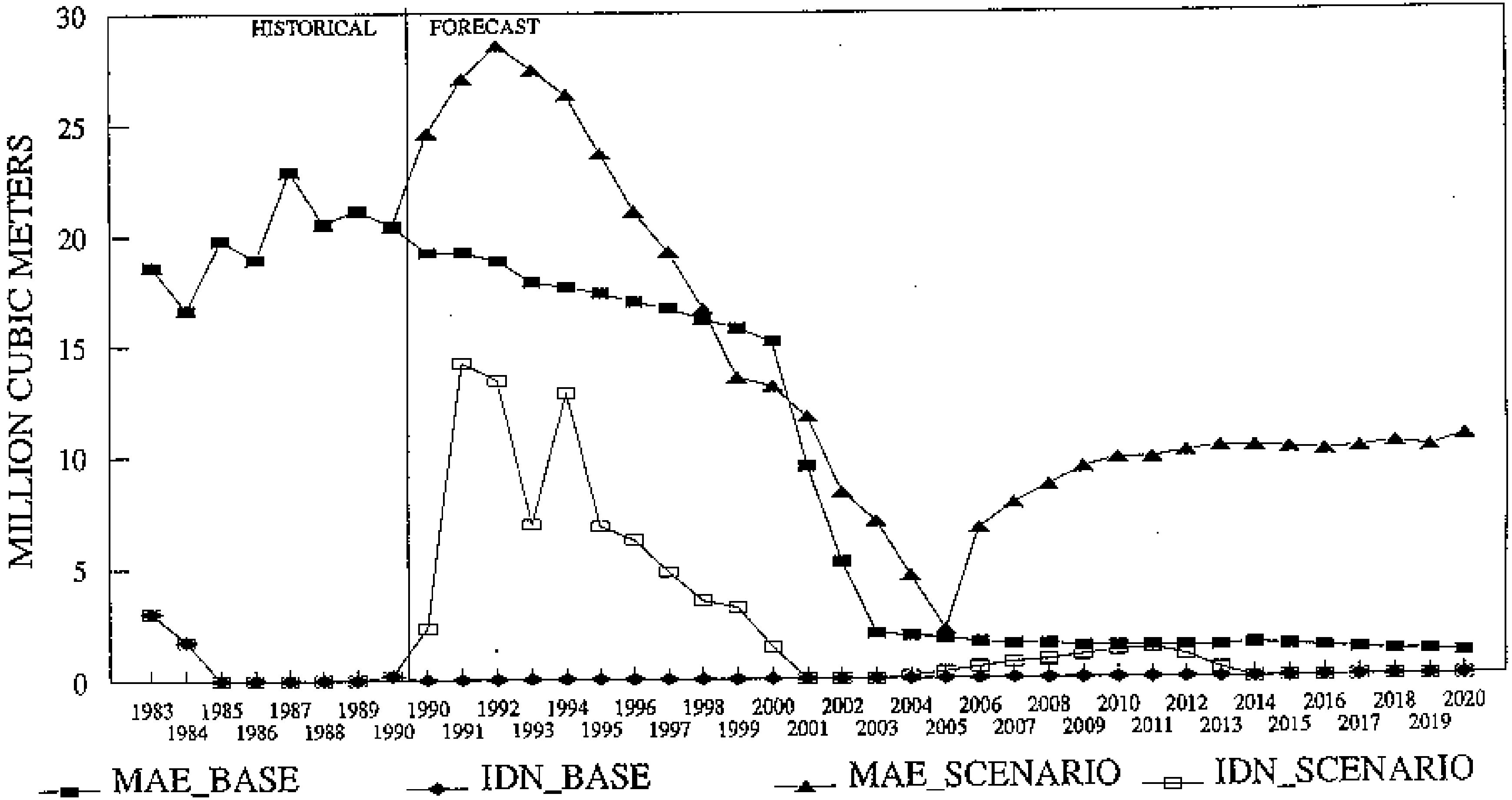


FIGURE 9.4: HARDWOOD SAWLOG EXPORTS
SCENARIO: GLOBAL TRADE LIBERALIZATION



they are at considerably higher levels under trade liberalization conditions, substituting for product imports. These results are illustrated in Figure 9.5.

Malaysia West, the tropical hardwood supplier with the greatest imbalance between growing domestic demand and supply, becomes a substantial log importer.

With lower log prices, Japan reduces plywood imports more quickly as illustrated in Figure 9.6 while at the same time Malaysia West exports more plywood processed from its log imports and Indonesia exports less plywood. Indonesia plywood exports remain about 10% lower with trade liberalization as shown in Figure 9.7

9.4 Trade Liberalization Conclusions

The reduction of tariffs and elimination of bans increases the demand on tropical hardwoods. As expected their is a significant producer log price increase of about 20%, an important contribution to motivate higher-growth-sustainable-forest-management.

The benefits to consumer countries are also large with significant declines in log prices as a consequence of open markets. Since the commodity that is in short supply is tropical hardwood logs and the hardwood producing countries have no comparative advantage in processing, they lose some of their processing to the consuming countries.

The fact that the economic and product demand growth is higher in the tropical hardwood producing countries than the consuming countries shifts some of the wood flow into Malaysia West, the producing country with the greatest imbalance.

FIGURE 9.5: HARDWOOD SAWLOG IMPORTS
SCENARIO: GLOBAL TRADE LIBERALIZATION

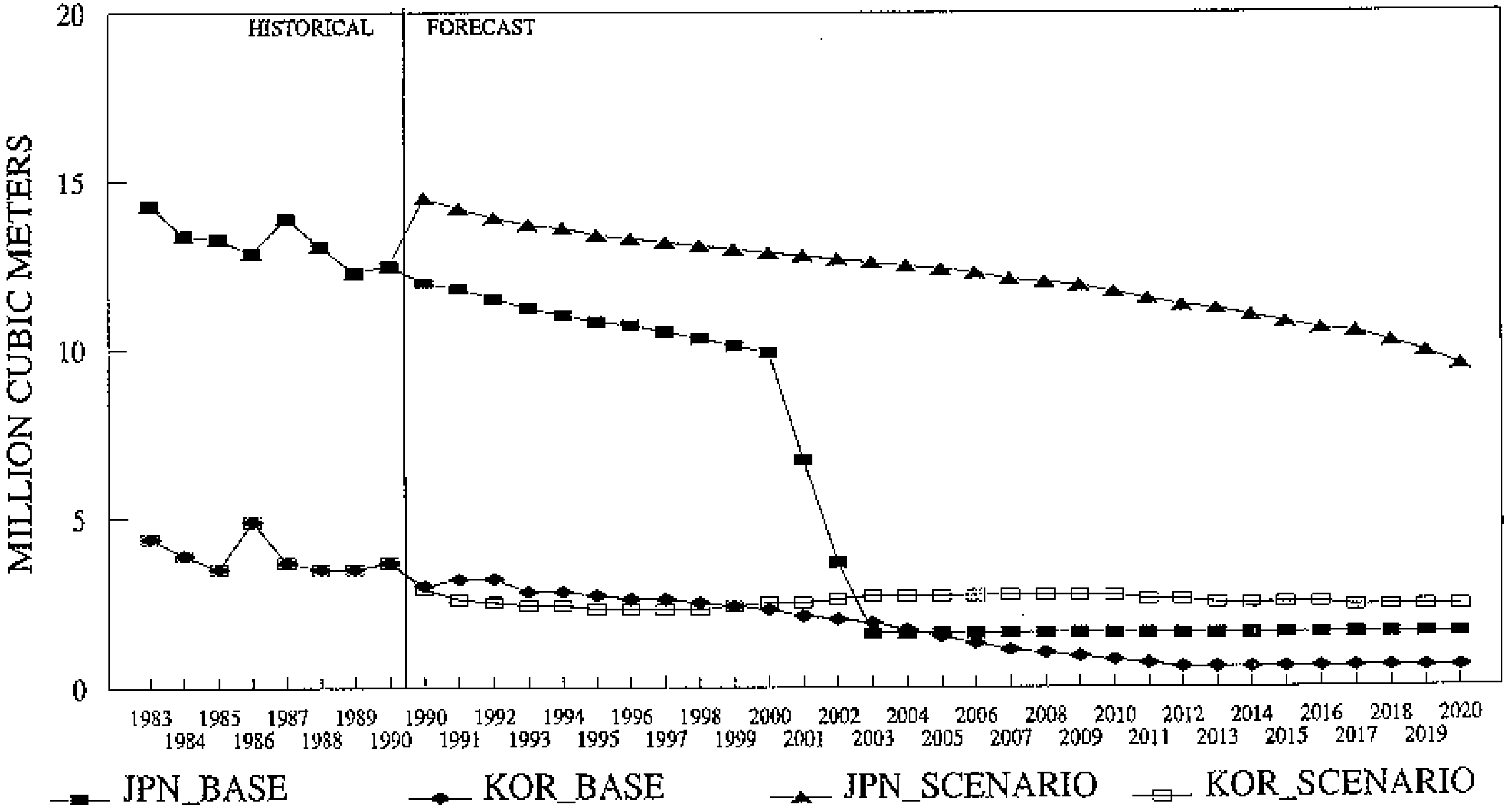


FIGURE 9.6: HARDWOOD PLYWOOD IMPORTS
SCENARIO: GLOBAL TRADE LIBERALIZATION

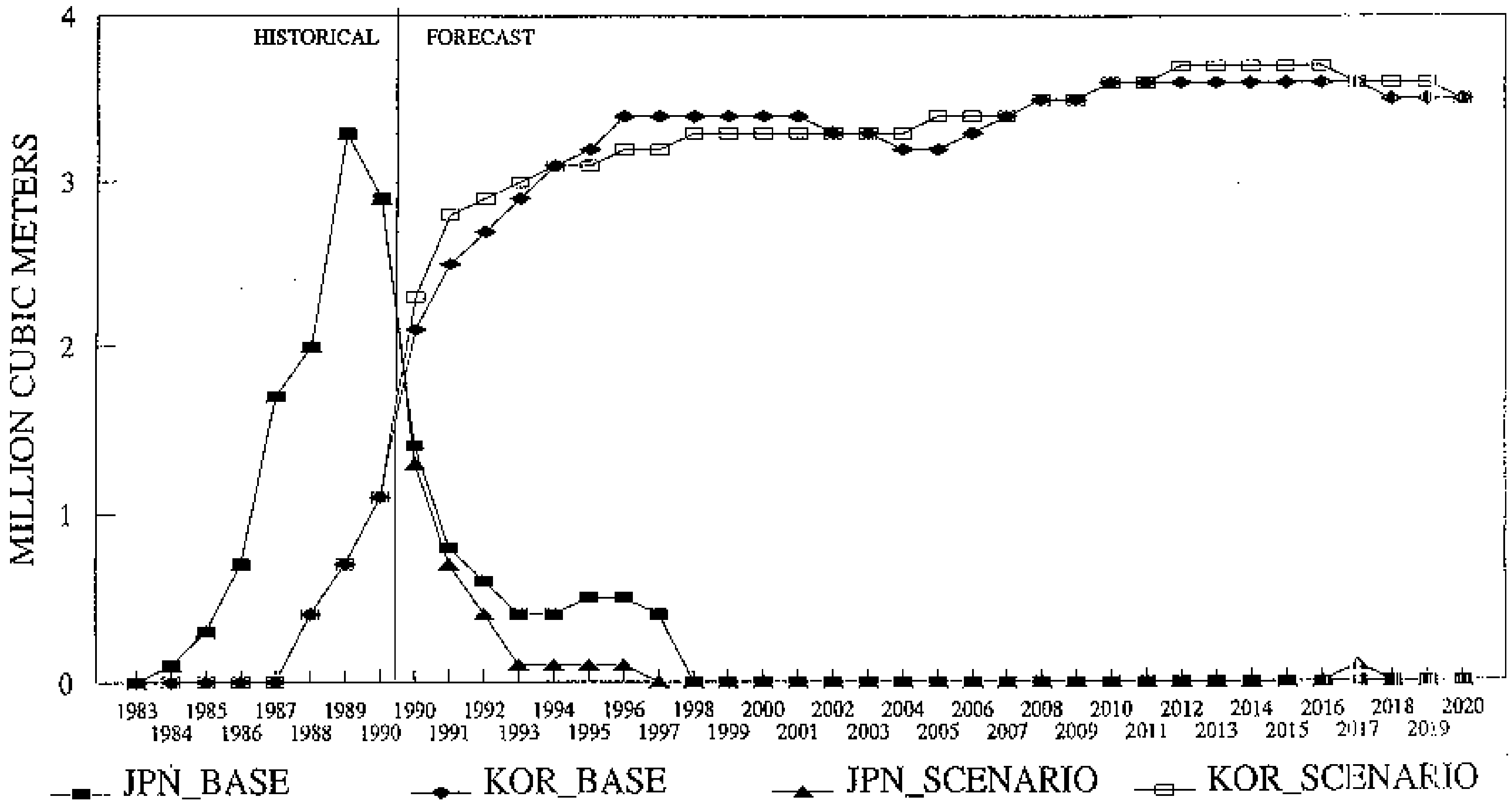
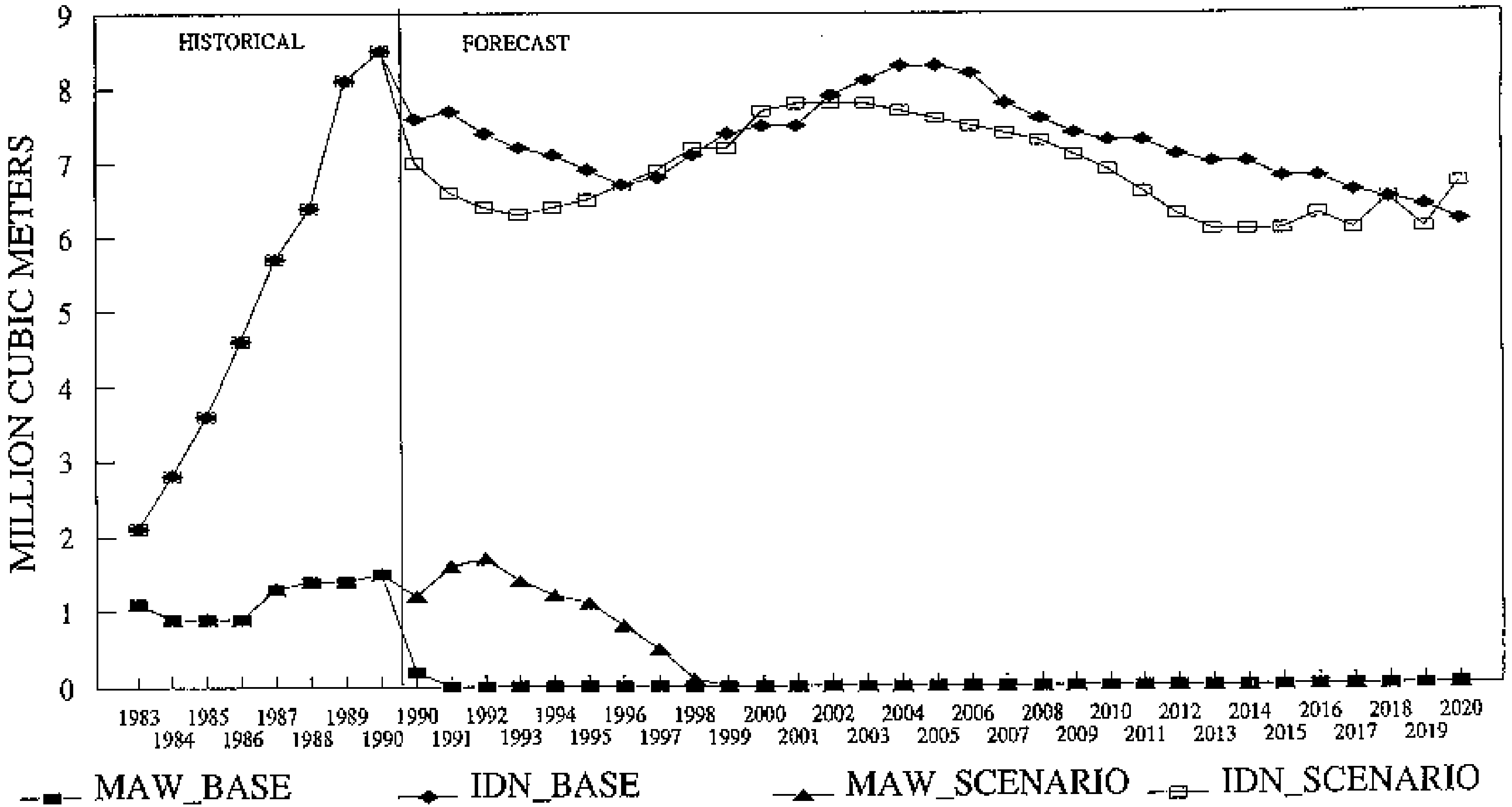


FIGURE 9.7: HARDWOOD PLYWOOD EXPORTS
SCENARIO: GLOBAL TRADE LIBERALIZATION



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