HERFINDAHL-HIRSCHMAN INDEX (HHI), VALUE CO-CREATORS AND GREEN PRACTICES FOR INDUSTRY

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Abstract

The intensity of inventiveness for green logistics and supply chain management in industries can be effectively measured using the Herfindahl-Hirschman Index (HHI) to encourage environmental compliance within the sustainable development goals (SDG) of SDG 9,11 and 12. These SDG goals adhere to responsible industry, innovation and infrastructure, sustainable cities and communities, and responsible consumption and production. Research in the telecommunications industry suggests that increased market efficiency correlates with greater opportunities for market segmentation and economic growth in green logistics and supply chain management. This study identifies value co-creators for industries to intensify and leverage inventiveness for green practices and environmental compliance measurable by the HHI. Utilizing time series data from the International Telecommunications Union and the World Bank, the research identifies the main value co-creators in India, including human capital and infrastructure, innovation and technology and economic indicators such as investments in telecommunications, purchasing power parity, and gross domestic product. These factors collectively drive the social and economic services value addition in India, fostering overall development and sector-specific growth.

Key words: *Herfindahl-Hirschman Index; green practices; environment; value co-creator; logistics; supply chain.*

JEL Classification: A11, E00, D12, D20, D46, D50, D83, D86, E10, E23, E29, F18, F64, O44

I. INTRODUCTION

The United States Department of Justice describes how the Herfindahl-Hirschman Index (HHI) used to measure market concentration is calculated by squaring the market share of each firm competing in a market and then adding the numbers (United States Department of Justice 2015). Each competing company's market share is squared to determine the HHI, which is then summed. For instance, the HHI is 2,600 ($30^2 + 30^2 + 20^2 + 20^2 =$ 2,600) for a market with four companies with shares of 30, 30, 20, and 20 percent. When there is a greater concentration of firms in a market competing for the market share, the HHI tends to zero and can reach a maximum value of 10,000 points when there is domination of the market controlled by one firm. The *Herfindahl-Hirschman index* can also be used to measure the intensity of industry inventiveness in the green logistics and supply chain management sector. Studies on the *Herfindahl-Hirschman index* have demonstrated in the telecommunications industry that greater the efficiency of markets, greater are the opportunities for market segments and economic growth (Sung 2014). Green practices may also have a positive effect on the financial performance of businesses (Chen and Ma 2021) attracting greater investments. Many industries are also adhering to a circular economy in terms of implementing green practices such as recycling (Mirela 2025).

Value co-creators (Gopalan 2017) may identify how inventiveness of industries for green logistics and supply chain management value co-create for the HHI. Time series data from the ITU and World Bank Data on these *value co-creators* for India were identified as labor force (Total), the business and innovation environment, energy production (KWh), mobile phone subscriptions, purchasing power parity (PPP) conversion factor, gross domestic product (GDP) (LCU per International US$), secondary education, tertiary (% gross), households with a computer, annual investment in telecommunications and services value addition (constant 2005 US$). This contributes to the economic and social services value addition for countries. Further, studies have shown that technology portfolios, technology coupling, technology transformation, firm size, alliance portfolio, business

acquisitions, profitability, research and development investments, sales growth and technology similarity have facilitated sustainable growth of industries (Martynov 2023).

Chen and Ma (2021) in their study have also discussed how investment in green practices such as environmental compliance among firms have a positive effect on the financial performance of firms. The industrial organization (IO) emphasizes the significance of market elements in determining firm success; it is commonly referred to as the structure–conduct–performance paradigm (Porter, 1979). Using this viewpoint, Bain (1951) demonstrated how a high level of market concentration suggests that players with a bigger market share have more market power, which leads to success in terms of increased resilience. Green practices may increase this resilience in terms of financial performance, investments and add value to environmental compliance. According to the market expansion approach, trade flows are caused by stable markets and costs among trading partners, indicating that nations invest in markets that are more efficient (Thomé et al. 2023). This can closely be associated with the advantage of purchasing power parity in countries and also encouraging opportunities for investments in green practices on the lines of the SDG goals of adhering to responsible industry, innovation and infrastructure, sustainable cities and communities, and responsible consumption and production. In the context of green practices, innovation as a strategic approach in industries can facilitate competitive advantage for brands, optimization of costs, and sustainability (Cornia 2025).

II. GREEN PRACTICES, ENVIRONMENT AND HHI

Despite the high level of popularity of the HHI in measuring industry and business concentration, there are limitations for the practical application of this index with respect to green practices and environmental compliance. The relevance of the index becomes null and void for the industry that need to align with markets. Decision makers rarely use this index for atypical monetary decisions for investing in green practices for environmental compliance. Structurally coefficient regression models in logistics and supply chain management speak only on investment needs while ignoring the bias towards green practices that creeps in when the stability of industry portfolio concentrations are more relevant.

In the electricity sector, there is an opportunity cost variable or flex pricing that can be calibrated for profits based on the money market rate and deposit rates and the demands of markets (Borenstein et al. 1999). A sector GDP concentration increase in an industry that significantly affects the environment calls for a proportional investment in green practices and environmental compliance from firms to add to the investor confidence and to the firm's financial performance. The SDG 9, SDG 11 and SDG 12 goals of responsible industry, innovation and infrastructure, sustainable cities and communities, and responsible consumption and production becomes more relevant.

When paradigm shifts happen, it is seen that *value co-creators* work best when applied in the broader spectrum of industry intensity and innovativeness guided by the HHI. Emerging industry patterns within the boundaries of green practices may encourage not only competition but environmental compliance if guidelines and regulations are formulated using the HHI. This index can well be a guiding factor where economies and green practitioners need to know where the Hirschman index is if its application can bring out the real information of the needs of markets in terms of improved environmental compliance. It is generally observed that the HHI index is applied to broad infrastructural industry requirements and is notated in the form of a whole number. Lesser estimates can be taken as being unfavorable where opportunity costs are relatively very high and industry players are unable to assimilate these costs from implementing green practices and environmental compliance. This forms the basis for economic decision making. This study focuses on a few relevant questions.

They are:

a. How best can inventions in green practices be supported at the macro level through government interventions?
b. What kind of market structure could arise from the intermodal nature of transition of economies to greener practices and environmental compliance?
c. Will regulations discourage new firms from innovating in the market or will it ease out disturbances from the already existing structure. (Cowling and Waterson 1976).
d. Would the nature of co-operation sustain in the long run or would there be increase in the intensity of inventiveness in green practices and environmental compliance based on studies of the HHI?

Could certain firms and industries that that adhere to green practices and environmental compliance be structured as oligopolies and would an increased intensity of inventiveness eliminate constraints in markets and

facilitate an ultimate level of sophistication?

N-firm oligopolies or consortiums with partially cooperative firms significantly decide the profitability of industries and it becomes challenging to implement green practices and adhere to environmental compliance. The co-operation of all firms cannot be detected as the HHI index does not identify firms that adhere to green practices and environmental compliances. In the case of dominating oligopolies, that is, huge markets and industries that do not have the option or do not comply with environmental regulations or greener practices, may always show no cooperation. In reality, there is the possibility that the cooperation of only a few firms that adhere to green practices and environmental compliance may not be that significant or relevant for measuring and evaluating the HHI.

Economics for businesses across industry sectors depends on various enablers and these need to be audited and verified by empirical analysis. Hypotheses of these enablers were identified and need empirical analysis (Gopalan and Natarajan 2015). The *value co-creators* for green practices and environmental compliance that justify the usefulness of the HHI for encouraging economic growth of relevant industry sectors must be audited and verified. A time series study of the telecommunications industry across India for the timeline between 1960 and 2013 (Gopalan 2017) identifies various value co-creators for economic growth in terms of economic and social services value addition in today's internet economy. The efficiency of the HHI for implementing green practices and environmental compliance may depend on the social, economic and intellectual motivation required for increased intensity of inventions.

Studies on applying HHI in industries have discussed about its credibility and ineffectiveness as a measure of containing corruption because of its inability in detecting anticompetitive behavior, non-cooperation and any collusion (Matsumoto et al., 2012) resulting in double standards. Evaluating the success of social services value addition using the telecommunications industry as an instrument to study economic growth has identified that the affordability of products and services, access to basic services, subscriptions and energy needs are significant requirements. A time series analysis of the telecommunications industry growth in India from the years 1960 to 2013 has demonstrated successful economic growth in the industry sectors of Information and Communication Technologies (ICT), Energy and Utilities, Business and Financial Services and Media (Gopalan 2017). There is a great opportunity for the implementation of green practices and environmental compliance in many of these sectors aligning with the SDG goals such as SDG 9, 11 and 12 that pay efforts for responsible industry, innovation and infrastructure, sustainable cities and communities, and responsible consumption and production.

III. TABLES, FIGURES, EQUATIONS

The general model can be specified as $Y = a+b_1X_1+b_2X_2 +b_3X_3+-------+biXi+----$ $i=1,2,3\ldots,n$ where Y = intensity or level of innovations in green practices and environmental compliance and co-creation measured by monetary value of these investments for an industry sector. This is measured by the amount invested in green practices and circular economies. It is the sum total of green practice projects * amount invested in each project. The independent variables Xi i=1,2,3,….n, for each sector are derived from the enablers for green practices given in Table 1.

The table 1 identifies the industry-wise enablers of economic growth (Gopalan and Natarajan 2015).

Table 1: Identifying industry-wise enablers of economic growth
(Gopalan and Natarajan 2015)

Y (Sector)	X_i (Enablers). i=1,2,3 ….n
ICT	X_1 = Growth rate of startups (last five years)
	X_2 = Number of new disruptive technologies (last five years)
	X_3 = Index of mobile computing use
Pharmaceutical	X_1 = Number of regulations that affect growth (last five years)
	X_2 = Number of new drugs introduced in the market (Industry average of last five years)
	X_3 = Cost index (industry average for last five years)

Advanced Manufacturing	X_1 = R&D cost index (Industry average)
	X_2 = Public sector budgets
	X_3 = Competition in industry (Measured by Herfindahl Hirschman Index)
Fast Moving Consumer Goods (FMCG)	X_1 = Competition in industry (Measured by Herfindahl Hirschman Index)
	X_2 = Shell life of products (Industry average)
Energy and Utilities	X_1 = Energy demand
	X_2 = Number of carbon related regulations
	X_3 = Number of new energy technologies
	X_4 = Kwh of energy used from renewable and sustainable sources
Business and Financial Services	X_1 = Mobile technology advances
	X_2 = Number of customers from new markets
Media	X_1 = Penetration of mobile technology (Measured by readership via mobile technology)
	X_2 = Number of new players in industry (Measured by Herfindahl Hirschman Index)
	X_3 = Number of new business models

Implementation of green practices and environmental compliance can be encouraged across various industry sectors. This may lead to improved financial performance of firms (Chen and Ma 2021) and encourage favorable investments in the firm.

Considering social services value addition (constant 2005 US$) across India, the ICT industry in India has benefitted significantly in terms of growth rate of start-ups, advanced technologies and sales of computers and mobile technologies. The fast moving consumer goods (FMCG) segment has also demonstrated sustained economic growth and also benefitted by the increasing popularity of online shopping and electronic commerce. The economic growth of the telecommunications industry has been sustained by energy production (kWh), energy and utilities services, mobile phone subscriptions and purchasing power parity or affordability, inventiveness of ICT and access to enhanced internet connectivity and numerous services. The manufacturing sector has benefited significantly from value co-creators in the logistics and supply chain sector by improvements in business process management facilitated by IT and efficiency in the procurement and shipping of products and services and creation of innovative business practices (Rai et al., 2012).

Business and Financial services in the net banking and mobile banking sector have benefitted from greater internet and mobile phone subscriptions providing access to innumerable economic and social services. Media businesses such as the entertainment and content delivery services have also benefited from increased viewership and readership in the Internet economy with an increase in participating firms and new revenue models. Economic growth indicators for India demonstrates the merits of labor force participation, school enrollment, tertiary (% gross), affordability of education and energy and utility services. This adds to the efficiency of business ecosystems and economic and social services by supporting the labor force (total). Usage of ICT across India measured by internet subscriptions, school enrollment, tertiary (% gross) benefits from economic and social services that have facilitated labor force (total) employment and economic growth. Table 2 shows the different *value co-creators* from investments in the telecommunications and internet economy across India (Gopalan 2017).

Table 2: Value Co-creators in the Internet economy across India

People usage of ICT	**Values Added – Economic**	**Values Added - Social**
Mobile Phone Subscriptions	Values added from ICT for new services and products	Values added from ICT on access to basic services
People using the Internet	Values added from ICT for new businesses	Participation index
Households with a personal computer and Internet access	**Government use of ICT**	**Affordability**
	Government prioritization of ICT as an indication of investment in telecommunications	Purchasing Power Parity (PPP) conversion factor, GDP (Local currency unit (LCU) per international US$)
Broadband Internet and Mobile broadband subscriptions	**Environments for Business and Innovation**	**Infrastructure**
	Secondary education gross enrolment rate (%)	Electricity Production (kwh)

IV.CONCLUSIONS

Today's internet economy is characterized by internet subscriptions, economic and social service subscriptions, telecommunications and ICT, business and innovation ecosystem, affordability of technology and services and infrastructure requirements. The economic and social services for economic growth in the internet economy depend on mobile phone subscriptions, Internet subscriptions, information and communications technologies (ICT), government investment in telecommunications, education, participation of labor force (total), affordability and energy production. Industries need to adhere to greener practices such as circular economy and environmental compliance that uphold the SDG 9, SDG 11 and SDG 12 goals of sustainable industry, innovation and infrastructure, sustainable cities and communities, and responsible consumption and production

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