Paper presented in

Seventh Biennial Conference

Indian Society for Ecological Economics (INSEE)

Global Change, Ecosystems, Sustainability

December 4-8, 2013

Host:
Tezpur University

Cohost:
OKD Institute of Social Change and Development

Sustainable Forest Use, Nature of Forward Linkage and the Pattern of Final Consumption: A Temporal Study on India

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Abstract

To be economically sustainable, the production matrix of the economic system should reveal tendency towards substituting forest dependent products in the production basket by other products. Whether any such tendency has been revealed by the Indian system or not has been verified by studying the forward linkage chain of the forestry & logging sector of India for 1993-94, 1998-99, 2003-04 and 2007-08, the years when Input-Output tables were made available by the Central Statistical Organization, GoI. The intensity of intermediate use of forestry products by other sectors of the economy has gone up over time. This dependence-pattern has further been decomposed into direct, indirect and induced effects and the total presence of the forestry and logging sector in India's GDP turned out to be nearly 86 per cent. When this usage pattern has further been decomposed between Government-use and Private-use, the former is temporally falling in aggregate and the latter is consistently on the rise. At the consumption point, additionally we consider the export-import related information. It is disturbing to observe that over time the net import of forestry & related products are sharply increasing indicating more final demand of the sector. The major importing countries for India for each forest related products have been identified and their changing profile is analyzed over time. The paper concludes by presenting an overall assessment of demand-supply gap in terms of appropriate model based predictions for each component product of forestry. This pattern of the use of forest and wood related products is not indicating any consistently designed integrated policy position towards forest conservation, but the problem of forest has been attempted to be managed from within the sector itself without paying much heed to the pattern of inter-sectoral interdependence at the aggregate economy level.

Keywords: Forest Products, Trade-flows, Input-Output Analysis, Demand Forecasting, Demand-Supply Gap

JEL: Q23, Q27, Q21, C67, C53

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I. Introduction

Maintaining a balance between urban land, agricultural land and forest land to facilitate better adaptation to the impact of climate change and mitigation of its adverse influences are almost universally recognized as a fundamental issue related to *our common future*. Designing and implementation of sustainable forest management policies are of national importance and India is no exception in this regard. Between 1990 and 2010 the area under forest land in India has gone up from 63.939 million hectares to 68.434 million hectares (http://data.gov.in/sites/default/files/FOREST_COVER_AREA_1.xls). In this paper an attempt has been made to explore the economic as well as ecological implications of this apparent success from the perspective of sustainable forest management.

The principal ways in which forests interact with economies are identified by Chopra (2006) as (i) forests as source of timber, renewable in the main but potentially depletable, usually harvested by government corporations or private loggers and used as input in wood-based industries; (ii) forests as a source of tangible non-timber forest products collected and consumed by households (e.g., fuel wood, resin, fruit, leaves, etc.) but not always bought and sold in the markets, (iii) forests as a source of less tangible forest amenities consumed directly either in the present or in the future (biodiversity related benefits), (iv) forests as a source of environmental services that benefit other productive sectors (e.g., watershed protection for downstream agriculture, forest based recreation and tourism, etc.), (v) forests as a disposal site for air pollutants that may be damaging to forest health (acid deposition); (vi) forests as a sink and source of carbon dioxide which potentially damages other sectors through global climate change (carbon sequestration); (vii) through deforestation, forests compete for land with agriculture and urban settlements and finally (viii) through the choice of institutions for forest management. The mix of services that is available to any economy from forests depends, in addition to their biological characteristics, on the nature of economic regime within which they are exploited. Some commodities, such as timber are extracted in a regime driven, in the main, by market forces. Others such as non-timber

forest products may be extracted under a variety of arrangements, the range varying from open access to common property regimes. Services such as those of water cycle augmentation and micro-climate regulation are typically available to communities as free goods (Chopra & Kumar 2003).

To be economically sustainable the production matrix of the economic system should reveal tendency towards substituting forest dependent products in the production basket by other non-forest dependent products. Whether any such tendency has been revealed by the Indian system is a major concern of this paper. Attempt has been made here to carry out the following exercises:

(a) The direct, indirect and induced contribution of forestry in India's Gross Domestic Product (GDP) has been estimated by using Input-Output transaction tables since economic reform and globalization. This has been verified by studying the forward linkage chain of the forestry & logging sector of India for 1993-94, 1998-99, 2003-04 and 2007-08, the years when Input-Output tables were made available by the Central Statistical Organization, GoI.

(b) Similar analysis has been carried out for sectors like wooden furniture & fixture, wood and wood products, paper, paper products & newsprint and printing and publishing (who are using the product of forestry and logging as direct input) to study the inter-temporal pattern of linkages.

(c) This usage pattern has further been decomposed between Government-use and Private-use to verify the presence of any consistently designed integrated conservation policy.

(d) At the consumption point, additionally we consider the export-import related information.

It is disturbing to observe that over time the net import of forestry & related products are sharply increasing indicating more final demand of the sector. If the government discourage use of forest produces as intermediate as well as final products and the affording class imports these as lifestyle products from abroad, then we are not culturally conserving the scarce resource but only draining the other countries with weaker environmental regulations to satisfy our own requirements.

(e) At a more disaggregated level for each forest related products analysis of trend and composite growth has been carried out over a twenty year period (1991-2010) with FAO data.

(f) To verify possibilities of over-consumption from imported sources, major importing countries for India for each forest related products have been identified and their changing profile is analyzed over time.

(g) Finally, an estimation of demand-supply gap is proposed to project the future crisis related to the degeneration of forest ecosystems in India.

With this introductory section rest of the paper will be organized as follows: section 2 will discuss the input-output framework to assess the forest dependence of India's GDP and its temporal profile [issues (a), (b) and (c)], section 3 will present an analysis of the pattern of expenditure on the produce of forestry and related sectors in terms of public and private consumption from both domestic and foreign sources over the chosen period of analysis [issues (d) & (e)], section 4 will concentrate on the changing profile of geographical spread of the source and destination countries in import and export of forestry & logging related products [issue (f)], section 5 will estimate the trend and growth of production, import and export in both volume and value for different forest based products with an aim to assess demand-supply gap, both actual and projected [issue (g)], to arrive at an assessment of sustainable forest use. Finally, section 6 will conclude the paper by providing an overall assessment and indicating the direction of effective policy targeting.

II. Forestry & Logging Sector: Contribution to GDP

The nature of inter-linkages among different sectors of the economy through technical inter-dependence gets reflected from input-output (I-O) tables and the Central Statistical Organization (CSO) of the Government of India publishes I-O tables periodically that shade light on the temporal change in this underlying structure at the disaggregated level[3]. In this section a few quantitative exercises have been undertaken on forestry and logging sector by using the available

[3] The I-O tables are in the form of square matrices showing in each row the disposal (use) of output of a sector as input used in different sectors (intermediate use) and for final use in the economy during the year. They cover all sectors of the economy and their subsectors.

I-O tables corresponding to years 1993-94, 1998-99, 2003-04 and 2007-08: first, the inter-sectoral consistency is checked for all four years in terms of Hawkins-Simon condition and the pattern of backward and forward linkages has been studied by using Chenery-Watanabe (C-W) method to assess the nature of technical progress over time; finally, we have estimated the direct, indirect and induced effect of Forestry on the GDP of India.

Inter-sectoral Consistency: Considering an economy with n number of inter-dependent sectors and a final consumption commitment, the input-output relation can be expressed as: $X = AX + C$ where $X = (X_1, X_2, ..., X_n)'$, the vector of output, $A = [a_{ij}]$ the matrix of input-output coefficients where a_{ij} represents the amount of X_i used in the unit production of X_j and $C = (C_1, C_2, ..., C_n)'$, the final consumption vector. The viability of the system is given in terms of HS condition that states:

(i) $(I - a_{ii}) > 0 \forall i$ and (ii) $|I - A| > 0$;

While the first condition ensures that to produce one unit of i-th commodity less than one unit of the same is needed, the second condition guarantees the existence of $(I - A)^{-1}$ where $X = (I - A)^{-1} C$ is the required amount of production to sustain $C > 0$. The a_{ii} values are always <1 and the $|I - A|$ values are all positive (0.000693 for 1993-94, 0.002867 for 1998-99, 0.000048 for 2003-04 and 0.000002 for 2007-08). Hence the system is internally consistent and can support a final demand vector.

Backward & Forward Linkages: We would like to check the attainment of technical progress in this sector in terms of an improvement in input-use efficiency. The input-output coefficient is likely to change following a change in relative input price and/or underlying technology. If we assume the technology to be of fixed coefficient type where no input substitution is possible following a change in relative input prices, then the change in technology will be the sole reason for the change in $a_{ij}'s$. Generally, the technical progress is said to occur when either the same amount of inputs produces more output or the same amount of output is produced by using less inputs. Dholakia et al. (2009) suggested a number of situations that may lead to such technical

progress even in the absence of change in relative prices of inputs and/or output: (a) quality of inputs may change, (b) quality of output may change, (c) new inputs may be introduced, (d) some inputs may become obsolete and be withdrawn from the use in production, (e) new production process and technique may be discovered and used, (f) better organization of production processes may increase input-use efficiency and (g) composition of output may change.

To assess the technical change, the corresponding coefficients of I-O matrices for any two successive periods have been compared by following Chenery-Watanabe (C-W) method that can be represented as follows:

$$\gamma^{t_1 t_0} = \left[\sum_j \left| a_{ij}^{t_1} - a_{ij}^{t_0} \right| \Big/ \frac{1}{2} \sum_j \left(a_{ij}^{t_1} + a_{ij}^{t_0} \right) \right]$$ where t_1 and t_0 represents two time points and a_{ij} represents the coefficient in i-th row and j-th column of matrix A. For Forestry & Logging sector $\gamma^{98-99,93-94} = 0.1845$, $\gamma^{03-04,98-99} = 0.6544$ and $\gamma^{07-08,03-04} = 0.5768$ and $\gamma^{07-08,93-94} = 0.9834$, indicating a marginal improvement in technical coefficients over these two decades.

Over the same period, the comprehensive coefficients of backward and forward linkages have also been estimated by following the Chenery-Watanabe formula:

$BL_t^{CW} = \sum_{i=1}^{n} a_{ij}^t$: jth column sum and $FL_t^{CW} = \sum_{j=1}^{n} a_{ij}^t$: ith row sum;

Table 1 (a & b) present the linkage coefficients for Forestry & Logging sector over time. Since Forestry and Logging is a primary sector, its backward linkage is rather weak, i.e., for production it has very little input-dependence on other sectors. The value of the linkage coefficient was stable around 0.09 till 2003-04 and suddenly it rose to 0.14 in 2007-08. However, for all wood-based products like wooden furniture & fixture, wood & wood products and paper, paper products and newsprints, the backward linkages are significant. For paper, paper products and newsprints it is almost stagnant around 0.73, for wooden furniture & fixture it is steadily

increasing from 0.46 in 1993-94 to 0.59 in 2007-08 and for wood & wood products, after a stable coefficient around 0.50 over 1993-94 to 2003-04 an increase of 10 per cent to 0.60 is noted for 2007-08.

Table 1 (a): Pattern of Backward Linkage in Forestry Sector over 1993-94 to 2007-08

Backward Linkage	1993-94	1998-99	2003-04	2007-08
Forestry and logging	0.0962509	0.0930202	0.0959087	0.1458529
Furniture and fixtures-wooden	0.465194	0.50532	0.5443203	0.5961433
Wood and wood products	0.5098075	0.4900507	0.504095	0.609471
Paper, paper prods. & newsprint	0.7387377	0.7315093	0.7262858	0.7383589

Source: Author's calculation from CSO data

Table 1 (b): Pattern of Forward Linkage in Forestry Sector over 1993-94 to 2007-08

Forward Linkage	1993-94	1998-99	2003-04	2007-08
Forestry and logging	0.5640165	0.4489985	0.5186232	0.6417659
Furniture and fixtures-wooden	0.0821346	0.0956462	0.0354089	0.1515827
Wood and wood products	0.626005	0.7171253	0.4029371	0.2629472
Paper, paper prods. & newsprint	0.9412298	0.9862425	0.9060414	0.851299

Source: Author's calculation from CSO data

This is indicating the possibility of some technological change after 2003-04 in forestry & logging and primary wood products. These sectors are gradually developing dependence on other secondary sectors. However, the implication of this technological change needs to be interpreted with some social caution. A key determinant of natural resource management is technology and as forest-product related technologies become more productive in an economic sense, forests are

more likely to be overexploited. Technological progress accelerates economic growth, but relatively slow-growing natural resource systems, like forests, come under greater pressure from the demands of economic efficiency (Harris, 2006).

The analysis of the pattern of forward linkage shows that the dependence of all other sectors of the economy on forestry & logging has gone up, though with some traces of intermediate fluctuations, from 0.56 in 1993-94 to 0.64 by 2007-08. So, there is no compelling evidence that the national policy towards forest conservation is paying much heed to forest-product-displacing technological progress. There are direct initiatives working through substitution mechanism for wood and wood products, suggested by a reduction in forwards linkage coefficient from 0.62 in 1993-94 to only 0.26 by 2007-08. A marginal but consistent change from 0.94 to 0.85 is noted in case of paper, paper products and newsprints which may be due to the revolution in information technology and the consequent spread in soft infrastructure in the post-reform era. However, in case of wooden furniture and fixture, the forward linkage coefficient is increasing over time from 0.8 to 0.15 indicating an enhanced use of wood panel, ply wood and wood chips by other sectors of the economy.

Multiplier Effect: To assess the importance of Forestry & Logging sector in the national economy we have to estimate the direct, indirect and induced contribution of the sector in GDP. The direct contribution is available in the break-up of the gross domestic product by the 'industry of origin'; the indirect contribution is assessed in terms of the contribution of directly forest dependent sectors like wooden furniture & fixture, wood & wood products and paper, paper products and newsprints in GDP through input-output channels of inter-sectoral interdependence. To estimate this indirect contribution the forest and related sectors are dropped from the I-O table and the final demand vector (GDP without forestry) is calculated. Difference between this adjusted GDP and the actual GDP gives the indirect contribution of forestry. Finally, the induced contribution is estimated by isolating the contribution of other non-wood related sectors in GDP who are connected with forestry & logging through forward linkage only by applying the same technique proposed for isolating indirect effect (Chart 1 & Table 2 presents this decomposition).

Let us consider the same *(n x n)* system $\boldsymbol{X = AX + C}$ where the n sectors can further be decomposed into one sector (Forestry & Logging), which is of original concern, next *(k-1)*

sectors that are indirectly related, next *(m-k)* sectors with induced dependence and the remaining *(n-m)* sectors as unrelated to the first sector. Then the contribution of each group in the final consumption $\boldsymbol{C}$ (the GDP) can be isolated by applying the following method:

$$(\boldsymbol{I}-\boldsymbol{A})\boldsymbol{X}=\boldsymbol{C}, \text{ or, } \boldsymbol{BX}=\boldsymbol{C}, \text{ where } \begin{bmatrix} \boldsymbol{B}_{kxk} & \boldsymbol{B}_{kx(n-k)} \\ \boldsymbol{B}_{(n-k)xk} & \boldsymbol{B}(n-k)x(n-k) \end{bmatrix}\begin{bmatrix} \boldsymbol{X}_k \\ \boldsymbol{X}_{n-k} \end{bmatrix}=\begin{bmatrix} \boldsymbol{C}_k \\ \boldsymbol{C}_{n-k} \end{bmatrix}$$

$$\text{Or, } \begin{bmatrix} \boldsymbol{B}_{kxk}\boldsymbol{X}_k+\boldsymbol{B}_{kx(n-k)}\boldsymbol{X}_{n-k} \\ \boldsymbol{B}_{(n-k)xk}\boldsymbol{X}_k+\boldsymbol{B}_{(n-k)x(n-k)}\boldsymbol{X}_{n-k} \end{bmatrix}=\begin{bmatrix} \boldsymbol{C}_k \\ \boldsymbol{C}_{n-k} \end{bmatrix}$$

So, contribution of first *k*-sectors in GDP could be isolated by taking out the contribution of remaining *(n-k)* sectors from the vector C, which is:

$$\boldsymbol{B}_{(n-k)x(n-k)}\boldsymbol{X}_{n-k}=\boldsymbol{C}_{n-k}-\boldsymbol{B}_{(n-k)xk}\boldsymbol{X}_k=\boldsymbol{D}_{n-k}$$

The aggregate value of this contribution would be $\left[\boldsymbol{e}'_{(n-k)}\boldsymbol{D}_{n-k}\right]$, where $\boldsymbol{e}'_{(n-k)}$ is the sum-vector of order *(n-k)*. When this part is subtracted from the total GDP, the contribution of the first k-sectors can be obtained as: $\left[\boldsymbol{e}'_n\boldsymbol{C}-\boldsymbol{e}'_{(n-k)}\boldsymbol{D}_{n-k}\right]$. Thus,

The direct contribution of Forestry & Logging (sector 1) in GDP: $\boldsymbol{C}_1$;

The indirect contribution in GDP through next (k-1) sectors: $\left[\boldsymbol{e}'_n\boldsymbol{C}-\boldsymbol{e}'_{(n-k)}\boldsymbol{D}_{n-k}-\boldsymbol{C}_1\right]$;

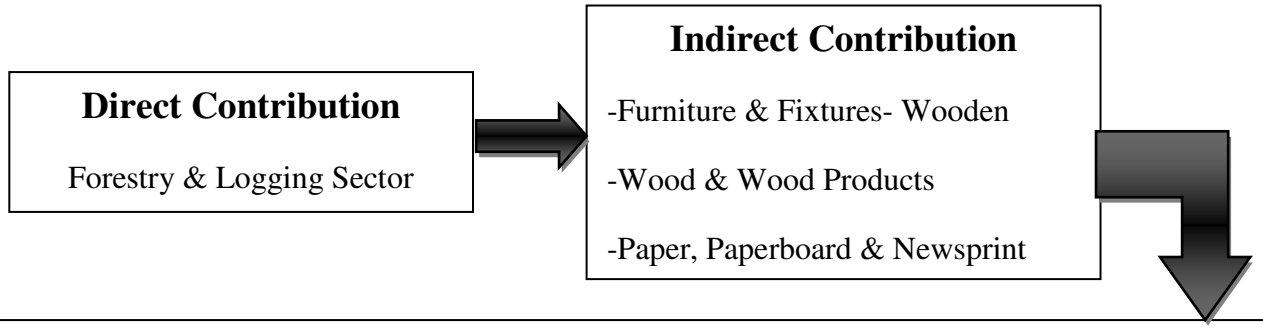
The induced contribution through next (m-k) sectors: $\left[\boldsymbol{e}'_n\boldsymbol{C}-\boldsymbol{e}'_{n-m}\boldsymbol{D}_{n-m}-\boldsymbol{e}'_{n-k}\boldsymbol{D}_{n-k}\right]$as $\boldsymbol{C}_1$ is already contained in the third term.

So, the gross contribution of Forestry & Logging through direct and indirect channels of technological dependence would come up to:

$$\boldsymbol{C}_1+\left[\boldsymbol{e}'_n\boldsymbol{C}-\boldsymbol{e}'_{(n-k)}\boldsymbol{D}_{n-k}-\boldsymbol{C}_1\right]+\left[\boldsymbol{e}'_n\boldsymbol{C}-\boldsymbol{e}'_{n-m}\boldsymbol{D}_{n-m}-\boldsymbol{e}'_{n-k}\boldsymbol{D}_{n-k}\right]$$

$$=\left[2\left(\boldsymbol{e}'_n\boldsymbol{C}-\boldsymbol{e}'_{n-k}\boldsymbol{D}_{n-k}\right)-\boldsymbol{e}'_{n-m}\boldsymbol{D}_{n-m}\right];$$

Chart-1: Direct, Indirect and Induced Contribution of Forestry & Logging Sector in GDP



Induced Contribution

Paddy	Iron ore	Art silk, synthetic fiber textiles	Other chemicals	Communication equipments	Water transport
Wheat	Manganese ore	Jute, hemp, mesta textiles	Structural clay products	Other electrical Machinery	Air transport
Jowar	Bauxite	Carpet weaving	Cement	Electronic equipments(incl.TV)	Supporting and aux. tpt activities
Bajra	Copper ore	Readymade garments	Other non-metallic mineral prods.	Ships and boats	Storage and warehousing
Maize	Other metallic minerals	Miscellaneous textile products	Iron, steel and ferro alloys	Rail equipments	Communication
Gram	Lime stone	Printing and publishing	Iron and steel casting & forging	Motor vehicles	Trade
Pulses	Mica	Leather footwear	Iron and steel foundries	Motor cycles and scooters	Hotels and restaurants
Sugarcane	Other non metallic minerals	Leather and leather products	Non-ferrous basic metals	Bicycles, cycle-rickshaw	Banking
Groundnut	Sugar	Rubber products	Hand tools, hardware	Other transport equipments	Insurance
Other oilseeds	Khandsari, boora	Plastic products	Miscellaneous metal products	Watches and clocks	Education and research
Cotton	Hydrogenated oil(vanaspati)	Petroleum products	Tractors and agri. implements	Medical, precision & optical instru.s	Medical and health
Tobacco	Edible oils,other than vanaspati	Coal tar products	Industrial machinery(F & T)	Gems & jewelry	Business services
Fruits	Tea and coffee processing	Inorganic heavy chemicals	Industrial machinery(others)	Aircraft & spacecraft	Legal services
Vegetables	Miscellaneous food products	Organic heavy chemicals	Machine tools	Miscellaneous manufacturing	Real estate activities
Other crops	Beverages	Fertilizers	Office computing machines	Construction	O.com, social & personal services
Milk and milk products	Tobacco products	Pesticides	Other non-electrical machinery	Electricity	Other services
Fishing	Khadi, cotton textiles(handlooms)	Paints, varnishes and lacquers	Electrical industrial Machinery	Water supply	
Coal and lignite	Cotton textiles	Drugs and medicines	Electrical wires & cables	Railway transport services	
Natural gas	Woolen textiles	Soaps, cosmetics & glycerin	Batteries	Other transport services	
Crude petroleum	Silk textiles	Synthetic fibers, resin	Electrical appliances	Land tpt including via pipeline	

Table 2 presents the number of sectors for each I-O matrix which are connected with the Forestry & Logging sector through induced channels. In 1993-94 and 1998-99, the total number of sectors was 115 and in 2003-04 and 2007-08, that has gone up to 130. Three wood-related sectors are already identified as indirectly dependent on Forestry & Logging. Out of the remaining 111 (and 126) sectors, 97 sectors show induced dependence for all four years and another 1 sector for three times, 17 for two times and so on. Thus, more than 80 per cent of GDP has some induced linkage with the Forestry & Logging sector and this dependence is temporally stable without any sign of decline over the last two decades.

Table 2: Frequency of Forest Dependency for Non-wood-related Sectors

Frequency	Sector	Number
4	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 15, 17, 18, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 94, 95, 96, 97, 98, 104, 105, 106, 107, 108, 109, 110, 111, 116	97
3	16	1
2	10, 13, 14, 19, 75, 91, 92, 93, 99, 100, 101, 102, 103, 112, 113, 114, 115	17
1	20	1

Note: The Sector codes follow Author's classification,
Sector names are provided in Table A.1 of Appendix;

Table 3 shows the direct, indirect and induced contribution of the Forestry sector on India's GDP over time. Though the direct contribution of Forestry sector in GDP never exceeded 2 percent, it has gone up from 1.05 per cent in 1993-94 to 1.72 per cent in 2007-08, by which time the size of the economy also increased nearly 2.64 times, i.e., from Rs.2.31 trillion to Rs.8.77 trillion in 1993-94 prices. So, there is no compelling reason to believe that a serious and comprehensive forest conservation policy is being followed by the Government. Of course, there is a marginal decline noted in the share of indirect contribution whereas the induced contribution is more or less stagnant; in all the total presence of the sector is highly visible at around 87 percent.

Table 3: Total Contribution (%) of Forestry & Logging Sector in India's GDP

Year	Direct Contribution	Indirect Contribution	Induced Contribution	Total
1993-94	1.05	4.51	80.53	86.09
1998-99	1.07	3.54	82.35	86.96
2003-04	0.65	3.73	82.60	86.92
2007-08	1.72	3.19	82.78	87.69

Source: Author's calculation

To supplement this production based analysis, one needs to study the pattern of expenditure over time by government and other private agents on the products of forestry sector and the share of domestic and foreign sources (imports as well as exports) to meet the demand. The following section will report that analysis.

III. Pattern of Expenditure on Forest Products

For the Forestry & Logging sector, the government consumption in 1993-94 prices has gone down from Rs.11.0 million to Rs.1.9 million over the period 1993-94 to 2007-08, and over the same period the private consumption expenditure on the same sector has gone up from Rs.73335.3 million (i.e., Rs.73.3 billion) to Rs.212216.4 million (i.e., Rs.212.2 billion), export from Rs.3.4 billion to Rs.6.1 billion and import from Rs.5.0 billion to Rs.23.9 billion (table 4). Though the government is trying to economize on the use of forest products in railway sleepers, construction industry (particularly in the public sector), furniture and panelling, mine-pit props, paper and paper board etc. (National Forest Policy, 1988), the attempted conservation strategies are getting jeopardized by the unbound increase in private consumption where in the dearth of domestic supply import from abroad is serving as a supplementary source. The pattern of consumption for Wood & Wood products is also suggesting a similar story. By 2007-08, though the government consumption is as low as Rs.2.5 million and the exports are also steady around Rs.1750.0 million (i.e., 1.75 billion), the private consumption and import are increasing exponentially, the former from Rs.2.1 billion to Rs.25.7 billion and the latter fromRs.0.3 billion to Rs.4.5 billion, suggesting a tendency for unleashed consumption.

Table 4: Pattern of Expenditure on Forest Related Products
(Rs. in million at 1993-94 prices)

Sector	Expenditure type	1993-94	1998-99	2003-04	2007-08
Forestry & Logging	**GFCE**	11.0	---	2.6	1.9
	PFCE	73335.3	87074.6	106050.7	212216.4
	Export	3383.0	7834.3	6262.0	6054.3
	Import	5030.1	13379.4	18661.2	23907.4
Wooden Furniture & Fixture	**GFCE**	969.0	1032.8	2338.4	11185.6
	PFCE	10144.9	26950.8	20322.3	64375.2
	Export	77.3	267.7	1377.6	4654.2
	Import	---	39.4	218.4	1415.3
Wood & Wood Products	**GFCE**	---	---	4.4	2.5
	PFCE	2112.6	5996.7	2086.9	25651.9
	Export	1761.7	1138.2	1071.3	1738.4
	Import	328.3	1279.5	6729.1	4529.8
Paper, Paper Products & Newsprints	**GFCE**	2961.8	5440.3	4543.4	20166.4
	PFCE	9082.6	15592.3	15180.3	32036.2
	Export	3276.6	16129.5	6048.0	8626.0
	Import	17906.3	40711.4	27510.7	49225.5

Source: Collated from different CSO commodity x industry transaction tables

For Wooden Furniture & Fixture, an increasing trend is observed for all components like government consumption, private consumption, export and import and in each case the change is quite substantial. However, the most noticeable change is observed in case of Paper, Paper products & Newsprints, where the value of government expenditure is the highest among all these four sectors. For all these forestry related sectors, the growth of private consumption surpassed that of government consumption and the growth of import surpassed that of export. So, it would be interesting to investigate the economic standing of our trading partners: where are we sending our products and who are our importers and what is the average value of our export vis-à-vis import? Are we selling raw timber/ wood and buying more processed one? If so, that would

be reflected in the average unit value of import and export of the relevant products. The following two sections will address those queries.

IV. Trade in Forest Products

It is observed in India's Forest Product Industry Outlook (2013) that over the last ten years India's trade deficit in forest products has soared from US$1.0 billion in 2001 to more than $5.0 billion in 2011. Due to the scarcity of domestic timber resources and rapidly growing demand, log imports in India have doubled since 2006 in order to meet the country's growing appetite for wood products. Major boost to this demand-hike came from the mostly skill oriented high economic growth, incentive to infrastructure development, spectacular expansion of the service sector including entertainment and tourism industry leading to a fantastic increase in construction activities and demand for wood and wood products. India's per capita consumption of paper and paperboard is less than 10kg (compared with 72kg/capita in China and 341kg/capita in the US), but demand has been growing rapidly and consumption of recovered paper, wood pulp and non-wood pulp have nearly doubled over the past decade.

Trend & Growth: Chart-2 presents the classification scheme of forest products by FAO where the major segments are roundwood (RW), wood charcoal, wood chips and particles and wood residues[4], sawnwood (SW), wood based panels (WBP), woodpulp (WP) and paper & paperboard (PPB). Annual trade data in '000 USD is available on RW and SW (SITC 24, revision 3), WBP (SITC 63), WP (SITC 25) and PPB (SITC 64) from COMTRADE_WITS site. Item-wise trend and compound growth of Export from India and Import to India over the 20 year period (1991-2010) is reported in Table 5 (a & b). For all the four items, the trend value of import is much bigger in magnitude compared to that of export (as shown in table 5a) indicating a wide gap in domestic production and domestic consumption. This observation endorses our finding on rapidly increasing value of private final consumption expenditure (PFCE) obtained from the relevant transaction matrices reported in the earlier section. However, the coefficient of

[4] Wood Charcoal, Wood Chips and Particles and Wood Residues were previously merged within the Roundwood segment and independent reporting started only after 1995. Since our timeframe is spanned over 1991 to 2010, so instead of considering it as a separate category, we have subsumed it under Roundwood.

compound growth rates reported in table 5b shows that export is also growing very fast almost at the same rate as imports but the initial base being considerably different, the demand-supply gap persists. The trend of net import reported in table 5(c) confirms this claim with high level of statistical significance.

Table 5a: Trend in Trade-flows of Forest Products (1991 - 2010)

$$Y_t = \alpha + \beta t + u_t$$

Variables (SITC Code)		β	R^2	F	df
Import Value	RW & SW (24)	65339.26***	0.8895	144.93***	18
	WBP (63)	11052.23***	0.7115	44.39***	18
	WP (25)	41856.26***	0.8256	85.20***	18
	PPB (64)	73490.08***	0.7587	56.59***	18
Export Value	RW & SW (24)	1567.693***	0.7614	57.44***	18
	WBP (63)	6264.637***	0.7113	44.36***	18
	WP (25)	81.51***	0.5046	18.33***	18
	PPB (64)	33306.02***	0.8719	122.53***	18

Source: COMTRADE_WITS Database; *indicates statistical significance

Table 5b: Growth in Trade-flows of Forest Products (1991 - 2010)

$$\ln Y_t = \alpha + \beta t + u_t$$

Variables (SITC Code)		β	R^2	F	df
Import Value	RW & SW (24)	0.1190***	0.9532	366.85***	18
	WBP (63)	0.2026***	0.922	212.85***	18
	WP (25)	0.1013***	0.9401	282.74***	18
	PPB (64)	0.1084***	0.879	130.79***	18
Export Value	RW & SW (24)	0.2423***	0.8473	99.91***	18
	WBP (63)	0.1044***	0.7097	44.01***	18
	WP (25)	0.1005***	0.5755	24.41***	18
	PPB (64)	0.1749***	0.9412	288.30***	18

Source: COMTRADE_WITS Database; *indicates statistical significance

Table 5c: Trend in Net Import of Forest Products					
Variables/ SITC Code		**β**	**R^2**	**F**	**df**
Net Import	RW & SW (24)	63771.57***	0.89	147.12***	18
	WBP (63)	4787.59***	0.47	15.66***	18
	WP (25)	41774.75***	0.82	84.83***	18
	PPB (64)	40184.06***	0.61	28.29***	18

Source: COMTRADE_WITS Database; *indicates statistical significance

Major Trading Partners: At next step we have taken up an analysis based on share of different countries as source (for import) and destination (for export) of trade flows in forest related products. Our interest lies in studying the changing profile of demanders and suppliers in the international market between 1993-94 (reported as 1994) and 2007-08 (reported as 2008), the period for which an analysis of domestic production is reported in section II. The countries explaining at least 1% of the relevant trade-flow (export/ import) for each SITC category have been culled out to identify the major export markets and importers in 1994 (table 6a) as well as 2008 (table 6b). The countries reported in *bold uppercase* are those who are enjoying important positions in both import and export in the initial as well as final year, and, therefore can be recognized as our major trading partners. We have such important partners in case of forest-based manufactured products like SITC 63 & 64 but not for semi-processed raw materials like SITC 24 & 25. For SITC 63 such countries are Germany, USA and Italy whereas for SITC 64 Germany, USA and UK belong to this group. The countries reported in *bold title case* are those which are important in terms of both import and export of that category in any particular year, suggesting possible presence of two-way trade. For SITC 24 in 1994 the countries important in terms of both export and import were Bhutan, Nigeria and Singapore; however, in 2008 the only country in this category was Germany. Similarly, for SITC 25 in 1994 the common partners in both export and import are Singapore and Thailand, whereas in 2008 the set changes to Belgium, Indonesia, Saudi Arabia, UK, UAE and USA. These drastic changes indicate strong market hold of India in the world economic order, where depending on the relative price and quality India is continually changing her trading partners. Finally, those reported in *regular case* are the

countries some of which were important earlier but not at present and the others are emerging as important trading partners in the recent time.

Table 6a: India's Trade Share in Forest Products: 1994		
Product Code	**Major Exporter**	**Major Importer**
SITC 24 (RW & SW)	**Bhutan, Nigeria, Singapore**, Australia, Canada, Finland, Japan, Oman, Spain, Sri Lanka, UK, USA	**Bhutan, Nigeria, Singapore**, Cameroon, Chile , China, South Africa, Cote d'Ivoire, Ghana, Malaysia, Myanmar, Papua New Guinea
SITC 63 (WBP)	**GERMANY, ITALY, USA, Japan, Singapore**, Bahrain, Kuwait, Nepal, Qatar, Saudi Arabia, UAE, UK, Bangladesh, China, Korea Rep., Spain, Sri Lanka, Sweden	**GERMANY, ITALY, USA, Japan, Singapore**, Indonesia, Malaysia, Finland, Portugal, Switzerland
SITC 25 (WP)	**Singapore, Thailand**, Bangladesh, Japan, Portugal, Sri Lanka	**Singapore, Thailand**, Canada, Finland, Russian Federation, South Africa, Sweden, Argentina, Chile, Indonesia, New Zealand, Norway, Saudi Arabia, UAE, USA
SITC 64 (PPB)	**GERMANY, UK, USA, China, Japan, Singapore, South Africa**, Australia, Bangladesh, Egypt, Iran, Nepal, Nigeria, Saudi Arabia, Sri Lanka, UAE, Jordan, Malaysia	**GERMANY, UK, USA**, **China, Japan, Singapore, South Africa**, Austria, Canada, Finland, France, Indonesia, Italy, Norway, Russian federation, Sweden, Slovenia, Switzerland

Source: Extracted from COMTRADE database

To study the change in relative trade shares, the countries are grouped into two classes (i) for whom the export share has gone up and (ii) for whom the import share has gone up. These two groups of countries have further been sub-divided into OECD and Non-OECD countries to explore the presence of correspondence, if any, between the flow of goods and the status of economic development for the products of a primary sector like forestry. The results are reported in table 7. Import share for relatively raw and semi-processed products under SITC 24 & 25 has gone up for Non-OECD countries of South Asia and Africa including China. For OECD countries the import share has increased only in case of manufactured products under SITC 63 & 64. Here the shares of both import and exports are increasing in some OECD countries like Germany, Italy, USA and UK where the dominant presence was noted from tables 6a & 6b.

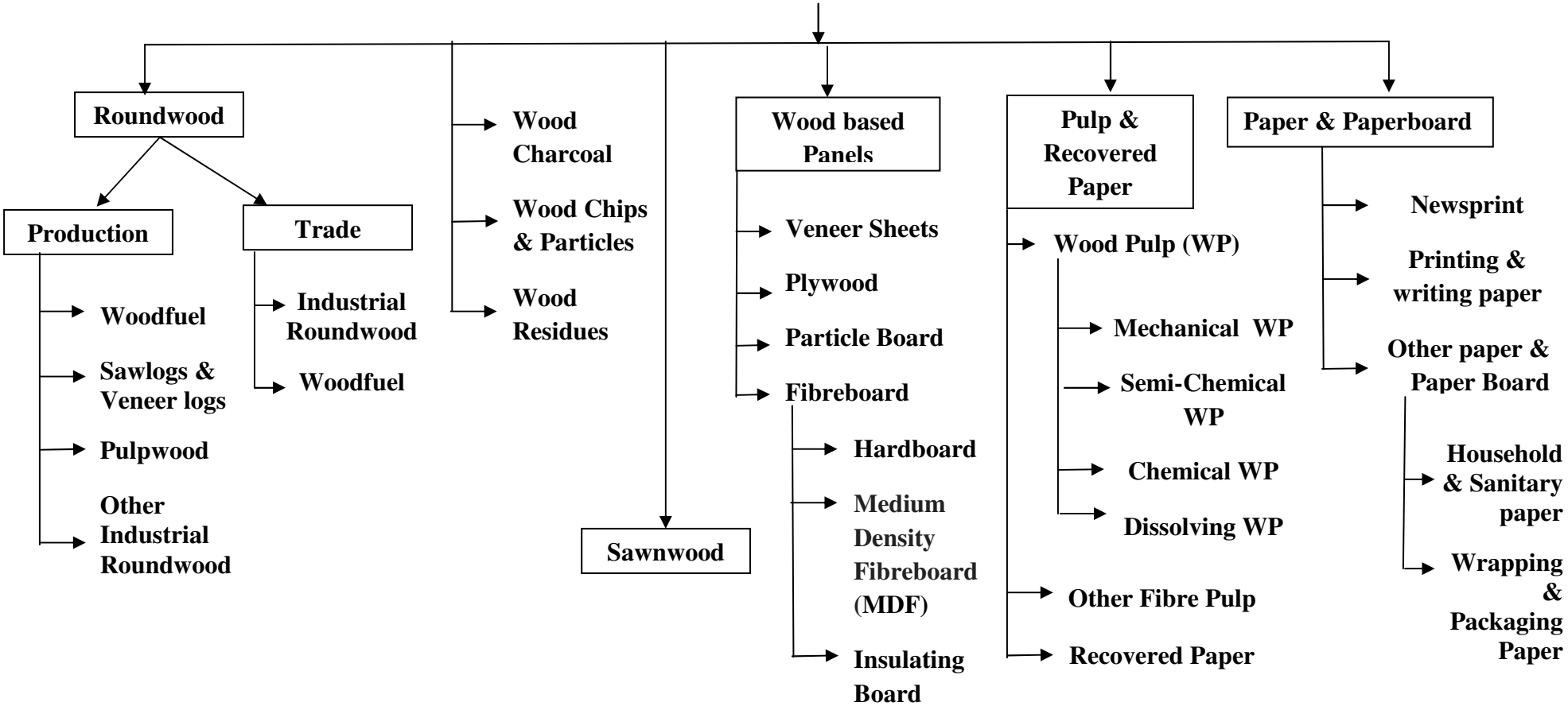
Table 6b: India's Trade Share in Forest Products: 2008		
Product Code	**Major Exporter**	**Major Importer**
SITC 24 (RW & SW)	**Germany**, Bhutan, France, Greece, Italy, Kuwait, Netherlands, Pakistan, Qatar, Saudi Arabia, Singapore, United Arab Emirates, Canada, Finland, Japan, Oman, Spain, Sri Lanka, UK, USA	**Germany**, Costa Rica, Ecuador, Gabon, New Zealand, Nigeria, Togo, Cote d'Ivoire, Ghana, Malaysia, Myanmar, Papua New Guinea
SITC 63 (WBP)	**GERMANY, ITALY, USA, Spain, Sri Lanka**, Bahrain, Kuwait, Nepal, Qatar, Saudi Arabia, UAE, UK, Australia, Belgium, Canada, Japan, Maldives, Netherlands, Turkey	**GERMANY, ITALY, USA, Spain, Sri Lanka**, Indonesia, Malaysia, Austria, China, Guinea, Korea Rep., Myanmar, Papua New Guinea, Singapore, Sweden, Thailand
SITC 25 (WP)	**Belgium, Indonesia, Saudi Arabia, United K, United AE, United SA**, Bahrain, Ecuador, Ghana, Italy, Libya, Malaysia, Nigeria, Qatar, Syrian Arab Republic	**Belgium, Indonesia, Saudi Arabia, United K, United AE, United SA**, Canada, Finland, Russian Federation, South Africa, Sweden, Germany, Netherlands, Sri Lanka
SITC 64 (PPB)	**GERMANY, UK, USA**, **Korea Rep., Malaysia**, Australia, Bangladesh, Egypt, Iran, Nepal, Nigeria, Saudi Arabia, Sri Lanka, UAE, Ethiopia, Ghana, Israel, Kenya, Singapore, South Africa, Tanzania	**GERMANY, UK, USA**, **Korea Rep., Malaysia**, Austria, Canada, Finland, France, Indonesia, Italy, Norway, Russian federation, Sweden, China, Japan, Netherlands, Philippines

Source: Extracted from COMTRADE database

Table 7: India's Trade Share in Forest Products: Increase over 1994 to 2008				
Product Code	**Increase in Export Share**		**Increase in Import Share**	
	OECD	**Non-OECD**	**OECD**	**Non-OECD**
SITC 24 (RW & SW)	Spain, UK, USA	Sri Lanka	-	Ghana, Myanmar, Papua New Guinea
SITC 63 (WBP)	Germany, Italy, Spain, USA	Qatar	Germany, Italy, USA	Malaysia
SITC 25 (WP)	-	-	-	Indonesia, South Africa
SITC 64 (PPB)	Germany, UK, USA	Iran, Nigeria, Sri Lanka, UAE	France, Italy, UK, USA	China, Indonesia

Source: Extracted from COMTRADE database

Chart 2: Classification of Forests Products by FAO



Source: Developed on the Basis of FAO Classification

Thus India is depending on her Non-OECD trading partners for the supply of semi-processed wood-products and the important source of manufactured forest products are the OECD countries. This observation raises another query related to the relative value of different forestry based trade-flows in the international market. Are we exporting low value raw materials, importing high value finished products and in the process depleting our valuable resource base? We need to study volumes, values as well as unit values of these exports and imports in a temporal frame. For that purpose one may carry out item-wise analysis of demand-supply gap by utilizing information provided by FAO (Food and Agricultural Organization).

V. Analysis of Demand - Supply Gap

The supply of any product category (RW/ SW/ WBP/ WP/ PPB) has been represented in terms of the domestic production data ($\boldsymbol{Q_s}$) obtained from FAO statistics and demand is estimated from consumption data ($\boldsymbol{Q_d}$) which is taken as domestic production plus net import ($\boldsymbol{Q_s + Import - Export = Q_d}$). We have considered both the value and volume for each product category to come up with an assessment of utilization from the perspective of both stock and flow. For trade-flows, in addition, depending on data availability, we have considered the temporal movement in unit value of export and import.

<u>*Trend & Growth*</u>: The analysis of trends and compound growths for production and consumption are reported in tables 8 (a, b) and that for import and export are reported in tables 9 (a, b). Except for SW, volume of all other products are having significantly positive statistical trend in production with RW enjoying the highest magnitude. However, the value of SW has a statistically significant trend (though at 10% level only) and PPB has larger trend value compared to WBP; here the trend of the *value of PPB* is more than proportionately bigger than the *value of WBP* suggesting the presence of difference in intrinsic market based valuation. The price of SW and PPB are increasing at a faster rate than that of WBP. The pattern in consumption, in terms of both volume and value, are more or less similar to that in production and in absolute term the estimated parameters are always larger in magnitude (and same in sign) for consumption compared to production indicating a possible presence of demand gap. For both volume and value of import, the trend for all components of forestry based products are positive

and statistically significant; the value for RW being the largest. However, the pattern across sub-groups are not compatible for volume and value as the value-coefficient of trend for PPB is very close to that of RW whereas the volume-coefficients are significantly different and against quite small volume-coefficient of SW the value-coefficient is considerably large. The same observation holds for the comparative position of WP and WBP. It seems to us that the imports are generally having high unit value. In fact, the unit value of SW is the largest with high statistical significance followed by WP and PPB. So, the consumption of SW is largely supported by the import of high value products.

Table 8a: Temporal Trends of Forest Products

$$Y_t = \alpha + \beta t + u_t$$

Variables			β	R^2	F	df
Production	**Volume**	**RW**	3269.54***	0.92	198.59***	18
		SW	-169.76	0.08	1.57	18
		WBP	169.60***	0.81	76.18***	18
		WP	80.95***	0.94	291.3***	18
		PPB	279.17***	0.68	38.22***	18
	Value	**RW**	2445207.00**	0.30	7.63**	18
		SW	182177.50*	0.16	3.45	18
		WBP	88392.94***	0.67	36.21***	18
		WP	64798.42***	0.80	70.98***	18
		PPB	286452.00***	0.54	21.25***	18
Consumption	**Volume**	**RW**	3548.61***	0.93	236.11***	18
		SW	-164.78	0.08	1.48	18
		WBP	180.71***	0.83	87.93***	18
		WP	105.14***	0.93	225.04***	18
		PPB	327.14***	0.75	53.17***	18
	Value	**RW**	2510252.00**	0.31	7.95**	18
		SW	183633.10*	0.16	3.51	18
		WBP	93048.33***	0.68	38.93***	18
		WP	81941.50***	0.81	76.01***	18
		PPB	328644.70***	0.58	25.28***	18

Source: FAO Statistics; *indicates statistical significance

In case of the volume of exports, some of the trends like that of RW are even negative with statistical significance and the largest positive volume is observed for PPB followed by WBP.

For export-value, except for RW the trend is everywhere positive and significant and the numerical value of PPB is very high. In terms of Unit value of export, SW reveals the largest trend with less than 1% statistical significance but, contrary to our expectation, the trend value for PPB is insignificant.

Table 8b: Temporal Trends of Trade-flows in Forest Products

$$Y_t = \alpha + \beta t + u_t$$

Variables			β	R^2	F	df
Import	Volume	RW	278.51***	0.89	150.70***	18
		SW	5.26***	0.72	45.28***	18
		WBP	13.88***	0.80	71.29***	18
		WP	24.87***	0.69	40.25***	18
		PPB	69.29***	0.83	85.53***	18
	Value	RW	65057.03***	0.81	75.67***	18
		SW	2195.64***	0.63	30.21***	18
		WBP	7037.17***	0.80	71.96***	18
		WP	17535.31***	0.70	41.75***	18
		PPB	62613.03***	0.76	56.33***	18
	Unit Value	RW	5.62*	0.18	4.01*	18
		SW	14.77**	0.25	6.05**	18
		WBP	0.14	0.00	---	18
		WP	12.20***	0.40	12.02***	18
		PPB	12.85**	0.26	6.49**	18
Export	Volume	RW	-0.56*	0.16	3.44	18
		SW	0.28	0.03	0.60	18
		WBP	2.77***	0.33	9.00***	18
		WP	0.62*	0.16	3.41	18
		PPB	21.32***	0.81	77.21***	18
	Value	RW	11.28	0.00	0.05	18
		SW	739.95**	0.28	6.92**	18
		WBP	2381.78 ***	0.58	25.34***	18
		WP	392.22*	0.18	3.89	18
		PPB	20420.40***	0.78	63.63***	18
	Unit Value	RW	10.54***	0.33	8.74***	18
		SW	34.37***	0.49	17.08***	18
		WBP	23.87*	0.16	3.47	18
		WP	15.56**	0.30	7.58*	18
		PPB	6.81	0.03	0.62	18

Source: FAO Statistics; *indicates statistical significance

Table 9a: Compound Growth of Forest Products $\ln Y_t = \alpha + \beta t + u_t$						
Variables			**β**	**R^2**	**F**	**df**
Production	**Volume**	**RW**	0.01***	0.92	202.27***	18
		SW	-0.01	0.04	0.76	18
		WBP	0.14***	0.74	49.99***	18
		WP	0.05***	0.95	350.56***	18
		PPB	0.06***	0.84	94.16***	18
	Value	**RW**	0.04**	0.30	7.86**	18
		SW	0.02	0.08	1.53	18
		WBP	0.14***	0.57	23.68***	18
		WP	0.07***	0.86	111.76***	18
		PPB	0.08***	0.70	41.90***	18
Consumption	**Volume**	**RW**	0.01***	0.93	241.50***	18
		SW	-0.01	0.04	0.71	18
		WBP	0.15***	0.80	70.09***	18
		WP	0.05***	0.95	328.94***	18
		PPB	0.06***	0.89	150.30***	18
	Value	**RW**	0.04***	0.31	8.22**	18
		SW	0.02	0.08	1.57	18
		WBP	0.14***	0.63	30.06***	18
		WP	0.07***	0.86	111.52***	18
		PPB	0.08***	0.74	50.89***	18

Source: FAO Statistics; *indicates statistical significance

In case of production as well as consumption, for both volume and value, WBP has the largest compound growth rate of 14% per annum and SW fails to exhibit any definite direction of growth. Though both the volume and value of the import of WBP have gone up at the highest rate (20%) over this period with strong statistical significance, the unit value remained almost unchanged indicating an expansion in terms of quantity alone. For most of the products the export performance is abysmally insignificant compared to the import dependence and the only important component turned out to be PPB. The unit value of PPB is not improving over time suggesting the absence of quality improvement and concentration on low value products only. From the forgoing analysis it may be concluded that India is a net consumer of forest products and it would be interesting to estimate the trend of this demand-supply gap over this period.

Table 9b: Compound Growth of Trade-flows in Forest Products $\ln Y_t = \alpha + \beta t + u_t$						
Variables			**β**	**R^2**	**F**	**df**
Import	**Volume**	**RW**	0.16***	0.80	73.87***	18
		SW	0.14***	0.72	45.66***	18
		WBP	0.20***	0.85	105.88***	18
		WP	0.06***	0.67	36.29***	18
		PPB	0.10***	0.83	86.38***	18
	Value	**RW**	0.18***	0.77	60.00***	18
		SW	0.14***	0.65	33.85***	18
		WBP	0.20***	0.95	371.06***	18
		WP	0.08***	0.67	36.98***	18
		PPB	0.11***	0.82	83.30***	18
	Unit Value	**RW**	0.03**	0.18	4.02	18
		SW	0.03**	0.21	4.71**	18
		WBP	0.00	0.00	0.04	18
		WP	0.02***	0.41	12.39***	18
		PPB	0.02**	0.21	4.81**	18
Export	**Volume**	**RW**	--	--	--	--
		SW	0.03	0.08	1.61	18
		WBP	0.07***	0.35	9.82***	18
		WP	--	--	--	--
		PPB	0.24***	0.80	73.94***	18
	Value	**RW**	--	--	--	--
		SW	0.06**	0.29	7.39**	18
		WBP	0.09***	0.57	23.79***	18
		WP	--		--	--
		PPB	0.25***	0.85	98.76***	18
	Unit Value	**RW**	0.06**	0.30	7.79**	18
		SW	0.07***	0.49	17.24***	18
		WBP	0.02	0.05	0.94	18
		WP	0.10	0.18	4.06	18
		PPB	0.01	0.03	0.56	18

Source: FAO Statistics; *indicates statistical significance

Demand-Supply Gap: To estimate the demand-supply gap on the basis of an economic model we are proposing demand as a function of income and supply as a function of investment in the forestry sector. We have taken GDP at current prices to represent income; however, for

investment on forestry sector no continuous data were available. To cover our chosen period (1991-2010), we needed information over the four Five-Year-Plan periods starting from the Eighth Five-Year-Plan. The year-wise information for the Ninth-Plan-period at 1993-94 prices was available in the site of Indiastat.com along with the aggregates over five periods for the Tenth and the Eleventh Five Year Plans. We have simulated the series by applying boot-strapping and converted it to current prices to make them compatible with the annual production data. Finally, we have estimated the following model:

(1): $Q_{dt}^{j} = \alpha + \beta(GDP_t) + u_t$; j= RW,SW,WBP,WP&PPB; where $Q_{dt}^{j} = Q_{st}^{j} + IMP_t^{j} - EXP_t^{j}$;

(2): $Q_{st}^{j} = \gamma + \delta(INV_{Ft}) + \varepsilon_t$; j= RW,SW,WBP,WP&PPB;

The income elasticity of consumption (demand) and the investment elasticity of production (supply) are also been estimated utilizing the corresponding log-linear versions as:

(3): $\ln Q_{dt}^{j} = \mu + \ln \lambda(GDP_t) + u_t$; with λ as the income-elasticity of demand coefficient and

(4): $\ln Q_{st}^{j} = \rho + \ln \theta(INV_{Ft}) + \varepsilon_t$; with θ as the investment elasticity of supply coefficient.

The next step would be to estimate the demand-supply gap. From the time series data on consumption and production the demand-supply gap over time for each item can be estimated as:

(5): $GP_t^{j} = \tau + \pi t + \nu_t$; where $GP_t^{j} = Q_{dt}^{j} - Q_{st}^{j}$;

The Demand-Supply model based prediction could be obtained from

(6): $Z_t^{j} = \zeta + \phi t + \omega_t$; where $Z_t^{j} = \hat{Q}_{dt}^{j} - \hat{Q}_{st}^{j}$;

To assess the statistical quality of this model based prediction of demand-supply gap vis-à-vis the simple time based forecast for each product on the basis of a rather limited data support we have used Theil's U statistics:

(6): $$U_j = \left[\frac{\frac{1}{T}\sum_t \left[\frac{Q_{dt}^{j}}{Q_{st}^{j}} - \frac{\hat{Q}_{dt}^{j}}{\hat{Q}_{st}^{j}} \right]^2}{\frac{1}{T}\sum_t \left(\frac{\hat{Q}_{dt}^{j}}{\hat{Q}_{st}^{j}} \right)} \right]^{\frac{1}{2}}$$ for j = RW, SW, WBP, WP and PPB;

If $U_j < 1$, the model predicts the gap better than the simple time based forecast; if $U_j = 1$ then the model and the simple time based forecasts are equivalent and for $U_j > 1$, the modeling exercise is futile. Smaller the value of U_j greater would be the statistical strength of the model. Table 10 presents the results.

Table 10: Estimates of Demand-Supply Gaps

Variables → **Parameter ↓**	**RW**	**SW**	**WBP**	**WP**	**PPB**
β $Q_{dt}^{j} = \alpha + \beta(GDP_t) + u_t;$	56.21***	5.11***	1.86***	1.47***	6.96***
δ $Q_{st}^{j} = \gamma + \delta(INV_{Ft}) + \varepsilon_t;$	62.54***	5.68***	1.85***	1.28***	6.25***
λ $\ln Q_{dt}^{j} = \mu + \ln\lambda(GDP_t) + u_t;$	0.51***	0.41*	1.72***	0.87***	0.99***
θ $\ln Q_{st}^{j} = \rho + \ln\theta(INV_{Ft}) + \varepsilon_t;$	1.55***	1.52**	4.79***	2.37***	2.74***
π $GP_t^j = \tau + \pi t + \nu_t$ $GP_t^j = Q_{dt}^{j} - Q_{st}^{j}$	65045.75***	1455.69***	4655.39***	17143.09***	42192.63***
ϕ $Z_t^j = \zeta + \phi t + \omega_t$ $Z_t^j = \hat{Q}_{dt}^{j} - \hat{Q}_{st}^{j}$	296240.70	27163.89	19173.72**	22929.01***	100466.20***
Theil's U $U_j = \left[\frac{\frac{1}{T}\sum_t\left[\frac{Q_{dt}^{j}}{Q_{st}^{j}} - \frac{\hat{Q}_{dt}^{j}}{\hat{Q}_{st}^{j}}\right]^2}{\frac{1}{T}\sum_t\left(\frac{\hat{Q}_{dt}^{j}}{\hat{Q}_{st}^{j}}\right)}\right]^{\frac{1}{2}}$	0.11	0.14	0.67	0.19	0.41

All the demand coefficients are positive and statistically significant with respect to income and the income elasticity of demand is the highest and statistically significant with a magnitude greater than unity for the wood based products (WBP). For paper & paper boards (PPB) and

wood pulp (WP) the income elasticities are close to unity, lending support to our earlier surmise that the demand for these forestry based products are going up with the increase in the size of the affording class following spectacular economic growth in the post reform period. By using transcendental and quadratic specifications of consumption function similar results have been obtained by Patil et. al (2013). The dependence of supply on investment on the forestry sector is also significant for all product groups and the most dominant effect is observed for Round Wood. The investment elasticity of supply is also everywhere statistically significant. Finally, the temporal trend in demand-supply gap assessed in terms of raw data is statistically significant for all products and is the maximum for RW followed by PPB and SW. That obtained on the basis of estimated values of gap, generated from the proposed model are also confirming the same claim. However, in absolute value, the model based prediction always surpassed the time series based forecasting by manifold and the Theil's U statistics is less than unity for all the forestry based sub-sectors and, therefore, we have reasons to believe that the model based predictions are more reliable than the ordinary analysis of temporal trends. The magnitude of value coefficient for RW [296240.70] is nearly 4.5 times greater than the forecasted value [65045.75], though the former is not statistically significant. The statistical insignificance of two base materials like RW and SW may be explained in terms of strict conservation policies adopted by the government with respect to timber harvesting. However, it is also important to note that all these forest based products are getting boost from the expanding macro economy through the input-output linkages, which the model based prediction can capture but the time based forecasting misses. So, the forecasted model under-reports the potential danger. This ever expanding demand-supply gap would cause economic vulnerability in the near future even over a shorter horizon than what is anticipated. A similar caution was given by Rai, Niwas & Khatkar (1983), way back in the late 70s, by using data over 1968 to 1979. The situation has deteriorated over time without showing any sign of improvement.

VI. Concluding Observations

In this paper, an attempt has been made to assess the prospect of sustainable forest management for an emerging economy, like India, where the area under forest coverage has gone up

marginally over the last three decades in spite of population growth and rapid urbanization. The share of government consumption in the total output of the forestry sector has gone down and a conscious attempt towards conservation is noted from the supply side. However, with rapid income growth, given the high demand elasticity of the wood based products, there is sharply growing gap between demand and supply. Major boost to this demand-hike came from the mostly skill oriented high economic growth, incentive to infrastructure development, spectacular expansion of the service sector including entertainment and tourism industry, leading to a fantastic increase in construction activities and demand for wood and wood products. India's per capita consumption of paper and paperboard is less than 10kg (compared with 72kg/capita in China and 341kg/capita in the US), but demand has been growing rapidly and consumption of recovered paper, wood pulp and non-wood pulp have nearly doubled over the past decade. This phenomenon indicates the presence of strong inter-sectoral linkages that makes the indirect and induced demand for forestry substantially high. In fact, even in 2007-08, more than 87% of India's GDP is found to be linked with the forestry based sectors through some indirect and/or induced channels. The import of forestry based products are increasing in terms of volume, value and unit prices throughout this period and the major importers of raw and semi-finished forestry based inputs are the South and East Asian countries. Patil et. al. (op. cit.) considers this import dependent growth in consumption as off-shoot of institutional reforms like liberalization and forest conservation. If the government discourage use of forest produces as intermediate as well as final products and the affording class imports these as lifestyle products from abroad, then we are not culturally conserving the scarce resource but only draining the other countries with weaker environmental regulations to satisfy our own requirements. The dominant importers of wood and paper based manufactured products are the OECD countries of the West. Since forest resource is very active agent in absorbing carbon-dioxide and supplying fresh oxygen to combat global warming, India's unleashed demand (met through import from outside) will eventually have its impact on reduced wood stock of the other countries and the consequent pressure on the climatic cycle of the planet will not only thwart the process of economic development but mere sustainable existence of the system will be doubtful. The time based forecasting of the demand-supply gap for different forestry related products were indicated by the researchers for more than three decades, but a model based estimate carried out in this paper by recognizing the role of the

type and speed of economic development at the national level in creating demand pressure on the forestry sector, shows the actual gap nearly five times more than the time based forecasts. This pattern of the use of forest and wood related products is not indicating any consistently designed integrated policy position towards forest conservation, but the problem of forest has been attempted to be managed from within the sector itself without paying much heed to the pattern of inter-sectoral interdependence at the aggregate economy level. If no restriction is imposed from the demand-side, mere supply-side management would be inadequate to ensure sustainable forest use for this slow-growing renewable resource which has enormous potential for climate balancing.

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Appendix

Table- A.1: Sector Codes - Author's Classification

1	Paddy	30	Khandsari, boora	59	Soaps, cosmetics & glycerin	88	Bicycles, cycle-rickshaw
2	Wheat	31	Hydrogenated oil(vanaspati)	60	Synthetic fibers, resin	89	Other transport equipments
3	Jowar	32	Edible oils other than vanaspati	61	Other chemicals	90	Watches and clocks
4	Bajra	33	Tea and coffee processing	62	Structural clay products	91	Medical, precision &optical instru.s
5	Maize	34	Miscellaneous food products	63	Cement	92	Gems & jewelry
6	Gram	35	Beverages	64	Other non-metallic mineral prods.	93	Aircraft & spacecraft
7	Pulses	36	Tobacco products	65	Iron, steel and ferro alloys	94	Miscellaneous manufacturing
8	Sugarcane	37	Khadi, cotton textiles(handlooms)	66	Iron and steel casting & forging	95	Construction
9	Groundnut	38	Cotton textiles	67	Iron and steel foundries	96	Electricity
10	Other oilseeds	39	Woolen textiles	68	Non-ferrous basic metals	97	Water supply
11	Cotton	40	Silk textiles	69	Hand tools, hardware	98	Railway transport services
12	Tobacco	41	Art silk, synthetic fiber textiles	70	Miscellaneous metal products	99	Other transport services
13	Fruits	42	Jute, hemp, mesta textiles	71	Tractors and agri. implements	100	Land tpt including via pipeline
14	Vegetables	43	Carpet weaving	72	Industrial machinery(F & T)	101	Water transport
15	Other crops	44	Readymade garments	73	Industrial machinery(others)	102	Air transport
16	Milk and milk products	45	Miscellaneous textile products	74	Machine tools	103	Supporting and aux. tpt activities
17	Fishing	46	Printing and publishing	75	Office computing machines	104	Storage and warehousing
18	Coal and lignite	47	Leather footwear	76	Other non-electrical machinery	105	Communication
19	Natural gas	48	Leather and leather products	77	Electrical industrial Machinery	106	Trade
20	Crude petroleum	49	Rubber products	78	Electrical wires & cables	107	Hotels and restaurants
21	Iron ore	50	Plastic products	79	Batteries	108	Banking
22	Manganese ore	51	Petroleum products	80	Electrical appliances	109	Insurance
23	Bauxite	52	Coal tar products	81	Communication equipments	110	Education and research
24	Copper ore	53	Inorganic heavy chemicals	82	Other electrical Machinery	111	Medical and health
25	Other metallic minerals	54	Organic heavy chemicals	83	Electronic equipments(incl.TV)	112	Business services
26	Lime stone	55	Fertilizers	84	Ships and boats	113	Legal services
27	Mica	56	Pesticides	85	Rail equipments	114	Real estate activities
28	Other non metallic minerals	57	Paints, varnishes and lacquers	86	Motor vehicles	115	O.com, social & personal services
29	Sugar	58	Drugs and medicines	87	Motor cycles and scooters	116	Other services