

# **Eleventh Faculty Seminar Retreat**

**Book of Abstracts**  
**23rd & 30th March, 2024**



**MADRAS SCHOOL OF ECONOMICS**  
**(Institution of Special Importance)**  
**GANDHI MANDAPAM ROAD, CHENNAI – 600 025**

## **Program Schedule**

**Venue: Conference Room, 1st Floor, New Academic Block**

**Day 1: 23.03.2024 (Saturday)**

**Inaugural Session: (10 am – 10:45 am)**

**Welcome address at 10 am**

**by**

**Dr. K.R. Shanmugam, Director MSE**

**Inaugural lecture at 10:05 am**

**by**

**Dr. C. Rangarajan**

**Former Chairman, Economic Advisory Council to the Prime  
Minister**

**& Former Governor, RBI;  
Chairman, Madras School of Economics**

**Tea/Coffee Break: 10:45 am -11 am**

Presenters are marked in bold letters. Each paper is scheduled for a maximum of 30 minutes out of which 20 minutes are for presentation followed by 10 minutes of discussion.

***Technical Sessions:***

**Technical Session 1: (11 am – 1:00 pm)**

**Chair: Dr. K.R. Shanmugam**

**Paper 1:** *Improving Women's Employment in India: A Low Hanging Fruit for Growth and Development*

**Brinda Viswanathan**

**Paper 2:** *Digital Finance: A Developing Country Perspective with Special Focus on Gender and Regional Disparity*

**Amrita Chatterjee**

**Paper 3:** *Do Exporting Industries Contribute to Better Female Labour Market Outcomes?*

Rozi Kumari, Prarthna Agarwal Goel and **Devasmita Jena**

**Paper 4:** *Quantifying Vulnerability to Tropical Cyclones: Evidence of Cyclone Shocks in Coastal Villages of India*

**Sweta Sen**, Narayan Chandra Nayak and William Kumar Mohanty

**Lunch Break: 1:00 pm- 1:45 pm**

**Technical Session 2: (1:45 pm- 3:15 pm)**

**Chair: Dr. Ekta Selarka**

**Paper 5:** *India @ 100 and the Significance of Top Six States*

**K.R. Shanmugam** and Mathew Koshy Odasseril

**Paper 6:** *Role of Macroeconomic Channels in the Debt - Growth Nexus: Evidence of Nonlinearity*

**Blessy Augustine** and Muhammed Rafi OPC

**Paper 7:** *Appetite for Official Reserves*

**Stefy Carmel** and M. Ramachandran

**Tea/Coffee Break: 3:15 pm -3:30 pm**

**Technical Session 3: (3:30 pm- 5:00 pm)**

**Chair: Dr. Saumitra Bhaduri**

**Paper 8:** *Dynamics of Gene Regulation*

**Rakesh Nigam**

**Paper 9:** *Corporate Boards in India – Optimal Board Size*

**Ekta Selarka**

**Paper 10:** *Multi-market Contact, Cartel and Product Quality*

**Neelanjan Sen** and Uday Bhanu Sinha

**Day 1 concludes**

**Day 2: 30.03.2024 (Saturday)**

**Technical Session 4: (10:00 am-11 am)**

**Chair: Dr. Amrita Chatterjee**

**Paper 11:** *Environment and Parliamentary Debates: Indian Evidence*

Animita Hazra and **K.S. Kavi Kumar**

**Paper 12:** *Use Of Information by Agricultural Households in India: Determinants and Preferences*

**Aritri Chakravarty**

**Tea/Coffee Break: 11 am -11:15 am**

**Technical Session 5: (11:15 am- 12:45 pm)**

**Chair: Dr. Brinda Viswanathan**

**Paper 13:** *Digital Trade and Wealth Inequality: Evidence from Asia Pacific Region*

**Sanjeev Vasudevan** and Mini P Thomas

**Paper 14:** *Drivers of Colocation of R&D and Manufacturing Activity in India*

**Gopal Krishna Roy**, Nandini Lahiri and Elizabeth Rose

**Paper 15:** *Investigating the Social Impact of the Actuarial Profession in India: The Case of Life and General Insurance*

**Rupel Nargunam** and Ritika Agarwal

**Lunch Break: 12:45 pm- 1:45 pm**

**Technical Session 6: (1:45 pm- 3:15 pm)**

**Chair: Dr. K. S. Kavi Kumar**

**Paper 16:** *Revisiting the nexus between R&D Intensity and Financial Constraint: Exploring the Role of Unobserved Heterogeneity with Finite Mixture Models*

Amal Jose and **Saumitra Bhaduri**

**Paper 17:** *Predictive Modeling of Initial Public Offerings (IPOs) Performance: A Feature Engineering Approach*

Durga Vaidynathan and **Parthajit Kayal**

**Paper 18:** *Fault-Assisted Side-Channel Analysis of HMAC-Streebog*

**Gautham Sekar**, Mabin Joseph and R. Balasubramanian

**Tea/Coffee Break: 3:15 pm -3:30 pm**

**Technical Session 7: (3:30 pm- 5 pm)**

**Chair: Dr. Rakesh Nigam**

**Paper 19:** *Manifolds: Why are the Maps of the Earth Never Completely Accurate?*

**Poorna Narayanan**

**Paper 20:** *Pulsar Mode Changes*

**Arpita Choudhary**, Manjari Bagchi and Dhruv Pathak

**Paper 21:** *Role of Multi-Valued Logic to Model Ethical Agent*

**Purbita Jana**

**Vote of Thanks**

**Day 2 concludes**

# **Improving Women's Employment in India: A Low Hanging Fruit for Growth and Development**

**Brinda Viswanathan<sup>1</sup>**

**Abstract:** Post COVID-19, there has been a small surge in women's labour force participation rate in India compared to an earlier decline between 2012-2017. More importantly, the quality of the newly employed women is poor, as the increase is in unpaid family enterprise or own account work with their absorption primarily into the low productive segments of agriculture, manufacturing or services. A better reallocation of human capital between economically productive activities and social reproduction is clearly a low hanging fruit for India's growth and development. However, this seems elusive as dogmatic social norms are pervasive across economic and educated segments of the population resulting in a skewed time-sharing of mundane household chores and care-giving between men and women. Households, firms and the state have to work together for an equitable time-use of men and women between SNA (system of national accounts) and non-SNA activities.

**Keywords:** Labour Force Participation, Time-Use, Occupational Choice

**JEL classification Codes:** J21, J22, J24

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<sup>1</sup> Madras School of Economics, Chennai

# **Digital Finance: A Developing Country Perspective with Special Focus on Gender and Regional Disparity**

**Amrita Chatterjee**<sup>1</sup>

**Abstract:** Even if Digital Financial services have a positive impact on financial inclusion, it creates a digital as well as gender divide within and across countries creating regional disparity even within developing nations. Though Pandemic has initiated digitalization of various services, there has been scanty research on whether digital transfer of income can improve digital financial inclusion in post-pandemic era, especially in developing countries. The current study intends to explain the regional disparity within developing countries from three regions East Asia Pacific, South Asia and Sub-Saharan Africa using latest World Findex data, 2021. We take an Instrumental variable approach to run bivariate probit model to find the factors that motivate the users to make digital payments. The study observes that electronic transfer of wages, government transfers and remittances can motivate individuals to make use of digital mode of transactions and mobile, practice of formal saving and borrowings are the prerequisites. However, this mechanism holds good for East Asia Pacific and not for South Asia and Sub-Saharan Africa, which are poor in ICT infrastructure. Women are lagging behind men but digital transfer of wages motivate them to make digital transaction. The current study corrects for the possible endogeneity issue which the extant literature has not paid attention to and provides region-specific and gender-specific policy recommendations for an improved digital inclusion. Digitalization of all government services and provision of affordable mobile network and internet services are necessary for regions like South Asia and Sub-Saharan Africa. In East Asia Pacific region, data protection, data governance and better regulatory framework are required. Higher female labor force participation with digital transfer of wages and empowerment with smartphones are key to reduction in Gender gap.

**Keywords:** Digital Finance, Electronic Wage transfer, World Findex Data, Bivariate Probit Model, Instrumental variable

**JEL classification codes:** G21, J3, J160

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<sup>1</sup> Madras School of Economics, Chennai



# **Do Exporting Industries Contribute to Better Female Labour Market Outcomes?**

**Rozi Kumari<sup>1</sup>, Prarthna Agarwal Goel<sup>2</sup> and Devasmita Jena<sup>3</sup>**

**Abstract:** International trade has emerged as one of the important channels of economic growth in developing countries in the recent decades. Nonetheless, the distributional impact of trade is widely conflicted and debated. Further, the trade and gender linkages remain comparatively underexplored. In this paper, we study whether exporting factories hire more female workers and pay better wages, thereby, contributing to favourable female labour market outcomes. Using Annual Survey of Industries data for India for the period 2010-2019, we estimate the association between export share and female labour market outcomes with capital intensity as the potential channel. Our preliminary findings show that there exists a positive association between export share of manufacturing factories and women employment and wage. However, this positive effect on female employment and wage gap is weaker as the capital-intensity of the exporting factory increases.

**Keywords:** Trade, female employment, gender wage gap, skill gap, Capital intensity, exporting manufacturing factories

**JEL Classification Codes:** F10, J16, J31

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<sup>2</sup> GGSIPU, New Delhi

<sup>3</sup> Madras School of Economics, Chennai

# Quantifying Vulnerability to Tropical Cyclones: Evidence of Cyclone Shocks in Coastal Villages of India

Sweta Sen<sup>1</sup>, Narayan Chandra Nayak<sup>2</sup> and William Kumar Mohanty<sup>3</sup>

**Abstract:** In east-coast of India, tropical cyclones are perennial phenomena. The conditions of rural coastal households remain precarious as they become vulnerable to poverty. The present study examines the vulnerability of the affected households to recurrent cyclones. The study is based on 504 sample households in selected coastal villages on the Indian east coast. We employ the three-step feasible generalized least-square (3FGLS) estimation in a multilevel model in this study to find the factors affecting the vulnerability of each household. We further decompose the estimated vulnerability into idiosyncratic and covariate, and poverty into chronic and transient. Results show that the current poor are less than those at risk of becoming poor due to tropical cyclones. Fishing as the main occupation affects the most vulnerable population as they are exposed to high consumption volatility and poverty. Risk attitude forms an integral part of the coastal population, and risktaker households are more vulnerable to cyclonic shocks. However, households with multiple sources of livelihood stay less vulnerable. Unlike other studies, we find covariate vulnerability almost equal to idiosyncratic vulnerability. From the policy perspective, we need to mitigate the covariate shocks by ex-ante mitigation interventions, which may help consumption smoothening for households having high consumption volatility.

**Keywords:** Tropical cyclones; Chronic and transient poverty; Idiosyncratic and covariate vulnerability; Fishing community; Coastal India

**JEL classification Codes:** C5, D1, Q5, R2

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<sup>3</sup> Indian Institute of Technology Kharagpur, Kharagpur

## **India @ 100 and the Significance of Top Six States**

**K.R. Shanmugam<sup>1</sup> and Mathew Koshy Odasseril<sup>2</sup>**

**Abstract:** India has a goal of achieving a US\$ 7 trillion economy in 2030 and subsequently a developed nation status by 2047, the year at which India will complete 100 years after achieving freedom from British rule. While some studies/reports have explored the possibilities of reaching these targets based on assumptions recording the growth rate, inflation etc, this study is an attempt to forecast the future growth of the Indian economy till 2048-49 using the Markov Switching model and real GDP growth data from 1993-94 to 2022-23 and verify when these goals will be achieved. Since the economic outcomes are highly heterogeneous across the Indian States and there are indications of divergence in economic growth, it also estimates and predicts the future growth prospects of the top six states and the rest of India. The findings suggest that India will achieve the US\$ 7 trillion target by 2031-32 and the per capita income level of developed nation of US\$ 13204 by 2045-46, assuming 4.5% inflation and 2% depreciation of exchange rate. While the Indian economy is expected to grow at an average rate of 6.21% from 2023-24 to 2048-49, Gujarat will grow at 8.31%, followed by Tamil Nadu at 7.55%, Karnataka at 6.73% and Maharashtra at 6.2%. West Bengal and Uttar Pradesh will grow at 5.74% and 5.59% respectively. The rest of India will grow at 6.56%. Gujarat's and Tamil Nadu's per capita income are expected to cross US\$ 13204 by 2036-37 while Karnataka's per capita income will cross after a year. While Maharashtra's per capita income will reach the threshold level by 2040-41, the rest of India by 2046-47. Both West Bengal's and Uttar Pradesh's per capita income will reach the target level only after 2047-48.

**Keywords:** Indian economy, Indian States, Markov Switching Regression, GDP/GSDP forecasts

**JEL classification Codes:** C34, E17, E66

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# **Role of Macroeconomic Channels in the Debt - Growth Nexus: Evidence of Nonlinearity**

**Blessy Augustine<sup>1</sup> and Muhammed Rafi OPC<sup>2</sup>**

**Abstract:** This research contributes to the existing body of literature on the relationship between public debt and economic growth by investigating potential nonlinearities within various macroeconomic channels. Utilizing data spanning from 1980 to 2019, the study employs country-specific threshold regression models to explore the nonlinear dynamics associated with public debt impact across Investment, Savings, Interest Rate, and Total Factor Productivity channels in a sample of emerging and developing economies. Our analysis reveals a nontrivial and diverse relationship between public debt and these macroeconomic channels, with considerable variation observed among countries in terms of identified thresholds. Moreover, the impact of public debt below and above these thresholds varies distinctly across countries for each channel. Notably, a universal threshold applicable to all countries within each channel could not be identified. The findings underscore the importance of conducting country-specific studies to comprehensively analyse the impact of public debt on an economy. Interestingly, only one country within our sample exhibited operational functionality across all four channels. Furthermore, the significance of each channel varies significantly among countries, emphasizing the nuanced nature of the relationship between public debt and economic growth. The implications of these results suggest that the effectiveness of public debt in influencing economic growth hinges on how efficiently each macroeconomic channel operates within specific countries. Understanding these dynamics provides valuable insights for policymakers, guiding them in targeting optimal channels for utilizing public debt effectively.

**Keywords:** Public debt, Macroeconomic channels, Nonlinearity, Threshold

**JEL classification Codes:** O11, O57, H63, C24

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## **Appetite for Official Reserves**

**Stefy Carmel<sup>1</sup> and M. Ramachandran<sup>2</sup>**

**Abstract:** There is a strong nexus between the level of reserves, frequency of intervention, and exchange rate variability. Given the current exchange rate arrangements, there is a mandate to accumulate reserves in line with other developments such as import growth, growth in short-term external debt, and so on. The Reserve Bank of India seems to have no option, especially in times of capital flight, but to allow the exchange rate to absorb market pressure if the volume of reserves held is not adequate. This indicates a limited scope for using other instruments. The objective of accumulating additional reserves seems to override the ambition of exchange rate stability when there is a limit on the capacity to intervene imposed by the reserve shortfall. The level of reserves must be maintained in line with certain reserve adequacy metrics so that the authority will have the capacity to execute market intervention to minimise fluctuations in exchange rates unwarranted by the underlying fundamentals. Therefore, reserves matter in times of crisis.

**Keywords:** Central bank intervention, Foreign exchange reserves, Reserve adequacy

**JEL Classification Codes:** F31, E52, E58

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# Dynamics of Gene Regulation

Rakesh Nigam<sup>1</sup>

**Abstract:** Many complex gene regulatory networks maintain multiple steady states, for example the embryonic stem cell network. In this talk a non-linear gene regulatory model is formulated and solved for a two gene network. The steady state expression of genes is computed for a given set of interaction parameters, and their stability is analyzed. This is called the forward problem, which can be complemented with experiments where certain genes in the network can be up, down regulated and even knocked out due to certain mutations. Finally, the inverse problem is formulated and solved using Regularized Regression, and the network interaction parameters are recovered. The model can be useful in predicting the role of gene expression in certain forms of diseases.

**Keywords:** Gene Regulation; Regularized Regression; Stem Cell Network

**JEL classification Codes:** C 610, C 620, C 630, C 650

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# Corporate Boards in India – Optimal Board Size

Ekta Selarka<sup>1</sup>

**Abstract:** This paper revisits the relation between firm value and board size. Using a large sample of non-financial listed firms on National Stock Exchange of India between 2005-2020, we find that there exists an optimal board size. This finding is in contrast with the existing theory that predicts a U-shaped relation, which suggests that either very small or very large boards are optimal and it depends on the firm size and complexity. Our findings suggest that Q ratio (a variant of Tobin's Q) consistently decreases in board size lower than this threshold. The effect of this relation is economically highest when the board size reaches a threshold. We run several econometric specifications that are accepted in the empirical literature on corporate board structure and firm value to verify our findings. We also draw several implications on the board structure around this threshold board size.

**Keywords:** Corporate governance, Ownership structure, Board Size, Tobin's Q, ROA, Emerging Markets, India

**JEL classification codes:** G32; G34; K22

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# **Multi-market Contact, Cartel and Product Quality**

**Neelanjan Sen<sup>1</sup> and Uday Bhanu Sinha<sup>2</sup>**

**Abstract:** This paper develops a model of multi-market contact and collusion in a setup where the firms may collude and choose product qualities for different markets. We show how multi-market contact and collusion can affect the quality choices adversely in the markets such that the availability of high-quality products reduces and the availability of low-quality products increases. There are two markets with identical demand which are geographically separated but served by both firms. Firms produce goods which are horizontally and vertically differentiated. It is shown that the firms can coordinate and collude during the quality choice stage, and as a result of this collusion in quality choice, the firms will under-invest in product quality improvement (and thereby save the fixed cost), leading to the availability of more low-quality products and the availability of less high-quality products in the market. We also discuss the stability of the different types of cartels. It is also shown that when the fixed cost is low so that producing only the high-quality product is the unique Nash equilibrium, then welfare may increase if the firms form the cartel and either of the firms switch to the lower quality product (instead of producing, the higher quality product). Otherwise, after collusion, welfare always reduces.

**Keywords:** Collusion; Multi-market contact; Product Differentiation; Quality; Cournot

**JEL classification Codes:** L 24, L 13, D 43, D 12

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# Environment and Parliamentary Debates: Indian Evidence

Animita Hazra<sup>1</sup> and K.S. Kavi Kumar<sup>2</sup>

**Abstract:** Parliamentary questions play an important role in policymaking by ensuring that all relevant concerns of the society are represented on national agendas in a well-functioning democracy. Using the questions asked by the Parliamentarians in during the Lok Sabha question hour over the three Lok Sabha terms (2004 to 2019), this research attempts to understand environmental consciousness in parliamentary discussions. In addition to question addressed to the Ministries concerned with environment, the research focusses on questions related to environment in general independent of the Ministry to which they are addressed. The results suggest that despite an increase in the questions related to environment over the three Lok Sabha terms, the interest in environment seems insignificant in Indian Parliament. Further the Parliamentarians from regional parties have raised significantly more questions than their counterparts from the national parties. The study also analysed the determinants of environmental consciousness of the Parliamentarians from Indian states – captured through activity score. While literacy levels and extent of industrialization seem to influence the activity scores of states, other state specific factors such as its vulnerability to natural disasters and geographic location did not play significant role in enhancing the environmental consciousness of the Parliamentarians.

**Key Words:** Lok Sabha; Parliamentary Questions; Environmental Consciousness

**JEL Classification Codes:** H11; Q50; Q56

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# **Use of Information by Agricultural Households in India: Determinants and Preferences**

**Aritri Chakravarty<sup>1</sup>**

**Abstract:** The NSSO report (2015) shows that 41 percent of the rural households in India have accessed information and 34 percent households have used them. This paper explores the households' use of information and understand their preference of information sources and their determinants. Households with better socio-economic conditions access information and from multiple sources. Media has the highest access while public sources have the lowest. Most of the households accessing information use it but the source-wise adoption rates show that, the source with the highest access, media, has the lowest use. This study tries to identify potential factors that lead to a systematic difference in using patterns across households and also across sources. Almost 80 percent of the households accessing information have used it and those not using information have cited lack of credit as a big hurdle to adoption among other reasons. Source-wise disaggregation of use shows that media has the lowest use at around 60 percent, even though it is the highest accessed resource. For all other sources, the share hovers around 80 to 90 percent. The analysis uses a Heckman Selection model to identify the potential factors that drive information use and also the differences between users and non-users of information from media. Overall, use of information is driven more by education and availability of credit than by other factors directly. Caste doesn't appear to be a significant determinant of use directly, but obviously through the caste dynamics that shape different outcomes like education, access to information and access to credit. This analysis finds evidence to support the existing argument that development of human capital is crucial in processing information and using it for efficiency gains.

**Keywords:** Agriculture, Information, Sample selection bias, human capital

**JEL classification Codes:** Q12, O13, D81

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# **Digital Trade and Wealth Inequality: Evidence from Asia Pacific Region**

**Sanjeev Vasudevan<sup>1</sup> and Mini P Thomas<sup>2</sup>**

**Abstract:** This paper examines the impact of digital trade on wealth inequality for 40 developed and developing member countries of the UNESCAP Asia Pacific region, for the period from 2005-2021. Data on digital trade, measured using two indicators, namely, trade in digitally deliverable services and trade in ICT goods, is obtained from UNCTAD. Data on within-country wealth inequality, measured using two indicators, namely, wealth share of the top 1 percentile and top 10 percentile of the adult population, is sourced from the World Inequality Database. The overall trend in digital services trade restrictiveness and wealth inequality within the Asia Pacific region is analysed. Based on a rich panel dataset inclusive of standard control variables, this study then estimates the digital trade-wealth inequality nexus with the help of panel fixed effects and instrumental variable estimation techniques. The following key findings emerge: First, we find empirical evidence in support of the positive and significant impact of international trade, in both digitally deliverable services and ICT goods, on within-country wealth inequality in the Asia Pacific region. Second, however, we observe marked heterogeneity between developed and developing member countries of ESCAP, with the effect of digital trade on wealth inequality turning out to be significant for developed countries and insignificant for developing countries. Policy recommendations for streamlining digital trade, to achieve the Sustainable Development Goal of reduced wealth inequality are put forth based on our findings. Elimination of monopolistic and restrictive digital trade practices, and improving the regulatory framework pertaining to digital trade can help mitigate increasing wealth inequality in the developed countries. On the other hand, removal of obstacles faced by small and medium-scale enterprises, youth and women entrepreneurs in accessing and participating in digital trade and digital platforms can go a long way in bringing down wealth inequality in the developing economies, particularly in the Asia-Pacific region.

**Keywords:** Digital trade, digitally deliverable services, wealth inequality, Asia Pacific, panel fixed effects, instrumental variable estimation

**JEL classification Codes:** D31, F10, F13, F14, O15, O57

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<sup>2</sup>BITS Pilani Hyderabad Campus

# Drivers of Colocation of R&D and Manufacturing Activity in India

**Gopal Krishna Roy<sup>1</sup>, Nandini Lahiri<sup>2</sup>, and Elizabeth Rose<sup>3</sup>**

**Abstract:** In this paper we explore the determinants of the colocation of R&D and manufacturing activities in India, using data from the Government of India's Annual Survey of Industries. Based on a sample of factory-level data for manufacturing units, we explore unit-level characteristics that predict the likelihood of manufacturing units' engaging in on-site R&D activity. Our results suggest that foreign ownership, managerial resources, and support services at the level of the unit influence its ability to realize economies of internal agglomeration. We also find that foreign- and domestic-owned units experience significantly different impacts of resources, both managerial and support, on the likelihood of colocation of manufacturing and R&D.

**Keywords:** R&D; Organised Manufacturing; India; Colocation; Foreign ownership

**JEL classification codes:** C33; D22; L52; O30; O32

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<sup>1</sup> Madras School of Economics, Chennai.

<sup>2</sup> American University, Washington, DC.

<sup>3</sup> Indian Institute of Management, Udaipur.

# **Investigating the Social Impact of the Actuarial Profession in India: The Case of Life and General Insurance**

**Rupel Nargunam<sup>1</sup> and Ritika Agarwal<sup>2</sup>**

**Abstract:** Social impact means any significant or positive changes that solve or at least address social injustice and challenges. Along those lines, the actuarial profession is defined as one which measures and manages risk and financial outcomes. As a part of this profession, each actuary is endowed with training in high technical standards and strong ethical values which inducts them into a community that contributes significantly to social welfare. The yardstick for evaluating the role of the actuary in social welfare is their compliance to the Actuaries' code, which forms the guiding principle for success and efficiency of actuary's role in meeting the needs of the society. In this research, a questionnaire survey was conducted to obtain views of partly and fully qualified actuaries on perceived potential ethical concerns facing actuaries when addressing social concerns within the Indian actuarial profession. This research employs a confirmatory factor analysis to identify the issues faced pertaining to compliance with the Actuaries' code, in the areas of grievance redressal, pensions, professional ethics, capital governance, monitoring and creating stability. The findings and recommendations of this study are expected to be valuable to industry stakeholders looking for avenues to improve the social impact of the actuarial profession in India.

**Keywords:** Actuaries' code, Ethical concerns, Social impact

**JEL classification Codes:** G22, G28

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<sup>2</sup> Acko General Insurance, India.

# **Revisiting the nexus between R&D Intensity and Financial Constraint: Exploring the Role of Unobserved Heterogeneity with Finite Mixture Models**

**Amal Jose**<sup>1</sup> and **Saumitra Bhaduri**<sup>2</sup>

**Abstract:** Research and development (R&D) plays a pivotal role in driving innovation and fostering economic growth within firms (Brown et al., 2015). Consequently, effectively allocating resources to R&D is essential for maintaining long-term competitiveness, especially for emerging economies. Given this context, we delve back into the complex connection between R&D investment and financial constraints to clarify the conflicting findings in this area. Furthermore, we explore the influence of unobserved heterogeneity on the relationship between R&D investment and financial constraints. The prevailing literature has overlooked the presence of unobserved heterogeneity among firms, predominantly relying on conventional linear models that assume a uniform response to financial constraints across all firms. The paper makes three key contributions to the existing literature. Firstly, it introduces a novel finite mixture model to identify three distinct classes within the population based on R&D intensity and their unique relationship with financial constraints. Secondly, it challenges the conventional interpretation of a strong correlation between R&D investment and cash flow, showing that this sensitivity is evident only for financially unconstrained firms with high R&D intensity. Lastly, the study highlights a double hurdle posed by financial constraints on firms' R&D behavior: financially constrained firms face barriers to entry into R&D investment, and even after initiating R&D spending, financial constraints continue to limit their R&D intensity.

**Keywords:** R&D intensity, Financial Constraints, Unobserved Heterogeneity with Finite Mixture Models, India

**JEL classification Codes:** G 30

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# **Predictive Modeling of Initial Public Offerings (IPOs) Performance: A Feature Engineering Approach**

**Durga Vaidynathan<sup>1</sup> and Parthajit Kayal<sup>2</sup>**

**Abstract:** This study attempts to propose a model architecture for modeling Initial Public Offerings (IPOs) by incorporating a diverse range of data sources, encompassing both textual and numerical inputs. Language models, machine learning models, and deep learning architectures are combined to make the final ensemble predictions. Several rich features are engineered and interpreted while providing scope for debugging using the game theory-based Shapley Additive exPlanations (SHAP) values. The study findings indicate that the feature-engineering is highly eloquent in IPO performance modelling. The study findings have high economic implications ranging from the efficient market theory hypothesis to acting as a fraud detection mechanism by information asymmetry theories.

**Keywords:** IPO; Feature Engineering; SHAP; Game theory; information asymmetry

**JEL classification Codes:** G10, G11, G14, G17, G24

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# Fault-Assisted Side-Channel Analysis of HMAC-Streebog

Gautham Sekar<sup>1</sup>, Mabin Joseph<sup>2</sup> and R. Balasubramanian<sup>3</sup>

**Abstract:** Streebog is a family of hash functions defined in the Russian cryptographic standard GOST R 34.11–2012. HMAC-Streebog, which is defined in RFC 7836, is a Streebog-based message authentication code. It supports keys of size ranging from 256 bits to 512 bits. In this paper, we present fault-assisted side channel attacks on HMACStreebog-256 and HMAC-Streebog-512 that can recover the keys in real-time with  $2^{12.98}$  and  $2^{14.97}$  average number of fault injections, respectively, to ensure a 95% success rate. The attacker is assumed to be able to simultaneously flip at the most 181 chosen bits of the inner hash if it is a 256-bit variant, and 361 chosen bits of the hash otherwise. In comparison to existing fault attacks on HMAC-Streebog, our attacks have a larger temporal window for fault injection, target a more accessible location and cannot be mitigated with output redundancy countermeasures. Some of the latest hardware vulnerabilities make the HMAC-Streebog implementations vulnerable to our attacks.

**Keywords:** Streebog; HMAC-Streebog; Carry flag; Side-channel; Fault analysis

**JEL classification Codes:** C6

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<sup>3</sup> The Institute of Mathematical Sciences, Chennai



# **Manifolds: Why are the Maps of the Earth Never Completely Accurate?**

**Poorna Narayanan<sup>1</sup>**

**Abstract:** Manifolds are objects that serve as a unifying concept in all physical sciences. The idea of a manifold enables us to manipulate and perform computations on many complicated spaces as though they are the Euclidean spaces  $\mathbb{R}^n$ . Much of higher mathematics is built on the knowledge of manifold theory. In this talk I will introduce manifolds and highlight how we have been unknowingly using them all our lives. I will talk about how analysis and algebra can be complementarily used to understand manifolds. I will also motivate one of the areas of my research 'Embedding properties in algebraic geometry' using the background developed.

**Keywords:** Manifolds, Embedding properties, Euclidean spaces

**JEL classification Codes:** C02

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## Pulsar Mode Changes

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**Abstract:** A Pulsar Timing Array (PTA) experiment employs an ensemble of pulsar clocks to detect gravitational waves (GWs) either from a stochastic background or from isolated individual supermassive black hole binaries. These experiments are poised to inaugurate the nano-Hertz window of the GW spectrum in the near future and will complement the hecto-hertz GW frequency window, opened by the LIGO-Virgo collaboration. Critical to the required nano-second timing precision are accurate characterization of variations of Dispersion Measure (DM) with epochs and pulse jitter. These are best measured at frequencies below one GHz, particularly with simultaneous multi-frequency wide-band observations. In addition, recently proposed new wide-band timing techniques hold promise to make precision low frequency timing a reality. The solitary millisecond pulsar J2124-3358 with a period of rotation of 4.9 ms and a Dispersion Measure of  $4.6 \text{ } \mu\text{pc}^{-3}$  at a distance of 410 pc from us, has several components in its flux profile. Observing it with the upgraded GMRT over a period of about a year, we see that the profile shows some signature of mode changes between its various components. K-S test and Monte-Carlo simulations support our initial results. J2124-3358 is already a well-timed pulsar at the uGMRT. Hence, discovering mode changes in this pulsar and accounting for them is likely to improve the precision of its times-of-arrival significantly.

**Keywords:** Pulsars, Millisecond pulsars, mode changing, GMRT

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# Role of Multi-Valued Logic to Model Ethical Agent

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**Abstract:** We will delve into the idea of geometric logic and its extensions using a multi-valued approach. It is well known that the propositional fragment of geometric logic (also known as the logic of finite observations) is nothing but the logic of affirmative assertions. Recall that an assertion is affirmative if and only if the assertion is true precisely in the circumstances where it can be affirmed. Note that we need to do the job in finite time, a finite amount of work and based on what we can observe. If we wish to make the idea of the logic of affirmative assertions closer to real-life situations then discussing the validity (truth value) of affirmative assertions up to some extent is a better idea, instead of, whether affirmative assertions are valid (true) or not valid (false). To address this issue we need to concentrate on the notion of valuation function. Generalisations in this direction can be used to interpret scenarios where the truth values are not comparable. In our previous work, we have already shown how the extension of the 3-valued logic of finite observations can be seen as the stepping stone to propose the logic of ethics. We will discuss this in detail. Moreover, if time permits, we will discuss how this study enhances the results of M. J. Healy for the LAPART architecture.

**Keywords:** Geometric logic; multi-valued Logic; ethical agent; topological system, frame.

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