

Ramjas Economic Review 2022-23

Volume V

Department of Economics
Ramjas College
University of Delhi

ISSN
2582-6093
(Online)



**Ramjas
Economic
Review
2022-23**

CONTENTS

1. Dynamic Stability Problems in Climate Transitions 1-10
Ishaan Sengupta and Samparna Mitra
2. Impact of Electrification on Women Empowerment: Evidence from Nepal 11-21
Annie Shrestha
3. Assessment of the Odd-Even Policy in Delhi: An Analysis of its Impact on Air Pollution 22-33
Ishu Goyal
4. Analysing the Self-Help Group Bank Linkage Program in India from 2013-2014 till 2019-2020: A case study analysis of North Eastern India 34-40
Ojasvi Ghai
5. The Indian Middle Class: An empirical exploration 41-51
Abhiram Lokanathan
6. Exploring the problems and solutions of the attitude-behaviour gap in sustainable consumption 52-63
Anjali Bhardwaj, Annie Shrestha, and Shruti Gauba
7. The Dynamic Stability Of Employment In A Non Clearing Market: An Enquiry 64-76
Srinjoy Majumder
8. Gender-Poverty Gap and the Indian MPI 77-84
Nehal Kaul
9. The Social Roulette: A gamble of chance and inequality in times of economic crises 85-94
Sarthak Sarkar and Utsa Kar
10. On the Economics of Climate Change and Child Preference: Malthus meeting Becker 95-102
Soumit Karkoon and Soumendra Das

Staff Advisor's Note

Congratulations on the 5th edition of Ramjas Economic Review, the academic journal of the Department of Economics!

I am indeed elated when I look back on the long journey to Ramjas Economic Review. When Budding Economist was first published in 2004–2005, it resembled a bulletin of the Economics Society and had a few scholarly and magazine-style articles. It was started by our students with the guidance of the department teachers. The academic year 2014–15 saw the shift from Budding Economist to the Journal of Economics Society comprising, of all academic papers. 2018–19 was a significant year when we received the ISSN number and the journal, thus was called the Ramjas Economic Review.

Ramjas Economic Review has turned 05 this year. What started off as an ambitious experiment is, today, the pride of the Department of Economics. I say this with the utmost conviction that the department's students as well as teachers are immensely proud of the issue of the fifth edition.

At this prestigious moment, I congratulate the authors who got their papers published. This edition of the journal is the culmination of several months of dedicated hard work by our dedicated team of editors. We sincerely thank the members of the Editorial Board as well as the Review Board for their valuable contributions, suggestions and feedback.

The publication has played an indispensable part in preparing students to become tomorrow's future professionals. I hope that you find this edition intriguing and informative.

Dr. Sonia Goel

Staff Advisor

Ramjas Economic Review

Dr Mihir Pandey

Dr Sonia Goel

Dr Alok Dash

Dr Pawan Kumar

Dr Lokendra Kumawat

Dr Archi Bhatia

Dr Priyanka

Mr Ashutosh Das

Mr Ankur Jain

EXTERNAL REVIEWERS

Mrs Poonam Kalra

Associate Professor

St. Stephen's College

Dr Ankur Bhatnagar

Professor

Satyawati College

Deepika Goel

Associate Professor

Aryabhatta College

Dr Apoorva Gupta

Assistant Professor

Hans Raj College

Dr Niti Khandelwal

Associate Professor

Kirori Mal College

Dr Rupali Sharma

Assistant Professor,

SGTB Khalsa College

Dr Suvojit Lahiri Chakravarty

Associate Professor

Aryabhatta College

Dr Jasmin

Assistant Professor

Jesus and Mary College

INTERNATIONAL REVIEWERS

Pritish Bhattacharya

Senior Research Officer

Regional Economic Studies

Programme (ISEAS)

Yusof Ishak Institute, Singapore

Harsh Vivek

Head, South Asia Agribusiness

Advisory Services

International Finance Corporation

World Bank Group

Dhaka, Bangladesh

EDITOR-IN-CHIEF

G Soundharya

editor.rer@ramjas.du.ac.in

DEPUTY EDITORS

Namit Mahajan

official.namitmahajan@gmail.com

Mehakdeep Kaur

mcdeepkaur@gmail.com

MEMBERS –

EDITORIAL BOARD

Priyanshu Gupta

Amal Varghese

Arjun Rastogi

Meghna Sharma

Aadya Bakshi

Kajal Singhal

Vibhor Vanvani

Editor-in-Chief's Note

Dear Readers,

I am delighted to present the latest edition of the Ramjas Economic Review. As the Editor-in-Chief, my team and I have strived to bring you a collection of insightful and thought-provoking research articles and papers that exemplify the rigorous screening process and double-blind review system that we implement.

Writing academic papers is a skill that should be inculcated in every student. It allows them to broaden their perspectives and explore matters deeply, beyond the textbooks. It also inculcates critical thinking skills. The Department of Economics, Ramjas College, has consistently nurtured a research-oriented culture among its students, and this journal stands as concrete evidence of its dedication to that principle.

I am extremely proud of the milestones that Ramjas Economic Review has reached. From rebranding and receiving the ISSN title, to seeing an inflow of entries from throughout the country and the globe, this journal has grown and served as a platform for the most inquisitive minds in academic pursuits above and beyond the textbooks. I am very glad to have had the opportunity to work on the current edition which covers a plethora of areas and interests from environmental economics to gender economics, employment and poverty, and it was truly a delight to put it together.

The task to bring everything offline again after 2 years of operating online was challenging, but thanks to the dedication and cooperation of the authors, the team, and the faculty, we have succeeded in curating a compelling edition. It was not an easy task to pick from the myriad of promising entries, each displaying remarkable potential. I would like to congratulate the authors for their wonderful submissions and thank them for cooperating with the lengthy process and matters of revisions.

The success behind the release of this edition is owed to numerous individuals, and I extend my heartfelt gratitude to each of them for giving me a chance to learn and explore.

I would like to express my gratitude to Dr. Sonia Goel, and Dr. Mihir Pandey for their guidance and unwavering support throughout this journey. Special thanks to Dr. Pawan Kumar, our teacher-in-charge, and all the faculty members, for their contributions and constant encouragement, which played a significant role in making this endeavor successful.

I would also like to thank the external reviewers for generously giving their time and expertise to provide valuable feedback. Big kudos to each member of the Editorial team who played a vital role in shaping this edition.

Namit Mahajan's design skills were nothing short of exceptional, and his efficient handling of team and tasks has been commendable. His memes have always kept my morale high. Mehakdeep Kaur has consistently displayed her capabilities, reliability, and finesse in managing her responsibilities. Needless to say, I could not have asked for more reliable Deputy Editors to accompany me on this journey.

I'll always be grateful to Priyanshu Gupta's commitment and meticulousness which have been invaluable to the Editorial board, providing me with insightful input. Amal Varghese's dedication and dutiful approach have made him a dependable team member who always stepped up when needed. Vibhor Vanvani deserves a special mention. His boundless enthusiasm and creativity brought in a constant flow of fresh ideas, engaging everyone throughout the process. Meghna Sharma's dependability and thoroughness have proven her ability to handle various responsibilities with flexibility.

I also extend my appreciation and gratitude to Kajal Singhal, Arjun Rastogi, and Aadya Bakshi for their unwavering diligence, inquisitiveness, and thoroughness throughout the process. Their professionalism has been exemplary and has greatly contributed to the success of our endeavours. I am certainly blessed to have such a board.

A special mention goes to Rijul Alvan Das and Sanjana Saxena, whose guidance and encouragement, when I was a member of their team, kindled my love for Ramjas Economic Review. I'm truly grateful to them for equipping me with the necessary skills and to lead the Board after them.

Last but not the least, a heartfelt thank you to the Student Council which was ready to cooperate, pitch in and lend a helping hand whenever needed.

I look forward to the next volume, and am excited to witness even more diverse topics explored in the coming editions. I have full faith that I am leaving the future of this journal to the best of minds and the most capable hands.

G Soundharya
Editor-in-Chief
Ramjas Economic Review

ABOUT

Ramjas Economic Review is a peer-reviewed academic journal for undergraduate students to showcase their research pertaining to the discipline of economics. Our mission is to provide a channel through which students can publish their scholarly findings to share with the research community at large. Though we are largely an undergraduate-run publication, we work under the guidance of the faculty of the University of Delhi, especially during the peer review process.

DISCLAIMER

The opinions expressed in this journal belong to the contributors and do not necessarily reflect the viewpoints of the Editorial Board, the Faculty Review Board or the External Review Board of Ramjas Economic Review.

PUBLISHER

Mr. Alok Dash
Assistant Professor
Department of Economics
Ramjas College

Address: E - 1401, Pan Oasis
Sector 70, Noida, Uttar Pradesh
India - 201301

Email:
alok.dash@ramjas.du.ac.in

Phone: +91 97179 43620

ISSUING BODY

Department of Economics
Ramjas College
University of Delhi

University Enclave,
North Campus,
Delhi, India—110007

DYNAMIC STABILITY PROBLEMS IN CLIMATE TRANSITIONS

ISHAAN SENGUPTA* and SAMPARNA MITTRA

St. Xavier's College (Autonomous), Kolkata

Abstract

We analyze descriptively and theoretically the recursive nature of climate change mitigation and adaptation measures. Climate mitigation technologies, such as green energy or electric vehicles, create further emissions and demand for energy and land. Adaptation measures generate similar issues with energy demand, land use, and financial constraints. These effects and their impact on the stability of climate change solutions are studied in this paper.

JEL Classification: Q16, Q21, Q28

Keywords: Dynamic Systems, Dynamic Stability, Partial Equilibrium, Climate Change, Renewable Energy, Input Coefficients

1. INTRODUCTION

As a scientific consensus on the threats posed by climate change has emerged, novel technological, scientific, and economic solutions have been proposed to tackle the crisis. These can be either mitigation measures that seek to minimize emissions, such as green energy technologies and electric vehicles, or adaptation measures that minimize the human cost of climate change, such as cooling technology and flood walls. Even as countries have made early efforts to implement these technologies, the problem of unstable growth in such climate change solutions is visible.

On the demand side, adopting mitigation technologies may create further spiraling demand for those technologies. For example, it is estimated that the projected increase in air conditioning use could quadruple the demand for electricity by 2050 (International Energy Agency 2018). This in turn would require further increases in renewable energy demand and emissions from non-renewable sources, which would further raise the need for cooling, leading to a spiral.

Supply problems may also emerge in the market for green technologies.

Widespread use of green technologies may create bottlenecks in supply or raise prices for scarce inputs significantly, culling the supply of those technologies. Electric vehicles (EVs), an essential part of a future with green transportation, require six times as many rare minerals as conventional vehicles (International Energy Agency 2021). Natural gas plants require just one-tenth the minerals needed in an offshore wind facility (ibid.). As the rapid deployment of such technologies is set in motion, the prices of these scarce inputs will constrain supply and set a ceiling on technology adoption.

In sum, technological solutions to climate change create demand and constrain supply for themselves, creating stability issues in the markets for these technologies. These issues are further exacerbated by the problem of asymmetric adoption and geopolitical considerations.

Some of the demand effects could be exacerbated if emissions are exported from the developed world with a greener energy grid to the developing world with a more fossil fuel-heavy system. If increases in demand for raw materials are sourced from resource-rich emerging economies such as Ghana without restrictions, the additional energy required for mining, quarrying, and transportation may be met by dirty technology, creating further emissions and

Corresponding Author's email address: sengupta.ishaan01@gmail.com

demand. This is the problem of asymmetric adoption. Similarly, control of key raw materials or technologies by geopolitical competitors could lead to sudden adverse supply shocks and the use of green technology as an economic weapon.

In Section 2 we perform a brief literature review of the fields of environmental economics, climate science, and economic theory. Section 3 describes the general methodology used in this paper. Section 4 introduces the partial equilibrium theoretical framework used in the paper and provides empirically estimable stability conditions. Data from various climate scientific and economics studies are used to justify the presence of concerning feedback effects in Section 5. Some policy prescriptions and concluding remarks are left to Section 6 and Section 7.

2. LITERATURE REVIEW

The basic problem of climate change solutions leading to spiraling demand and constrained supply for themselves has been relatively understudied in the economics literature. (Wang 2015) sheds light on dynamic instability during critical transitions, such as the climate transition. Another general model of dynamic instability includes Marsili et al. (2009), where unstable asset markets are analyzed. Steenge (1990) analyses instability in a Leontief model while dynamic oscillations in a modern economy due to investment and innovation are analyzed by Goodwin (1990). However, none of these papers focus on the climate transition and analyze its components specifically.

The model most similar to the one employed in this paper is the Cobweb model developed by Ezekiel (1938) and Nerlove (1958). Tamari (1981) develops a model with dynamic effects on both the demand and supply sides to analyze the housing sector in Israel and analyzes stability effects in these markets.

The critical difference between these models and the one employed in this paper is that in the former, past equilibrium prices affect current demand and supply while in the latter, past equilibrium quantities play the same role.

We also make use of Kellogg (2014) to show the

adverse effect that uncertainty in input or output prices has on investments with the example of oil drilling technology. Pescatori et al. (2021) analyze the climate transition from the perspective of rare metals.

Literature from climate and agricultural science and reports of various international agencies have analyzed our problem, but in isolation from each other and without a dynamic economic analysis. We bring them together and analyze them in this paper using an economics-oriented approach. International Energy Agency (2018) alerts us to the significant climate repercussions of the increased demand for air conditioners in emerging countries over the next thirty years. The results are discussed in Section 4.1. International Energy Agency (2021) warns about the massive increase in input requirements of metals in green technologies and their associated shortages. This report is analyzed in Section 4.2. U.S. Geological Survey (2022) reported on the concentration of mineral commodities required for the climate transition in a few countries, which could cause supply disruptions due to geopolitical problems.

Our paper seeks to synthesize the scientific literature on various isolated technologies and bring it into an economic dynamics framework using first theory to conceptualize demand and supply effects (and the difference between them) and then empirics to justify the possible presence of instability effects.

3. METHODOLOGY

3.1 DATA SOURCES

Empirically, we focus primarily on descriptive data from scientific publications. Heavy use is made of International Energy Agency (2018) and International Energy Agency (2021), the two landmark reports on cooling and metals respectively.

Other scientific sources include various publications by IPCC (see IPCC (2019)) or in major journals such as Nature (see Vargas Zeppetello et al. (2022)) or various subject-specific articles on heating, pesticides, etc. We also make use of IMF data (Pescatori et al. 2021) to describe expected future fluctuations in metal prices.

A fairly simple econometric analysis is conducted to show how pesticide use intensity increases significantly when mean temperatures in a country rise, controlling for per capita GDP. This analysis uses data from the World Bank and Food and Agricultural Organisation.

3.2 EQUILIBRIUM FRAMEWORK

We build a dynamic partial equilibrium framework that can be taken as the market for any individual technology related to climate solutions. This helps us understand the dynamic stability problems as split between demand side problems and supply side issues, and find some relevant stability conditions.

The model is a partial equilibrium one since we take only one market for a given technology at a time. Dynamic questions appear since we contend that the equilibrium quantity in a given period influences the demand and supply of future periods – in general, higher quantity leads to steeper demand and lowered supply in the future. For such a market, stability occurs when the dynamic changes in demand and supply do not cause large enough fluctuations to disrupt a long-term transition.

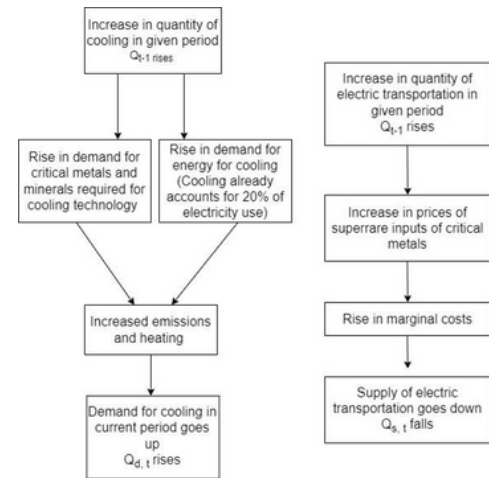
4. THEORETICAL FRAMEWORK

We conceptualize these stability problems within a standard partial equilibrium framework in each of the markets we are interested in. While this is unable to account for the inter-sectoral effects of these heavily interlinked markets, it helps us analyze the basic problem. The crucial addition to the model is that other than usual factors affecting demand and supply, we add the effects of the previous period's equilibrium quantity on demand and supply as the source of instability in the model.

Equilibrium quantity in a given time period adds to pre-existing demand and constrains supply in the next period through channels described earlier. We give two examples here, one in the market for cooling technology and one in the market for electric transportation. Further causation linkages of demand and supply effects with data are left to section 3. For the rest of this section, we develop our dynamic partial equilibrium model. First, we build a simple linear model and analyze its stability conditions.

Then we develop a more general model and repeat our analysis. Stylized examples of the effects discussed in this paper are provided in Fig. 1

Figure 1: (L) Demand effects in the market for cooling technologies. (R) Supply effects in the market for electric transportation.



Source: Authors' Descriptions

THE MODEL

First, we look at a basic linear model. This and the following generalized model holds for any technology related to the climate transition. The given functions and parameters differ from technology to technology.

Consider a market with the following demand and supply conditions:

$$Q_{d,t} = \alpha_d - \beta_d P_t + \gamma_d Q_{d,t-1}$$

$$Q_{s,t} = \alpha_s + \beta_s P_t - \gamma_s Q_{s,t-1}$$

The explanation behind this is that aside from the usual effects induced by α_d and β_d , we have a γ_d term. This term shows the fact that higher equilibrium quantities in a given period raise the demand in the next period, causing inter-temporal demand cycles. Similarly, the γ_s term shows how higher equilibrium quantity constrains supply in the future period via supply-side effects.

Solving this model we obtain the following linear, first-order, autonomous difference equations:

$$P_t = \frac{\gamma_d + \gamma_s}{\beta_d + \beta_s} Q_{t-1} + \frac{\alpha_d - \alpha_s}{\beta_d + \beta_s}$$

and

$$P_t = \frac{\gamma_d + \gamma_s}{\beta_d + \beta_s} Q_{t-1} + \frac{\alpha_d - \alpha_s}{\beta_d + \beta_s}$$

These equations show the equilibrium prices and quantities evolve over time in the system. We see that a higher Q_{t-1} unambiguously raises the price in the current period, while its effect on Q_t is ambiguous.

The steady state for this model is given by:

$$\bar{Q} = \frac{\alpha_s + \beta_s \frac{\alpha_d - \alpha_s}{\beta_d + \beta_s}}{1 - \frac{\beta_s \gamma_d - \beta_d \gamma_s}{\beta_d + \beta_s}}$$

We know that this model will converge to the steady state iff

$$\left| \frac{\beta_s \gamma_d - \beta_d \gamma_s}{\beta_d + \beta_s} \right| < 1$$

Essentially this shows us that for a certain condition on the intertemporal parameters given by γ and the price derivative parameters β , the model may reach a steady state. We would interpret this as a successful climate transition where the dynamic demand or supply effects do not cause perennial shortages or inflation. We provide an elasticity interpretation of this condition in our generalized analysis.

We now repeat this analysis in a generalized framework.

In order to allow demand and supply to be influenced by the previous year's quantity in non-linear ways and also account for other variables, we consider a more general model as follows:

$$Q_{d,t} = \alpha_d - \beta_d P_t + f_d(Q_{t-1}) + g_d(Y_t, G_t, \text{other factors}), f'_d(\cdot) > 0$$

$$Q_{s,t} = \alpha_s + \beta_s P_t - f_s(Q_{t-1}) + g_s(Y_t, G_t, \text{other factors}) - v, f'_s(\cdot) > 0$$

Here Y and G stand for GDP and a government policy variable in year t respectively. v stands for a random supply shock variable. The interpretation of g and g are similar to the γ parameters earlier – they show the intertemporal demand and supply effects of equilibrium quantity in the next period.

Solving this, we get

$$P_t = \frac{(f_d + f_s)(Q_{t-1})}{\beta_d + \beta_s} + \frac{(\alpha_d - (\alpha_s - v)) + (g_d - g_s)}{\beta_d + \beta_s}$$

$$Q_t = \frac{\beta_s f_d(Q_{t-1}) - \beta_d f_s(Q_{t-1})}{\beta_d + \beta_s} + \left(\alpha_s - v + g_s + \beta_s \frac{(\alpha_d - (\alpha_s - v)) + (g_d - g_s)}{\beta_d + \beta_s} \right)$$

Once again, we see that a higher Q_{t-1} unambiguously raises the price in the current period, while its effect on Q_t is ambiguous.

While a general steady state cannot be computed from the above model, we state the condition required at the steady state \bar{Q} for local stability as:

$$\left| \frac{dQ_t}{dQ_{t-1}}(\bar{Q}) \right| < 1$$

$$\left| \frac{\beta_s f'_d(\bar{Q}) - \beta_d f'_s(\bar{Q})}{\beta_d + \beta_s} \right| < 1$$

In elasticity form, we get a relatively simple condition. At the steady state we require that

$$\left| \epsilon_{s,P} \cdot \epsilon_{d,Q_{t-1}} - \epsilon_{d,P} \cdot \epsilon_{s,Q_{t-1}} \right| < 1$$

The interpretation of this, as earlier, is that for a certain condition on the intertemporal parameters and the price derivative parameters, the model may reach a steady state. We would interpret this as a successful climate transition where the dynamic demand or supply effects do not cause perennial shortages or inflation.

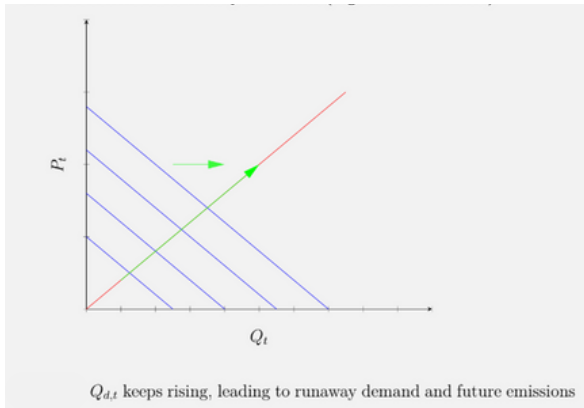
Moreover, once an empirical estimate of $f_d(Q_{t-1})$ and $f_s(Q_{t-1})$ using curve fitting techniques is obtained, a phase diagram analysis of Q_t will help us analyze global stability conditions as well.

REMARKS

1. For most markets, only one of the demand or supply effects is significant. E.g. demand effects are more prominent for ACs and pesticides, while supply effects are significant for EVs and renewable energy.
2. Within the renewable energy market, there is a trade-off between β_s (responsiveness of supply to price) and γ_s (self-constraining supply effect). This is explored in Table 5 and the following discussion.
3. When there is runaway demand, the equilibrium quantity keeps rising leading to adverse effects such as emissions (see fig. 2).
4. When there is chronic supply instability, equilibrium quantity keeps falling and there is a failed transition (see Fig. 3).

5. When both demand and supply effects exist and there is instability, there is runaway inflation of the good.

Figure 2: Problem of Runaway Demand (e.g. in AC market)



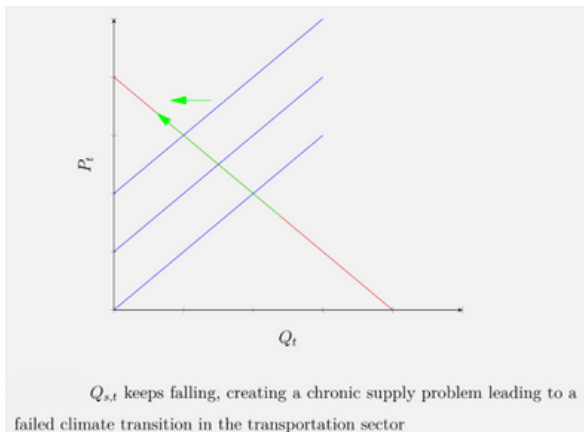
Source: Authors' Calculations

Example

Suppose we have obtained using curve fitting techniques

$$f_d(Q_{t-1}) = Q_{t-1}^{1/2}$$

Figure 3: Problem of Chronic Supply Shortage (e.g. in EV market)



Source: Authors' Calculations

To simplify our model suppose f_s, g_d, g_s and ν are 0. Then we have

$$Q_{d,t} = \alpha_d - \beta_d P_t + Q_{t-1}^{1/2}$$

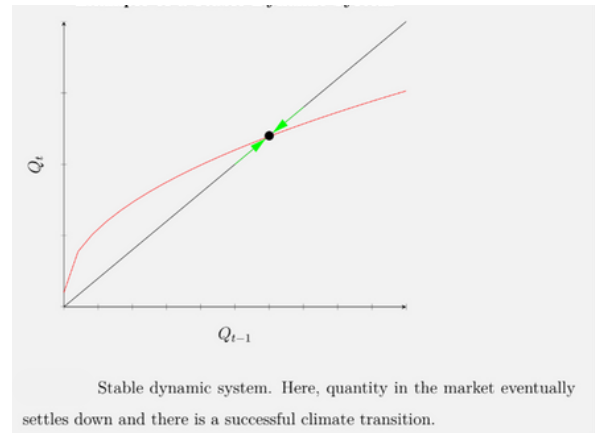
$$Q_{s,t} = \alpha_s + \beta_s P_t$$

The solution of this gives the following nonlinear, autonomous difference equations and phase diagram.

$$P_t = \frac{Q_{t-1}^{1/2}}{\beta_s + \beta_d} + \frac{\alpha_d - \alpha_s}{\beta_s + \beta_d}$$

$$Q_t = \frac{\beta_s}{\beta_s + \beta_d} Q_{t-1}^{1/2} + \frac{\alpha_s \beta_d + \beta_s \alpha_d}{\beta_s + \beta_d}$$

Figure 4: Example of a Stable Dynamic System



Source: Authors' Calculations

5. DATA AND FURTHER ANALYSIS

5.1 DEMAND SIDE EFFECTS

Several technologies needed in the climate transition create demand spirals for themselves and each other. The most concerning such technologies are air conditioners and other cooling technologies, pesticides, and hydraulic fracking, other than renewable energy sources themselves.

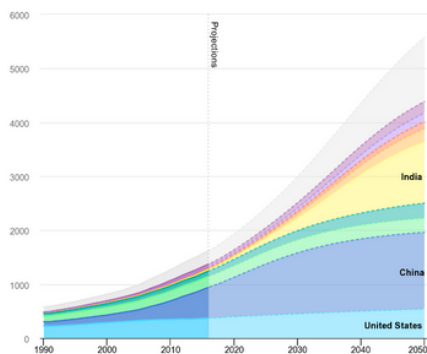
Air Conditioners and Cooling Technologies

The globe has already warmed by about 1.1°C above pre-industrial temperatures, and heatwaves are increasingly common and projected to increase in frequency and intensity in the near future (Vargas Zeppetello et al. 2022). Air conditioners and other cooling technology is therefore already a necessity to prevent mass mortality from heat-related deaths. However, the International Energy Agency warns us that

the world faces a looming “cold crunch.” Using air conditioners and electric fans to stay cool accounts for nearly 20 % of the total electricity used in buildings around the world today...But it will have a significant impact on countries’ overall energy demand, putting pressure on electricity grids and *driving up local and global emissions* [emphasis added] (International Energy Agency 2018).

International Energy Agency (2018) estimates that the demand for air conditioning units in buildings will triple (see Fig. 5) over the next thirty years. More significantly, this increase is concentrated in countries like India, China, Brazil, Indonesia, and the Middle East which have significantly fewer green electricity grids. Over the last thirty years, emerging countries accounted for only 12% of the increase in air conditioners used whereas over the next thirty, their share in the increase is estimated to be over 50%.¹ Since these countries have conventional energy-heavy electricity grids, the rise in emissions associated with this increased demand will be massive.

Figure 5: Projected increase in demand for air conditioners.



Source: International Energy Agency (2018)

Moreover, air conditioning is already a major part of worldwide CO₂ emissions, accounting for nearly 5% of global CO₂ emissions in 2016. This could rise to 10% or more by 2050, thereby driving a significant proportion of future warming and hence demand for air conditioners.² As a result, air conditioners alone could cause close to 0.5 °C increase in global temperatures by 2050. This leads to a *tipping point effect*, where air conditioners are used in regions that did not require them previously. (e.g. Western Europe) pushes more regions across the tipping point, post which those regions also demand air conditioners (e.g. Scandinavian countries).

Direct emissions from the potent greenhouse gases used as refrigerants in ACs are also a major source of dynamic instability in this market. Hydro-fluorocarbons commonly used in air conditioners are extremely damaging to the climate. For instance, trifluoromethane has 11,700 *times* the warming effect of CO₂ (Han et al. 2012).

[1] Calculated by author from International Energy Agency 2018

[2] ACs account for 12% emissions from buildings, which in turn account for 40% total global CO₂ emissions (International Energy Agency 2018; International Energy Agency 2019). More- over, this number has doubled over the last thirty years and we can expect a similar trend in the future.

[3] Author's own calculations from Vetter et al. (2017)

Other Technologies

Other technologies required during and after the climate transition also pose serious risks to the transition. Pesticides, space heating, and hydraulic fracking are some glaring examples.

Warmer temperatures also create demand for pesticides, since agricultural pests grow better in warmer temperatures (IPCC 2019). We show this demand-side feedback effect using a relatively simple regression analysis in Table 2.

The equation we estimate is

$$pesticide = \beta_0 + \beta_1 temp + \beta_2 percapgdp + \epsilon.$$

This uses a cross-country data set of 143 countries comprising Food and Agricultural Organisation (FAO) data for pesticide use and temperature, and World Bank data for GDP per capita. Since richer countries (which are generally located in temperate regions) usually have higher pesticide use because of a wealth effect, we control for this in the regression. The result shows that at the 1% level of significance, an increase in mean temperature of 1 degree Celsius increases the kg of pesticide used per hectare by 0.214. This significance holds even when computing heteroskedasticity-robust errors. Studies such as Cech et al. (2022) and Heimpel et al. (2013) show how emissions-intensive pesticides are, completing the causal loop from warmer temperatures to increased pesticide use to finally more emissions and further warming.

Table 1: Agricultural chemicals, fracking and heating have significant demand effects

Technology	Data
I. Agricultural Chemicals	<ol style="list-style-type: none"> 5794.61 metric tons CO₂ from pesticides in India alone³ $r = 0.42$ for nitrogen use and emissions Pesticide use increases with increase in daily minimum temperature (Palikhe 2007)
II. Hydraulic Fracking	<ol style="list-style-type: none"> Significant emissions of methane Leakage rates as high as 8%, worse than coal for emissions Methane 10x to 25x more potent at warming than CO₂ (Howarth 2015)
III. Heaters	<ol style="list-style-type: none"> Residential heating & cooling account for 7.6% emissions in the US Heating emissions as a proportion of total has been increasing due to erratic winters (Leung 2018; Pistochini et al. 2022)

Source: Authors' Calculations

Climate change and global warming also lead to more extreme winters, raising the demand for heaters (Cohen et al. 2021). At the same time, heaters cause a large amount of emissions: Department of Energy and Climate Change, Government of UK (2012) estimates that close to 20% of total CO₂ emissions in the UK were from space heating.

Fracking, a relatively cleaner source of energy compared to more traditional sources, is touted as an intermediate source in the energy transition for poor countries. However, it releases the extremely potent greenhouse gas called methane in dangerous amounts either directly or indirectly through leaks (Howarth 2015).

Table 2: *Adjusted for GDP per capita, an increase in mean annual temperature increases pesticide use with a confidence level > 99%*

<i>Dependent variable:</i>	
kg of pesticide per hectare	
Mean Temperature	0.214*** (0.075)
GDP per capita (2017)	0.0001*** (0.00003)
Constant	-1.468 (1.718)
Observations	143
R ²	0.085
Adjusted R ²	0.072
Residual Std. Error	6.217 (df = 140)
F Statistic	6.497*** (df = 2; 140)

Note: *p<0.1; **p<0.05; ***p<0.01

Source: Authors' Calculations

5.1.1 THE PROBLEM OF ASYMMETRIC ADOPTION

Metal requirements for renewable energy are higher than conventional technologies (see section 5.2). Moreover, these metals are concentrated in certain emerging countries with dirty energy grids (see section 5.1.1). This leads to a demand spiral problem since the massive energy demand for mining these metals will be met by dirty energy, increasing demands for green energy, pesticides, air conditioners, etc.

Table 3: *Concentration of metals in emerging countries.*

Metal	Co	Cu	Ni
1	Congo (50%)	Chile (25%)	Indonesia (22%)
2	Australia (20%)	Peru (12%)	Australia (21%)
3	Cuba (7%)	Australia (11%)	Brazil (16%)
4	Philippines (4%)	Russia (8%)	Russia (7%)
5	Russia (4%)	Mexico (7%)	Cuba (6%)

Source: Author's own calculations from U.S. Geological Survey (2022)

5.2 SUPPLY SIDE EFFECTS

Green energy technologies and electric transportation requires a much larger input of metals and rare earths compared to their conventional counterparts. In table 4 we note that electric vehicles require more than six times the metals per car when compared to conventional vehicles. Moreover, this includes metals with deficient supply, such as lithium, nickel, and graphite, and not just the common copper. Similarly, in Table 5 we see that on a per megawatt basis, non-conventional energy requires significantly more metals. An offshore wind facility requires 13x and a solar PV requires 6x metals to produce a megawatt of power when compared to a natural gas facility.

Table 4: *Metals required in EVs and CVs.*

Metals (kg/car)	Cu ⁴	Li	Ni	Mn	Co	Gr	Zn	Rare earths	Others	Total
Electric car	53	9	40	25	13	66	0.1	0.5	0.3	206.9
Conventional car	22	0	0	11	0	0	0.1	0	0.3	33.4

Source: Author's own calculations from International Energy Agency (2021)

Table 5: *Metals required in various green energy and conventional energy technologies.*

Metals (kg/MW)	Cu	Ni	Mn	Co	Cr ⁵	Mo	Zn	Rare earths	Others	Total	Index ⁶
Offshore wind	8,000	240	790	-	525	109	5,500	239	6	15,409	1,322
Onshore wind	2,900	403	780	-	470	99	5,500	14	-	10,166	872
Solar PV	2,822	1.3	-	-	-	-	29	-	3,979	6,833	586
Nuclear	1,473	1,297	147	-	2,190	70	-	0.5	94	5,273	452
Coal	1,150	721	4	201	307	66	-	-	34	2,484	213
Natural gas	1,100	16	-	2	48	-	-	-	-	1,165	100

Source: Author's own calculations from International Energy Agency (2021)

[4] Cu = Copper, Li = Lithium, Ni = Nickel, Mn = Manganese, Co = Cobalt, Gr = Graphite, Zn = Zinc

[5] Cr = Chromium, Mo = Molybdenum

[6] Here we have calculated the index of metal use taking natural gas total = 100

Some things are immediately clear. Nuclear energy requires significantly fewer metals than other renewable energy facilities and so it has fewer adverse supply effects in our dynamic system. On the other hand, it is significantly more costly and hence supply is less receptive to price. Solar energy requires around \$ 40 per MWh and onshore wind requires \$42 per MWh, while nuclear energy costs between \$112 and \$182 per MWh (WNISR 2019). This trade-off between two sources of instability must be resolved when the appropriate energy mix is selected by policymakers.

Therefore, the energy transition poses a twin challenge: (a) a rapid increase in input demand coefficients and (b) a shortage of inputs. These twin factors put tremendous upward pressure on input prices and raise marginal costs. Prices of key metals are forecast to rise to historically high levels and stay there for a decade or more following a net-zero transition (Pescatori et al. 2021).

The prices of metals are forecast to rise to historically high levels in this paper. More worryingly, there is significant uncertainty in future prices (reflected in a higher value of $V ar(v)$), which acts as a deterrent to large-scale long-term green investments in the private sector. A similar study of the oil drilling industry showed firms reduce their drilling activity when expected volatility rises. (Kellogg 2014) Therefore there is a risk of chronic under-investment which may constrain supply further.

5.2 GEOPOLITICAL CONCERNS AND SUPPLY VOLATILITY

Another concern in the input markets for green technologies and electric vehicles is the concentrated control of these metals in certain countries. This adds to the price volatility (v in the given model) of these metals since their supply might be used as an economic weapon. The Herfindahl index for rare earth production is 0.37, with China alone controlling close to 60 percent of global production. Owing to its natural resource advantage, the manufacturing capacity for batteries required in EVs, with a Herfindahl index of 0.64, is also concentrated in China (U.S. Geological Survey 2022).

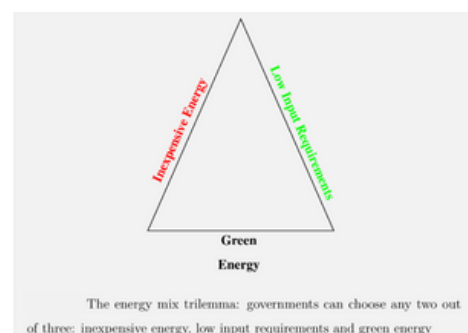
6. POLICY PRESCRIPTIONS

Government policy and regulations have a key role to play in the climate transition. Since dynamic effects are a cause for concern in this process, it is crucial that policy be made to manage these effects and minimize harm.

Energy efficiency standards in air conditioners, reduced usage of greenhouse gas-emitting hydro-fluorocarbons (like the successful phasing out of chlorofluorocarbons after the Montreal Protocol), more organic agricultural implements, and efficient space heating technology can all boost demand stability. Since developed countries have an oligopsony in the market for key metals, they could subject purchases of these metals to be conditional on the use of green energy for mining. Improving the output of electric vehicles and electricity generation infrastructure per unit of metals used is especially relevant for culling supply bottlenecks. Substitutability between metals and recycling batteries could ease these problems and augment flexible production capacities. Government purchase agreements for key technologies indexed for input price changes could reduce the uncertainty of investment and boost capacity.

Planning for the appropriate future energy mix must take into account input use and cost as well. The time and financial costs of marginal energy units from wind or solar energy are lower, but they require far more inputs than nuclear energy, which costs more. This trade-off must be accounted for while planning the national energy mix, a fact all too often disregarded in planning. Governments face the **energy mix trilemma** – to develop green energy, they must choose between costly technology (nuclear) and technology with large input requirements (wind and solar). Otherwise, they must choose dirty energy sources. (see Fig. 6).

Figure 6: *The Energy Mix Trilemma*



Source: Authors' Description

THE INDIAN CONTEXT

While the government has continuously set several targets and policies in alignment with eco-friendly policies, the result is insufficient. In August 2022, the Indian government set the policy of reducing emissions by 1 billion tonnes, reducing the carbon intensity of the Indian economy by 45%, and shifting at least 50% of total energy requirement to renewable sources of energy by 2030. This, if achieved within the time frame, would be a sufficient measure to reach the targets set by international treaties like the 1.5 ° C limit set in the Paris Climate Agreement. However, policies are conflicting while the government should try to remove coal usage completely from the generation of the energy sector by 2040, a recent report by the Central Energy Authority states that India's coal capacity would increase a lot by 2030. If India tries to justify its lack of climate change legislative frameworks by the excuse of it being a developing country, it seems to forget that some of the worst effects of climate change are occurring in the country itself, where farmers are facing famine and drought thereby affecting the food supply in the economy, while islands and coastal areas are sinking due to higher sea level, seriously affecting the trade portals in these coastal zones.

India produces 10% of the total GHG emissions due to air conditioning, approximately 146 million tonnes. This is backed by the fact that ownership of air-conditioners in India rose from 2 million units in 2006 to 14 million units in 2016, and this is projected to rise further. As shown by the author's calculations in Section 4.1, if air-conditioners emit 10% of international GHGs and cause a consequent rise of 0.5° C in 2050, then India alone may cause nearly 0.05° C rise in global temperature by 2050, solely due to emissions from ACs.

REFERENCES

1. Cech, R., Leisch, F., & Zaller, J. G. (2022). Pesticide Use and Associated Greenhouse Gas Emissions in Sugar Beet, Apples, and Viticulture in Austria from 2000 to 2019. *Agriculture*, 12 (6).
2. Cohen, J., Agel, L., Barlow, M., Garfinkel, C. I., & White, I. (2021). Linking Arctic variability and change with extreme winter weather in the United States. *Science*, 373 (6559), 1116–1121.
3. Department of Energy and Climate Change, Government of UK. (2012). Emissions from Heat.
4. Ezekiel, M. (1938). The Cobweb Theorem. *Quarterly Journal of Economics*.

India has produced the largest amount of emissions from agriculture since 2011. This is not shocking considering India is a majorly agricultural nation. According to the Third Biennial Report submitted by the Govt. of India to the UNFCCC in 2021, 19.1% of emissions from the agricultural sector were due to pesticide and fertilizer use. Such a large amount of emissions is bound to push India into the cycle of overuse of pesticides causing climate change and in return high temperatures prompting an increase in pesticide use. Thus, the example of pesticides is demonstrated through the instance of India too.

7. CONCLUDING REMARKS

Possible future research on this topic can be along two pathways. One, computable advanced models taking into account sectoral interlinkages, GDP growth, and factor demands could be used for a more realistic view of the green economy. Two, empirical work needs to be done on estimating the various coefficients in the model under various policy and technological scenarios to help in policymaking.

Our paper looked at the crucial problem of dynamic instability in climate technology markets and developed a novel framework while separating demand and supply effects. We first developed a dynamic partial equilibrium model and described stability conditions for the same. Then, we used comprehensive data from research in climate science on various technologies to support our framework. Finally, we provided policy prescriptions and framed a future research agenda on one of the pressing issues of our day.

5. Goodwin, R. M. (1990). *The Structural and Dynamical Instability of the Modern Economy*. In *Chaotic Economic Dynamics*. Oxford University Press.
6. Han, W., Li, Y., Tang, H., & Liu, H. (2012). Treatment of the potent greenhouse gas, CHF₃—An overview. *Journal of Fluorine Chemistry*, 140, 7–16.
7. Heimpel, G. E., Yang, Y., Hill, J. D., & Ragsdale, D. W. (2013). Environmental Consequences of Invasive Species: Greenhouse Gas Emissions of Insecticide Use and the Role of Biological Control in Reducing Emissions. *PLOS ONE*, 8 (8).
8. Howarth, R. (2015). Methane emissions and climatic warming risk from hydraulic fracturing and shale gas development: implications for policy. *Energy and Emission Control Technologies*.
9. International Energy Agency. (2018). *The Future of Cooling*.
10. International Energy Agency. (2019). *Global Status Report for Buildings and Construction*.
11. International Energy Agency. (2021). *The Role of Critical Minerals in Clean Energy Transitions*. PCC. (2019). *Special Report on Climate Change and Land*.
12. Kellogg, R. (2014). The Effect of Uncertainty on Investment: Evidence from Texas Oil Drilling. *American Economic Review*, 104 (6), 1698–1734.
13. Leung, J. (2018). *Decarbonising U.S. Buildings*.
14. Marsili, M., Raffaelli, G., & Ponsot, B. (2009). Dynamic Instability in Generic Model of Multi-Assets Markets. *Journal of Economic Dynamics and Control*, 33 (5), 1170–1181.
15. Nerlove, M. (1958). Adaptive Expectations and Cobweb Phenomena. *Quarterly Journal of Economics*.
16. Palikhe, B. R. (2007). *Journal of Agriculture and Environment*, 8, 83–91.
17. Pescatori, A., Boer, L., & Stuermer, M. (2021). *Energy Transition Metals (IMF Working Papers No. 2021/243)*. International Monetary Fund.
18. Pistochini, T., Dichter, M., Chakraborty, S., Dichter, N., & Aboud, A. (2022). Greenhouse gas emission forecasts for electrification of space heating in residential homes in the US. *Energy Policy*, 163, 112813.
19. Steenge, A. E. (1990). Instability Problems in the Dynamic Leontief Model: an Economic Explanation. *Economic Systems Research*, 2 (4), 357–362.
20. Tamari, B. (1981). Cobweb Model in the Housing Sector of Israel 1960 – 2010. *Economics Quarterly*.
21. U.S. Geological Survey. (2022). *Mineral Commodity Summaries*.
22. Vargas Zeppetello, L. R., Raftery, A. E., & Battisti, D. S. (2022). Probabilistic projections of increased heat stress driven by climate change. *Communications Earth & Environment*, 3 (1), 183.
23. Vetter, S. H., Sapkota, T. B., Hillier, J., Stirling, C. M., Macdiarmid, J. I., Aleksandrowicz, L., Green, R., Joy, E. J. M., Dangour, A. D., & Smith, P. (2017). Greenhouse gas emissions from agricultural food production to supply Indian diets: Implications for climate change mitigation. *Agric Ecosyst Environ*, 237, 234–241.
24. Wang, J. (2015). *Modelling and Estimation of Dynamic Instability in Complex Economic Systems*.
25. WNISR. (2019). *World Nuclear Industry Status Report*.

IMPACT OF ELECTRIFICATION ON WOMEN EMPOWERMENT: EVIDENCE FROM NEPAL

ANNIE SHRESTHA*

Indraprastha College for Women, University of Delhi

Abstract

This study aims to investigate the relationship between household electrification and women's empowerment, as measured by a range of indicators such as decision-making power, freedom of movement, control over resources, degree of sexual autonomy, and perception of domestic violence, using data from the Nepal Demographic and Health Survey 2016. An empowerment index was constructed from these indicators, and an ordered logistic regression model was used to predict the association between household electrification and the index. To establish a causal link, various propensity score matching techniques were employed. The results reveal that the odds of women being better empowered are 1.4 times higher for those living in households with access to electricity compared to those without. These findings underscore the importance of household electrification as a means to enhance women's empowerment in Nepal.

JEL Classification :D120 ,D910 , Q580

Keywords: Electrification, Women Empowerment, Nepal, Propensity Score Matching

1. INTRODUCTION

According to the World Economic Forum's Global Gender Gap Index, achieving full gender parity globally is estimated to take around 130 years, while the South Asian region is projected to close the gender gap in an alarming 197 years, performing poorly compared to other regions (World Economic Forum, 2022). In this context, women's empowerment becomes a crucial development goal, and various interventions, such as microcredit programs, promoting girls' education, and self-help groups, are being implemented. The electrification of households, while appearing to modernize agriculture and improve living standards, significantly impacts women's empowerment by reshaping time allocation and household dynamics.

In Nepal, the Community Rural Electrification Program (CREP) was launched in 2003/04 by the Nepal Electricity Authority to increase access to electricity in areas without power (CREP Nepal – Energypedia, n.d). Since then, national electrification rates have risen from 24% in 2001 to 90% in 2020 (World Development Indicators, 2020). However, the impact of this impressive growth in electrification on women's empowerment is still a subject of investigation. The electrification

of households has positive effects on women, such as reducing gender-based violence, alleviating time constraints, providing access to educational resources through television and the internet, and increasing opportunities for education and employment (Samad and Zhang, 2019)

Evaluating the impact of infrastructure projects like electricity provision presents econometric challenges due to the lack of experimental data. In non-experimental settings, addressing potential sample selection bias is a major challenge since electrified households may differ from non-electrified households, which could bias the impact assessment. To address this issue, this research utilizes the propensity score matching technique to examine the causal relationship between household electrification and women's empowerment in the absence of appropriate data and a reliable instrument.

The literature review in Section 2 discusses the definitions of empowerment and the relationship between household electrification and women's empowerment. Section 3 explains the variables and methodology, including data sources, construction of the empowerment index, and empirical strategy. The results are discussed in Section 4, followed by the conclusion in Section 5.

* Author's email address: annie.shrestha03@gmail.com

2. LITERATURE REVIEW

2.1. DEFINITIONS OF EMPOWERMENT

Researchers and different institutions have adopted a range of definitions of and approaches to understanding empowerment. Most of the definitions converge to an agreement that an individual's empowerment entails at least the exercise of control to enhance their livelihood. The literature is rife with words like control (Jejeebhoy and Sathar 2001), power (Agarwal 1997) agency, autonomy (Dyson, Tim, and Moore, 1983), and bargaining power (Beegle, Frankenber, and Thomas 2001) which in essence allude to women's ability to make decisions for themselves and their family members and are relevant in the discussion of empowerment.

The World Bank identifies empowerment as a key element to alleviating poverty and defines it as the "expansion of assets and capabilities of poor people to participate in, negotiate with, influence, control, and hold accountable institutions that affect their lives." UNICEF (2018) says that empowerment is about women, men, girls and boys taking control over their lives: setting their own agendas, developing skills (including life skills), building self-confidence, solving problems, and developing self-reliance. The process of empowerment enables women, men, girls, and boys to question existing inequalities as well as act for change.

Scholars have viewed empowerment as a process or an outcome or both. Kabeer (1999) views empowerment as a "process of change" that entails exercising consequential choices given that the decision-maker has the ability to choose among other alternatives. The ability to make choices has three dimensions: resources, agency, and achievement. Resources include material resources and social relationships which enhance the decision-maker's ability to exercise choice. Agency implies the ability of the individual to set goals for themselves and pursue them. Achievements of the decision-maker can range from the individual's fulfillment of basic necessities to their representation in political space depending upon the context. Bennet (2002) defines empowerment as a process of "the enhancement of assets and capabilities of diverse individuals and groups to engage, influence, and hold accountable

the institutions which affect them." Dixon-Mueller (1993) defines empowerment as "both a group and an individual attribute; both process (that of gaining power) and a condition (that of being empowered)." Along the lines of encapsulating both the dimensions of empowerment (process and outcome), Batliwala (2007) says that "women's empowerment is thus the process, and the outcome of the process, by which women gain greater control over material and intellectual resources, and challenge the ideology of patriarchy and the gender-based discrimination against women in all the institutions and structures of society". Batliwala (2007) has also emphasized on "empowerment spiral" in addition to grass-roots level initiations to galvanize macro level transformative political action. Malhotra et al. (2002) point out that empowerment frameworks identify a number of unique dimensions, suggesting that empowerment must occur along economic, socio-cultural, familial/interpersonal, legal, political, and psychological lines.

Given the literature and data availability, this paper aims to capture women empowerment in terms of their decision-making power, freedom of movement, control over resources, degree of sexual autonomy, and perception of domestic violence.

2.2. ELECTRIFICATION AND EMPOWERMENT

Electrification of a household has a profound impact on women empowerment. Access to electricity allows women to engage in various activities that enhance their economic and social well-being. Energy also provides social power by facilitating information access, connections to extended family through mobile phones and TV, and improved health outcomes. In Bamiyan, Afghanistan, electric lighting had a transformative effect. It improved visibility, reducing accidents in the home, such as unintentionally harming children in the darkness. Additionally, it ensured that meals were cooked to perfection, enhancing their quality. This positive change not only boosted women's self-esteem in their relationships with their husbands and extended families but also improved overall marital dynamics. The efficient fulfilment of responsibilities resulted in fewer complaints and increased harmony. The introduction of electricity brought significant

improvements to the community's well-being (Standal & Winther, 2016). Empirical studies show that electrification disproportionately benefits women. Access to electricity has multiple empowering effects on women in developing countries. Firstly, it increases the efficiency of home production, allowing women to allocate more time to income-generating activities. This boosts their assets and income prospects. Secondly, electricity reduces indoor air pollution caused by alternate lighting sources, improving women's health and productivity. Lastly, access to electronic media enhances knowledge and information, enabling economic empowerment and increased participation in public life (Samad and Zhang, 2019). Adoption of time saving appliances after electrification allowed women to be freed from housework, and it was one of the primary factors leading to steady increase in female labor supply in the United States during the 20th century, according to an influential paper by (Greenwood, Seshadri, and Yorukoglu 2005). Between 1880 and 1990 in the United States electrification decreased fertility and delayed the timing of childbearing of young women and that higher levels of required educational attainment increased the employment response of young women to electrification (Vidart, 2022).

Sedai, Nepal, and Jamasb (2022) show that having access to electrification enhances women's economic autonomy, agency, mobility and decision-making abilities in India. Polansky and Laldjebaev (2021) find that women in grid-supplied communities are on average 27% more literate and complete more years of schooling compared to women in off-grid communities in Afghanistan. Rathi, Singh, and Vermaak (2018) show that household electrification delayed dinner-time by one hour on average (by raising productive hours) while increasing women's income by 20%. Solar electrification has been shown to improve women's empowerment through economic independence in West Africa (Burney et al. 2017).

In Nepal, there is a noticeable scarcity of studies examining the impact of infrastructural projects, such as household electrification, on women's empowerment. This research gap underscores the significance of this study, which seeks to investigate the relationship between electrification of households and the empowerment of women. By establishing a causal relationship between these two variables,

this paper aims to contribute to the understanding of how electrification influences women's empowerment in the Nepalese context.

Furthermore, this study will outline key policy implications derived from its findings, offering valuable insights for policymakers and stakeholders involved in promoting women's empowerment and sustainable development in Nepal.

3. METHODOLOGY

3.1. DATA

This study uses 2016 Nepal Demographic and Health Surveys (DHS). DHS is a nationally representative population-based survey with a large sample size and is funded by the United States Agency for International Development (USAID). The DHS data can offer the benefits of large datasets while allowing for an analysis of decision-making and women's autonomy in the household at the individual level. The survey includes information on women's socio-demographic characteristics, employment characteristics, decision-making abilities, control over resources (earnings), control over sexual activities, perception of domestic violence, and freedom of movement. The total sample size of the dataset is 12,862.

3.2. VARIABLES

Drawing from the extant literature, this study uses information on women's decision-making, freedom of movement, control over resources, sexual autonomy, and perception of domestic violence as indicators of women's empowerment and their relationship with women's employment represented by women's working status, occupation and who they work for.

Explanatory Variable

The main explanatory variable is the dummy variable electrification of a household that takes value 0 if the household does not have access to grid electricity and 1 if it does.

Indicators of Empowerment

i) Decision-making

Two questions about who makes decisions about the

respondent's major household purchases and healthcare are used to gauge decision-making. In this case, the response categories were changed to 0 for "spouse or others" and 1 for "respondent alone or jointly with partner". Finding the average of the answers produced a dichotomous decision-making variable with numerical codes 0 and 1.

ii) Freedom of movement

The questions that asked if the respondent needed permission to visit their family and relatives were used to gauge the respondent's freedom of movement. If the answer to this variable was "yes," it was recoded as 0, and if it was "no," it was recoded as 1.

iii) Control over resources

Who decided the control over the respondent's earnings and if the respondents had a financial account were the questions that best captured financial autonomy. Answers to the question on control over wages were recoded to 0 if the decision-maker is "spouse or others" and 1 if the respondent is "respondent alone or jointly with partner". If they did not have a financial account, the response to the inquiry was recorded as 0, and if they did, it was recorded as 1.

iv) Views on violence against women

A variable of views on violence against women was constructed by combining six questions that asked respondents if it was justifiable for the husband to beat their wife if the wife went out without telling, neglected the children, argued with the husband, refused to have sex with husband, and burnt the food. The response is recorded as 0 if the woman reports that violence against wives is acceptable in one or more situations. Having a record of 1, and therefore saying that wife-beating is never okay, is associated with empowerment.

v) Sexual autonomy

The ability to deny sex and request that a partner take contraceptives was used to test the final indicator of empowerment, control over sexual autonomy. Like the decision-making variable, the final sexual autonomy variable was constructed by finding the average of the two questions.

Covariates

The study in this research takes the literature into

account and adjusts for a few significant respondents' socio-demographic traits. Education level is broken down into no education, primary school, secondary school, and higher school. Together with age, marital status, and religion, a respondent's sociodemographic characteristics that are essential including whether they live in an urban or rural location.

Women's response to their marital status includes being married, widowed, divorced, not living with their husbands, and never in a union. I categorize the responses into "married" if the respondents are married or are cohabiting and "others" for the rest. I divided religious affiliation into "major religions" and "others" to examine if women's ties to major religions facilitated their empowerment. A measure of the household head's sex and age are also included. I combined the poorest and poor categories to make a final category poor and rich and richer categories to make a final category rich in the wealth index. Table 1 shows the frequency distribution of women based on the mentioned socio-demographic characteristics.

Table 1 : Socio- Demographic Characteristics of the Sample

Variable	Frequency
Type of Place of Residence	(n = 12, 862)
Urban	64.37
Rural	35.63
Education Level	(n = 12, 862)
No Education	22.79
Primary	16.18
Secondary	36.04
Higher	13.99
Age	(n = 12, 862)
15-19	20.39
20-24	17.93
25-29	16.28
30-34	13.91
35-39	12.32
40-44	10.39
45-49	8.79
Wealth Index Combined	(n = 12, 862)
Poor	42.24
Middle	20.21
Rich	37.54

Source : Author's Calculations

3.3. CONSTRUCTION OF EMPOWERMENT INDEX

Because empowerment is multidimensional in nature, it is important to be careful about constructing an empowerment index. Inappropriate combining of indicators may mask the differential impact of individual variables on the outcome of interest (Mallhotra and Schuler 2005). Since the indicators are collectively indicative of women's ability to make decisions in various aspects of their life, empowerment index can be confidently constructed. I first computed the mean score of women's responses (1 or 0).

I computed the 33rd and 66th percentiles of the index to turn it into an ordinal variable. Women in the 33rd percentile were labeled less empowered, between 33rd and 66th percentile were labeled partially empowered and beyond the 66th percentile were labeled highly empowered.

Mathematically, let x be the mean score of women's responses (ranging from 0 to 1). p_{33} represents the 33rd percentile of the empowerment index. p_{66} represents the 66th percentile of the empowerment index. The ordinal categorization of the empowerment index can be expressed as follows:

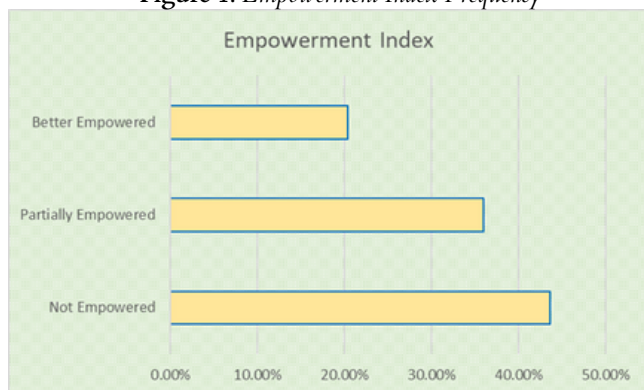
If $x \leq p_{33}$, the woman is labeled as "less empowered."

If $p_{33} < x \leq p_{66}$, the woman is labeled as "partially empowered."

If $x > p_{66}$, the woman is labeled as "highly empowered."

I computed the frequency for the empowerment index as shown in Figure 1. More than 40 percent of respondents fall under the category of not empowered.

Figure 1: Empowerment Index Frequency



Source : Author's Calculations

3.4. EMPIRICAL STRATEGY

Since the dependent variable, the empowerment index, is ordinal in nature (no empowerment, partial empowerment, better empowerment) I use the ordinal logistic model, using equation 1, to identify the association between household electrification and the empowerment index. The ordinal logistic regression is considered a generalization of a binary logistic regression model when the response variable has more than two ordinal categories. This model is used to estimate the odds of being at or below a particular level of the response variable, however, with some manipulation, it can be used to estimate the odds of being beyond a particular level of the response variable as well. One of the main assumptions of the ordinal logistic model is the proportional odds assumption which means that the relationship between each pair of

outcome groups is the same. I run regressions assuming that this holds true. The ordinal logistic regression model that estimates the odds of being beyond a particular level can be expressed in the logit form as follows:

$$\text{logit} [\pi (y > j | x_1, \dots, x_p)] = \alpha_j + (\beta_{1j} x_1 + \beta_{2j} x_2 + \dots + \beta_{pj} x_p)$$

where,

α_j = intercepts or cut points

β_{ij} = logit coefficients

X_p = a vector of independent variables

y = Empowerment Index

3.5. MATCHING ANALYSIS

Establishing a causal relationship between the empowerment index score of women and access to electricity requires careful consideration. Merely comparing the scores of women with and without electricity is insufficient, as household connectivity to electricity depends on various factors, leading to a potential sample selection bias. Since it is impossible to compute the empowerment index score for the same woman in both scenarios, a quasi-experimental method called Propensity Score Matching (PSM) is used to mimic a randomized controlled trial. Each observation is assigned a probability or propensity score based on covariates, and participants from the treatment and control groups are matched to form a counterfactual group (Gertler et al., 2016). The resulting matched data helps establish a causal relationship between household electrification and the empowerment index of women.

Several studies have employed the propensity-score matching method to investigate the causal relationship between household electrification and household welfare. Using the Indian Human Development Survey, Samad and Zhang (2019) found that electrification enhances women's empowerment, leading to an 11-percentage point increase in the overall empowerment index in rural India. Rathi, Singh, and Vermaak (2018) discovered that women who work benefit the most from the productivity gains of electrification, experiencing greater increases in earnings compared to men. Salehi-Isfahani and Taghvatalab (2022), utilizing propensity score matching, determined that electrification contributed to the narrowing of the gender gap in literacy, providing a potential solution to the puzzle of female empowerment in the face of

rising patriarchy in Iran. The PSM technique relies on two assumptions. The first assumption is conditional independence, which considers the probability of receiving treatment given the covariates. The second assumption requires a substantial overlap between participants in the treatment and control groups within the common support region, where propensity scores are close to each other (Khandker, Koolwal, and Samad 2010). Accordingly, the first step in the PSM technique is to select relevant covariates. Table 2 displays the chosen covariates, such as working status, education, residence, ownership of livestock, household head sex, household head age, age squared, and wealth level, based on their positive association with the treatment variable, electricity.

Table 2: Difference in Means of Covariates

Covariate	Electricity	Non-Electricity	Difference in Means
Working	0.58	0.68	-0.1***
Education	1.33	0.81	0.52***
Residence	0.67	0.43	0.17***
Owens Cow	0.46	0.72	-0.26***
Owens Horse	0.01	0.02	-0.01***
Owens Poultry	0.41	0.52	-0.11***
Household Head Sex Female	1.32	1.33	-0.01
Household Head Age	44.9	42.5	2.4***
Household Head Age Square	2187.9	1958.1	229.8
Wealth Level	1.04	0.06	0.98***

*** $p < .01$, ** $p < .05$, * $p < .1$

Source: Author's Calculation

Once the first assumption is fulfilled, the next step is to conduct propensity score matching. The ultimate goal is to ensure reduction of bias. These matching techniques give us the Average Treatment Effect (ATE), Average Treatment Effect on the Treated (ATET), and the Average Treatment Effect on the Untreated (ATEU). The three PSM techniques I compare are nearest neighbor, radius caliper, and kernel. Based on the chosen technique, the number of matched observations will vary but the number of observations off common support will remain the same i.e. 1 untreated observation and 904 treated observations.

I find that nearest neighbor PSM technique produces the least amount of bias i.e. 12.8 compared to 19.2 and 21.2 of radius caliper and kernel techniques, respectively. Thus, I use the nearest neighbor PSM technique to conduct the analysis using the probability weights generated by matching. According to Khandker, Koolwal, and Samad (2010) the nearest neighbor matching technique matches each treatment unit to k control units on the selected set of covariates. The number of nearest neighbors (k control units) may be specified but the consensus is to

set the same between 3 and 5.1 limit the matching to 5 nearest neighbors. The total number of observations in the common support region in nearest neighbor matching is 8,438 (963 from untreated and 7,475 from treated).

4. RESULTS

4.1 PRE-MATCHING ANALYSIS

The outcome variable, the empowerment index, has been summarized in Table 3 which suggests that women who reside in house with access to electricity are more empowered than women who reside in home without access to electricity.

Table 3: Summary Statistics of the Empowerment Index

Outcome Variable	Electricity	Non-Electricity	Mean Difference
Empowerment Index	1.94	1.62	0.32***

*** $p < .01$, ** $p < .05$, * $p < .1$

Source: Author's Calculation

As shown in Table 4, the results of the pre-matching Ordinal Logistic Regression demonstrate a positive relationship between women's empowerment and household electrification. An odds ratio greater than 1 indicates a positive relationship, while a ratio below 1 signifies an inverse relationship. Holding other predictors constant, women in households with electricity have 1.51 times the odds of being better empowered compared to women in households without electricity. This result is statistically significant at $p < 0.01$ and aligns with the existing literature mentioned earlier.

Furthermore, women's empowerment is directly associated with their working status, with working women being more likely to experience empowerment than non-working women. Higher levels of education also increase the likelihood of empowerment compared to lower levels or no education. Residing in urban areas is linked to a higher likelihood of empowerment. While the likelihood of empowerment initially increases with age, it does so at a decreasing rate, as indicated by an odds ratio of age squared less than 1. Contrary to expectations, being affiliated with the majority religion exhibits a lower likelihood of empowerment. Higher household wealth contributes to a higher likelihood of empowerment, and having a female household head positively influences the respondent's empowerment.

The likelihood of empowerment decreases with the age of the household at an increasing rate, as represented by an odds ratio less than 1 for household head age and greater than one for household head age squared. This may be due to older households being less likely to change and women facing more traditional norms. Lastly, having at least one child under the age of five decreases the likelihood of empowerment. This could be because after having children, women often choose to take on traditional roles at home, resulting in a loss of income and decision-making power. All covariates exhibit statistically significant odds ratios at $p < 0.01$, except for religion, which is insignificant.

While the findings of Table 4 indicate a higher likelihood of empowerment for women with access to electricity, these results do not establish a causal relationship. The next section will present the results of the nearest neighbor PSM technique and the corresponding odds ratios obtained from the generated weights.

Table 4: Ordered Logit Model Predicting Average Empowerment Index by Electrification Status and Socio-Demographic Characteristics before Propensity Score Matching

Variables	Odds Ratios
Electricity (Yes)	1.51*** (0.11)
Working Status	
Yes	1.49*** (0.069)
Highest Education Qualification	
Primary	1.39*** (0.08)
Secondary	2.18*** (0.13)
Higher	4.25*** (0.34)
Residence	
Urban	1.33*** (0.061)
Age	1.49*** (0.03)
Age Squared	.99*** (0.00)
Religion	
Majority: Hindu	.97 (0.063)
Wealth Level (Base: Poor)	
Middle	1.21*** (0.072)
Rich	1.53*** (0.08)
Household Head Sex (Base: Male)	
Female	2.24*** (0.10)
Household Head Age	0.84*** (0.01)
Household Head Age Square	1.001*** (0.00)
Children Under Five (Yes)	.803*** (0.035)
Cut 1	4.5*** (0.43)
Cut 2	5.7*** (0.043)
Pseudo R- Squared	0.1291
Observations	9, 795

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Source: Author's Calculation

4.2. MATCHING ANALYSIS

As mentioned earlier, the nearest neighbour matching technique produces the least bias i.e. 12.8. The technique enables us to estimate the Average Treatment Effect (ATE), Average Treatment Effect on the Treated (ATET) and Average Treatment Effect on the Untreated (ATEU) for the outcome variable, empowerment index. Table 5 presents the results of the same and shows an increase in the treatment effect on the matched sample as opposed to the unmatched sample.

Table 5: Treatment Effects for Unmatched and Matched Samples (Nearest Neighbour Matching)

Sample	Treated	Control	Difference
Unmatched	1.93	1.61	0.31
ATT	1.91	1.61	0.29
ATU	1.61	1.76	0.14
ATE	--	--	0.27

Source: Author's Calculation

Source: Author's Calculation

The odds ratios are presented in Table 6. As can be observed, odds for women with access to electricity being better empowered are 1.4 times the odds for women without access to electricity in the household when holding all the other predictors constant. The result is statistically significant at $p < 0.01$. We can now establish that electrification of the household positively empowers women.

The relationship between some covariates and empowerment has either changed or become less significant after the matching process. Working women have lower odds of experiencing empowerment, possibly due to facing exploitation in the workplace while also fulfilling domestic responsibilities (Batliwala 2007; Pearson 2004). Although the association between higher education and empowerment remains, its significance has decreased after matching. Similarly, the impact of wealth level and residing in urban areas has also become less significant. Robustness checks using radius caliper and kernel matching techniques, presented in Appendix Table 7, support the findings from the nearest neighbor PSM technique. Across all three matching techniques, electrification of households consistently emerges as a positive and statistically significant determinant of women's empowerment. However, the significance level decreases in radius caliper and kernel matching techniques, and the direction of the relationship between wealth and empowerment becomes inverse.

The consistent significance and relationship between electrification and empowerment, both before and after matching, while other variables change, suggest that even after accounting for non-randomized access to electricity, household electrification is associated with a higher level of women's empowerment.

Table 6: Ordered Logit Model Predicting Average Empowerment Index by Electrification Status and Socio-Demographic Characteristics after Propensity Score Matching (Nearest Neighbor)

Variables	Odds Ratios
Electricity	1.4*** (0.17)
Working Status	
Yes	0.63 (0.31)
Highest Education Qualification	
Primary	2.76* (1.31)
Secondary	2.2* (0.92)
Higher	2.1 (1.7)
Residence	
Urban	1.3 (0.39)
Age	1.75*** (0.34)
Age Squared	.99** (0.003)
Religion	
Majority: Hindu	1.2 (0.44)
Wealth Level (Base: Poor)	
Middle	0.60 (0.28)
Rich	1.46 (0.31)
Household Head Sex (Base: Male)	
Female	2.57*** (0.78)
Household Head Age	0.84** (0.06)
Household Head Age Square	1.01 (0.00)
Children Under Five	
Cut 1	6.57 (3.32)
Cut 2	7.91 (3.33)
Pseudo R- Squared	0.129
Observations	7, 921

***p<0.01, **p<0.05, *p<.1

Source: Author's Calculation

5. CONCLUSION AND POLICY IMPLICATIONS

This study used the Nepal Demographic and Health Survey 2016 to find the impact of household electrification on women empowerment. This paper defines women empowerment based on the indicators of decision-making power, freedom of movement, control over resources, degree of sexual autonomy, and perception of domestic violence. An empowerment index was created to form an average representation of empowerment based on those indicators. To address the issue of non-random nature of electrification, this paper used different propensity score matching technique and established a positive causal link between electrification and women empowerment index. Access to electricity can be an important policy tool for empowering women. Nearest neighbor matching produces least mean bias and radius caliper and kernel matching techniques are used as robustness checks.

In addition to electrification, this paper has found higher levels of education, the presence of a female household head and age of the respondent to be positive determinants of women empowerment in all three matching techniques. The impact of age on empowerment increases at a decreasing rate. Presence of at least one child lowers the likelihood of empowerment. Associated religion and level of wealth are not significant determinants of empowerment. The relationship of working status with women empowerment switches from positive to negative after the matching analysis. The fact that the significance and direction of relationship for covariates has changed but remained the same for the coefficient of electrification means that the propensity score matching has worked and a causal link between household electrification and women empowerment has been established.

Firstly, the results suggest that promoting household electrification can be an effective policy tool for empowering women. Governments and policymakers should prioritize the expansion of electricity infrastructure to households, particularly in rural areas, to ensure that women can benefit from access to reliable electricity. Secondly, the study found that education, female household heads, and the age of the respondent were positive determinants

of women's empowerment. Policymakers should focus on promoting education for girls and women, supporting female-headed households, and implementing policies that target women of all ages to enhance their empowerment. Lastly, the study indicates that working status can have both positive and negative effects on women's empowerment, depending on the context. Policymakers should consider the potential impact of employment policies

on women's empowerment and design interventions that promote gender equality in the workplace. Overall, the findings of this study suggest that promoting household electrification, improving electricity infrastructure, investing in education for girls and women, supporting female-headed households, and promoting gender equality in the workplace can enhance women's empowerment and promote gender equality.

APPENDIX

Table 7: Ordered Logit Model Predicting Average Empowerment Index by Electrification Status and Socio-Demographic Characteristics after Propensity Score Matching (Kernel and Radius Caliper)

Variables	Radius Caliper	Kernel
Electricity	1.37*** (0.14)	1.43*** (0.13)
Working Status		
Yes	1.41 (0.42)	1.07 (0.35)
Highest Education Qualification		
Primary	1.66 (0.66)	1.77 (0.74)
Secondary	1.74 (0.69)	1.27 (0.56)
Higher	1.52 (0.96)	1.36 (0.92)
Residence		
Urban	1.22 (0.31)	1.03 (0.28)
Age	1.43** (0.19)	1.56*** (0.22)
Age Squared	.99** (0.002)	0.99** (0.00)
Religion		
Majority: Hindu	1.65 (0.66)	1.62 (0.68)
Wealth Level (Base: Poor)		
Middle	.81 (0.24)	0.78 (0.23)
Rich	0.63 (0.37)	0.68 (0.05)
Household Head Sex (Base: Male)		
Female	2.92*** (0.80)	2.31*** (0.65)
Household Head Age	0.98 (0.06)	0.90 (0.06)
Household Head Age Square	0.99 (0.00)	1.00 (0.00)
Children Under Five	0.46*** (0.12)	0.39*** (0.1)
Cut 1	6.75 (2.66)	5.96 (2.6)
Cut 2	8.18 (2.66)	7.42 (2.66)
Pseudo R- Squared	0.129	
Observations	7, 921	

***p<0.01, **p<0.05, *p<.1

Source: Author's Calculation

Table 8: *Treatment Effects for Unmatched and Matched Samples (Radius Caliper and Kernel Matching)*

Sample	Treated	Control	Difference
Unmatched	1.93	1.61	0.31
ATT	1.91	1.61	0.29
ATU	1.61	1.76	0.14
ATE	--	--	0.27

Source: Author's Calculation

REFERENCES

1. Agarwal, Bina. 1997. ““Bargaining” and Gender Relations: Within and Beyond the Household.” *Feminist Economics* 3 (1): 1–51.
2. Batliwala, S. (2007). Taking the power out of empowerment: An experiential account. *Development in Practice*, 557–565.
3. Bernard, Tanguy, and Maximo Torero. 2015. “Social Interaction Effects and Connection to Electricity: Experimental Evidence from Rural Ethiopia.” *Economic Development and Cultural Change* 63 (3): 459–84.
4. Bennett, Lynn. 2002. “Using Empowerment and Social Inclusion for Pro-poor Growth: A Theory of Social Change”. World Bank Working Draft of Background Paper for the Social Development Strategy Paper. Vol-12.Pp-43-45.
5. Burney, Jennifer, Halimatou Alaofè, Rosamond L. Naylor, and Douglas Taren. 2017. “Impact of a Rural Solar Electrification Project on the Level and Structure of Women’s Empowerment.” *Environmental Research Letters* 12 (9): 095007.
6. Clark, Lauren. 2021. “Powering Households and Empowering Women: The Gendered Effects of Electrification in Sub-Saharan Africa.” *Journal of Public and International Affairs*. 2021.
7. Chakravorty, Ujjayant, Martino Pelli, and Beyza Ural Marchand. 2014. “Does the Quality of Electricity Matter? Evidence from Rural India.” *Journal of Economic Behavior and Organization* 107 (November): 228–47.
8. “Community Rural Electrification Programme (CREP) Nepal - Energypedia.” n.d.
9. Dixon-Mueller, R. 1993, September. The Sexuality Connection in Reproductive Health. *Studies in Family Planning*, 24(5), 269.
10. Dyson, Tim, and Mick Moore. 1983. “On Kinship Structure, Female Autonomy, and Demographic Behavior in India.” *Population and Development Review* 9 (1): 35.
11. Gertler, Paul J., Sebastian Martinez, Patrick Premand, Laura B. Rawlings, and Christel M. J. Vermeersch. 2016. “Impact Evaluation in Practice, Second Edition”. World Bank and Inter-American Development Bank.
12. “Global Gender Gap Report 2022.” 2021. 13: 978-2-940631-36-0. World Economic Forum.
13. Greenwood, Jeremy, Ananth Seshadri, and Mehmet Yorukoglu. 2005. “Engines of Liberation.” *The Review of Economic Studies* 72 (1):
14. Jejeebhoy, Shireen J., and Zeba A. Sathar. 2001. “Women’s Autonomy in India and Pakistan: The Influence of Religion and Region.” *Population and Development Review* 27 (4): 687–712.

15. Kabeer, Naila. 1999. "Resources, Agency, Achievements: Reflections on the Measurement of Women's Empowerment." *Development and Change* 30 (3): 435–64.
16. Kondal, Kappa. 2014. "Women Empowerment through Self Help Groups in Andhra Pradesh, India." *International Research Journal of Social Sciences*, January, 13–16.
17. Khandker, Shahidur R., Gayatri B. Koolwal, and Hussain A. Samad. 2010. "Handbook on Impact Evaluation". World Bank.
18. Malhotra, Anju, and Sidney Ruth Schuler. 2005. "Women's Empowerment as a Variable in International Development." *PsycEXTRA Dataset*, January.
19. Malhotra, A., Mather, M. Do schooling and work empower women in developing countries? *Gender and Domestic Decisions in Sri Lanka*. 12, 599–630 (1997).
20. Pearson, R. (2004, October). *Women, Work and Empowerment in a Global Era*. *IDS Bulletin*, 35(4), 117–120.
21. Pitt, Mark A., Shahidur Khandker, and Jennifer Cartwright. 2003. "Does Micro-Credit Empower Women? Evidence from Bangladesh." *World Bank Policy Research Working Paper*, March.
22. Polansky, Jakub, and Murodbek Laldjebaev. 2021. "Gendered Energy Relations at the Crossroads of Asia: Electrification, Empowerment, and Mixed Outcomes in Northeastern Afghanistan." *Energy Research and Social Science* 73 (March): 101928.
23. Rathi, Sambhu Singh, and Claire Vermaak. 2018. "Rural Electrification, Gender and the Labor Market: A Cross-Country Study of India and South Africa." *World Development* 109 (September): 346–59.
24. Salehi-Isfahani, Djavad and Taghvatalab, Sara. "Electrification and the Closing of the Gender Gap in Education in Rural Iran". *Social Science Research Network*.
25. Samad, Hossain, and Fan Zhang. 2019. "Electrification and Women's Empowerment: Evidence from Rural India." *Policy Research Working Paper No. 8796*. The World Bank.
26. Sedai, Ashish Kumar, Rabindra Nepal, and Tooraj Jamasb. 2022. "Electrification and Socio-Economic Empowerment of Women in India." *The Energy Journal* 43 (2).
27. Standal, Karina and Tanja Winther. (2016). "Empowerment Through Energy? Impact of Electricity on Care Work Practices and Gender Relations". *Forum for Development Studies*, 43(1), 27–45.
28. The World Bank. 2021. "Access to Electricity (% of Population)." Data set. *World Development Indicators*.
29. UNICEF ROSA Gender Section. 2018. "Gender Toolkit: Integrating Gender in Programming for Every Child in South Asia." UNICEF.
30. Vidart, Daniela. 2022. "Human Capital, Female Employment, and Electricity: Evidence from the Early 20th-Century United States." *Department of Economics, University of Connecticut*.

“ASSESSMENT OF THE ODD-EVEN POLICY IN DELHI: AN ANALYSIS OF ITS IMPACT ON AIR POLLUTION

ISHU GOYAL*

Ramjas College, University of Delhi

Abstract

This research paper critically evaluates the effectiveness of the odd-even policy in Delhi in reducing air pollution. The paper conducts a comprehensive review of existing literature on the policy, which has produced varying findings. While some studies have reported a reduction in air pollution and traffic congestion, others have found little or no impact. To analyze the impact of the first round of the odd-even transportation policy, as well as other controlled factors, on pollution levels in Delhi, time series data and OLS regression is used. The data includes daily measurements of the Air Quality Index (AQI) over 69 days in Delhi from 2015 onwards. The explanatory variables include the implementation of the odd-even policy, time variables, and climatic factors. The analysis is based on data from the Central Pollution Control Board offices in Delhi. For the second round, the ambient air quality data is divided into two periods and compare the values of different pollutants between the two periods. Based on the findings, the paper provides policy recommendations for reducing pollution in the city.

JEL Classification: Q51, Q53, Q58

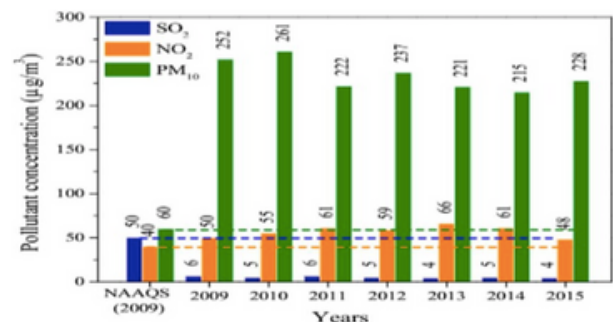
Keywords: Odd-even policy, Air pollution, Delhi, Exemptions, Impact assessment, multi-pronged approach

1. INTRODUCTION

Air pollution in Delhi, India is a significant threat to the well-being of the city. An air pollutant is a substance in the air that can have negative effects on humans and the environment. The major causes of increased pollution in Delhi, as identified in this study, include industrial emissions, weather patterns and temperatures during summer and winter, human activities such as motorization and vehicular traffic, government policies on fossil fuel prices, burning of agricultural waste in neighboring states, traffic congestion, population density, industrial activity, housing, and clustering of housing and industry. Delhi has some of the highest levels of particulate matter pollution, including PM 2.5 and PM 10, in the country. The main sources of PM 2.5 are vehicle traffic and grinding operations, while sources of PM 10 include all types of combustion, such as motor vehicles, forest fires, power plants, residential wood burning, some industrial processes, and agricultural burning. Sulphur dioxide (SO₂) mainly comes from fossil fuel at power plants and other industrial

facilities, as well as fuel combustion in mobile sources such as trains, ships, and equipment. Nitrogen dioxide (NO₂) is primarily from traffic, while carbon monoxide (CO) is from the incomplete burning of carbon-containing fuels like gasoline, natural gas, oil, coal, and wood. In urban areas, the main source of CO is vehicular emissions.

Figure 1: Air Quality Trends in Delhi (2009-2015) Based on Manual Air Quality Monitoring Stations



Source: CPCB

Prolonged exposure to particulate matter can lead to respiratory and cardiovascular diseases such as asthma, bronchitis, lung cancer, and heart attacks (Key Facts by WHO, 2018). According to a 2015

*Author's email address: Ishugoyal124@gmail.com

study by the Institute for Health Metric and Evaluation (IHME), outdoor air pollution is the fifth largest killer in India, after high blood pressure, indoor air pollution, tobacco smoking, and poor nutrition (WHO, 2018). The Central Pollution Control Board (CPCB) runs nationwide programs for monitoring ambient air quality known as the National Air Quality Monitoring Program (NAMP). Information on air quality at ITO is updated every week. To effectively control pollution, it is important to have a thorough understanding of emission sources and their effects on air quality. Although the physical and chemical processes of pollution can be complex, mathematical and econometric models can provide insight into the underlying relationships.

This paper mainly focuses on the 1st round of odd even policy (1Jan -15 Jan 2015), we use statistical methods to analyze the relationship between this new transportation policy adopted by the Delhi government, other controlled factors such as weather conditions, fossil fuel prices, and the AQI (Air Quality Index) which is based on the concentration of different pollutants in the air. Econometrics/Regression analysis is also used to help determine if the first round odd-even transportation policy has been effective in reducing pollution in Delhi, and its impact on existing pollution levels in the city.

The odd-even transportation policy, which requires odd-numbered vehicles to be driven on odd-numbered days and even-numbered vehicles to be driven on even-numbered days, was first implemented for Fifteen days from January 1st to 15th, 2016, and once again in the summer month of April 16th to 30th, 2016. The policy is in effect from 8:00 AM to 8:00 PM. (See appendix for second rounds analysis)

Exemptions to this policy include two-wheelers, trucks, women-driven cars, VIP and emergency vehicles, student-driven vehicles, public transport buses, and CNG-operated passenger/private cars. The goal of the policy is to reduce vehicular pollution in Delhi. The city has 3 million cars, 6 million scooters and motorbikes, and 0.2 million private vehicles. The odd-even transportation policy only applies to four-wheeler vehicles.

1.1. OBJECTIVE

In recent years, the National Capital, Delhi, and adjoining areas have experienced alarmingly poor air quality and therefore it is becoming necessary to come out with an analysis to look at such factors explaining pollution in Delhi.

Firstly, the goal of this study is to evaluate the effectiveness of the odd-even policy in reducing pollution levels in Delhi and to determine whether such policies can be used to combat rising pollution levels in the city. Additionally, the study aims to identify the changes required to make such policies successful. The study will analyze the factors that contribute to air pollution in Delhi, India, using daily time series data. The impact of climate factors on pollution levels will be examined, and statistical methods will be used to analyze the relationship between the odd-even policy and other factors, such as fossil fuel prices, on pollution levels in different locations in Delhi. The study will also use regression analysis to determine the impact of the odd-even policy on air pollution in the city. By conducting this analysis, the study aims to provide insights into the effectiveness of policies aimed at reducing pollution levels in Delhi and to identify the changes required to make such policies successful.

2. LITERATURE REVIEW

The existing literature on the odd-even policy in Delhi presents a complex picture, with studies reporting varied outcomes and highlighting different aspects of the policy's impact. To better understand the policy's effectiveness and how it differs from previous research, it is essential to weave a coherent narrative that connects these studies and identifies the gaps that our study aims to address.

The story begins with the mixed results reported by the Centre for Science and Environment (CSE) and the Indian Institute of Technology (IIT) Delhi. While the CSE study found a 15-17% reduction in air pollution and improvements in traffic congestion and public transport usage, the IIT Delhi study reported a negligible 1-4% reduction in air pollution and little impact on traffic congestion. This discrepancy raises questions about the policy's true effectiveness and warrants further investigation.

Critics of the policy highlight its disproportionate impact on low-income families and its failure to address the root causes of air pollution and traffic congestion. These concerns are supported by studies from the Ministry of Road Transport and Highways and the Delhi Transport Corporation (DTC), which point to poor enforcement of traffic laws, inadequate public transportation infrastructure, and a decline in public transport usage as key contributors to the ongoing issues in Delhi.

The literature also reveals implementation challenges, such as inconsistent enforcement and a lack of proper infrastructure, which have limited the policy's effectiveness. Experts suggest that a more comprehensive approach, including increased investment in public transportation, improved traffic law enforcement, and promotion of non-motorized transportation modes, is necessary to address the underlying issues.

This study aims to build on this existing literature by examining the odd-even policy's impact on air pollution and traffic congestion in Delhi through a more comprehensive lens. The paper will explore the policy's effectiveness in addressing the root causes of these issues, its impact on different socio-economic groups, and the potential benefits of implementing additional measures alongside the policy. By doing so, we hope to provide a more nuanced understanding of the policy's implications and contribute to the ongoing debate on the best strategies for combating air pollution and traffic congestion in Delhi.

3. DATA AND METHODOLOGY

To assess the effectiveness of the 1st round Odd-Even policy on AQI, a multiple linear regression analysis was conducted using the collected data from CPCB reports for the period of 69 days, analyzing data from 24 days prior to the introduction of the odd-even policy, during the implementation of the odd-even scheme, and 30 days after the end of the odd-even scheme. Specifically, the data analyzed covered the time period from December 8, 2015, to February 14, 2016. By including data from before, during, and after the implementation of the policy, this study aims to capture any short-term changes in AQI that may have been caused by the Odd-Even policy. The analysis of this specific time period also allows for a more accurate

assessment of the policy's effectiveness, as it accounts for any potential confounding factors such as seasonal variations in air pollution.

The dependent variable in the analysis was AQI, and the independent variables were petrolps, dieselp, temperature, humidity, wind speed, and oddevendummy. The regression equation was estimated using the ordinary least squares (OLS) method. The assumption of linearity, normality, and homoscedasticity of residuals was checked and met before proceeding with the analysis.

To control for the potential confounding effect of meteorological variables, we included them as independent variables in the model. We also included a binary variable indicating whether on a given day the odd-even policy was in effect or not, as this is the key element of the Odd-Even policy.

The statistical software R, Excel, and Gretl was used to perform the regression analysis and to obtain the estimates of the regression coefficients, standard errors, and associated p-values. The coefficient of determination (R-squared) was used to measure the overall goodness of fit of the model.

For the second round of analysis, we collected ambient air quality data from Delhi using a combination of Continuous Ambient Air Quality Monitoring Systems (CAAQMS) and manual stations (NAMPS) located throughout the city. The data includes measurements of pollutants such as PM10, PM2.5, Sulphur Dioxide (SO₂), Benzene, Ozone (O₃), Nitrogen Dioxide (NO₂), and Carbon Monoxide (CO). The data was gathered from stations operated by the Central Pollution Control Board (Shadipur, Dwarka, Dilshad Garden, DCE, and ITO) and 8 manual stations (Pitampura, Sirifort, Janakpuri, Nizamuddin, Shahzada Bagh, Shahdara, BSZ Marg, and ITO). The data, as recorded in the CQMS systems operated by Delhi Pollution Control Committee, were also collected for 4 stations (Mandir Marg, R. K. Puram, Punjabi Bagh, and Anand Vihar). We analyzed the data for two periods: pre-odd-even days (April 1-14) and odd-even days (April 15-30). (See Appendix for analysis.)

The results of this analysis will be used to assess the effectiveness of the Odd-Even policy in reducing AQI levels in Delhi and to identify any potential

challenges or limitations of the policy. The findings of this study will be useful for policymakers and public health officials in making informed decisions about the implementation of similar policies in the future.

Table 1: Variable Description And Data Sources

Variable	Variable Description	Source	Hypothesis
AQI	Air Quality Index in Delhi	Central Pollution Control Board Report	This is the Dependent variable
Temp	Average Daily Temperature of Delhi in Fahrenheit	Central Pollution Control Board websites	Affects positively
Petrol ps	Petrol price per liter in Delhi in Rupees	Website Of Indian Oil	Affects Negatively
Diesel ps	Diesel price per liter in Delhi in Rupees	Website Of Indian Oil	Affects positively
Humidity	Average Relative Humidity % of Delhi	Central Pollution Control Board websites	Affects positively
Wind	Average Wind Speed (mph) in Delhi	Central Pollution Control Board websites	Affects Negatively
oddevendummy	Dummy for the day odd-even rule was introduced	Central Pollution Control Board websites	Affects Negatively

Source: Authors' descriptions

3.1. HYPOTHESIS/EXPLANATION OF VARIABLES

1. AQI: This is the dependent variable AQI (Air Quality Index) is used to measure the level of air pollution in urban areas in real-time and inform the public. AQI is based on human exposure and health effects and takes into account pollutants such as PM10, PM2.5, NO₂, O₃, CO, SO₂, NH₃, and Pb. AQI values are reported on a scale of 0–500, with higher values indicating higher air pollution. The data obtained from online air quality monitoring stations is used to determine AQI. The worst sub-index reflects overall AQI. There are six AQI categories, namely Good, Satisfactory, moderately polluted, Poor, Very Poor, and Severe, and color bands are used to represent the different levels of AQI for ease of understanding.

Table 2: AQI Categories

AQI Category	Good	Satisfactory	Moderately Polluted	Poor	Very Poor	Severe
AQI	0-50	51-100	101-200	201-300	301-400	401-500

Source: CPCBs

2. Odd-even dummy: The dummy variable is assigned a value of 1 during the days when the policy is in effect and a value of 0 during the days when the policy is not in effect. This allows for a comparison of air quality between days when the policy is in effect and when it is not, in order to measure the effectiveness of the policy on reducing air pollution. This can be done by comparing the average AQI during the days when the policy is in effect with the

average AQI during the days when the policy is not in effect. Odd-even dummy in the Regression model is hypothesized to have a *negative* impact on pollution in Delhi.

3. Climatic factors such as *wind speed* are known to play an important role in *reducing* the level of pollution in the environment. These factors help to carry away the pollution particulates, thereby reducing the concentration of pollutants in the air.

4. *Temperature and humidity* can *increase* pollution levels. High temperatures can increase emissions and chemical reactions in the atmosphere. High humidity can make it harder for pollutants to disperse, leading to higher concentrations in the air and increased formation of secondary pollutants.

5. Petrol and Diesel prices are hypothesized to have positive and negative impacts on pollution levels respectively. This may be because petrol and diesel may be substitutes for each other, leading to the replacement of petrol-driven cars by diesel-driven cars once the price of petrol goes up, which in turn would lead to a rise in pollution levels. On the other hand, if the price of diesel goes up, then people may reduce consumption of diesel-driven cars leading to reductions in pollution levels.

The above arguments are based on the fact that diesel causes more pollution than petrol. Therefore, it's important to include petrol and diesel prices as variables when conducting regression analysis.

The Descriptive Statistics for the data are given as follows:

Table 3: Descriptive Statistics

Variable	Mean	Standard Error	Range	Minimum	Maximum
AQI	329.4783	7.734942	294	140	434
Petrol ps	59.85551	0.045246	1.45	59.03	60.48
Diesel ps	45.28377	0.089079	2.37	44.18	46.55
Temperature (° F)	58.26087	0.516362	18	48.7	66.7
Humidity (%)	78.67971	0.884415	33.7	59.4	93.1
Wind Speed (mph)	2.469565	0.199843	6.9	0	6.9

Source: Authors' calculation

3.2. LIMITATIONS

One limitation encountered during the research was the unavailability of data, which resulted in an uneven analysis of the first round of the odd-even policy. The analysis was conducted before and after

the implementation phase, with durations of 24 and 30 days, respectively. Similarly, the second round of the policy was also affected by the unavailability of data, as several monitoring stations did not have data for various pollutants.

4. ECONOMETRIC MODEL AND ESTIMATION METHODS

To evaluate the effectiveness of the odd-even policy in reducing pollution levels, we hypothesized that the odd-even dummy variable would have a negative impact on the Air Quality Index (AQI). To test this hypothesis, an econometric model that takes the form shown in Equation (1) has been utilized:

$$AQI = \beta_0 + \beta_1 Petrolps + \beta_2 Dieselps + \beta_3 Temp + \beta_4 Humidity + \beta_5 Wind + \beta_6 OddEvenDummy + ui \quad (1)$$

Where AQI is the dependent variable, and Petrolps, Dieselps, Temp, Humidity, Wind, and OddEvenDummy are the independent variables. The model also includes the error term, ui. The coefficients ($\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5,$ and β_6) were estimated using Ordinary Least Squares (OLS) method, and the data was collected from observations 1-47. The model was then used to determine the relationship between AQI and the independent variables and to test whether the odd-even dummy variable has a statistically significant impact on AQI.

5. RESULTS AND INTERPRETATION

Table 4: Regression Results

Variable	coefficient	std. error	t-ratio	p-value
Intercept	-2450.26	1329.83	-1.843	0.0702*
Petrolps	68.1229	26.3599	2.584	0.0121 **
Dieselps	-40.1311	9.35905	-4.288	6.42e-05 ***
TemperatureAF	3.92771	1.32958	2.954	0.0044 ***
Humidity	3.89266	0.776158	5.015	4.72e-06 ***
WindSpeedmph	-10.5086	3.26375	-3.220	0.0020 ***
oddevendummy	47.5529	20.8671	2.279	0.0261 **

Source: Authors' calculation

Note: Significance codes: '***' 0.01 '**' 0.05 '*' 0.10

(2) Equation represents the linear regression model

$$\hat{aqi} = -2.45e+03 + 68.1*Petrolps - 40.1*Dieselps + 3.93*TemperatureAF + 3.89*Humidity - 10.5*WindSpeedmph + 47.6*oddevendummy$$

(1.33e+03) (26.4) (9.36) (1.33) (0.776) (3.26) (20.9)

N = 69, R-squared = 0.602
(standard errors in parentheses)

Table 5: Regression Statistics

Mean dependent var	329.4783
S.D. dependent var	64.25126
Sum squared resid	111629.1
S.E. of regression	42.43193
R-squared	0.602346
Adjusted R-squared	0.563864
F(6, 62)	15.65242
P-value(F)	7.67e-11

Source: Authors' calculation

The results of the model show that all of the independent variables have a significant impact on the AQI.

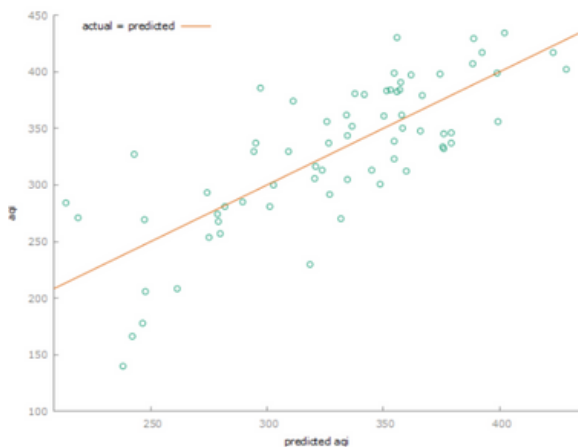
- The coefficient for petrol price is positive, indicating that as petrol price increases, AQI increases.
- The coefficient for diesel price is negative, indicating that as diesel price increases, AQI decreases.
- The coefficient for temperature is positive, indicating that as temperature increases, AQI increases.
- The coefficient for humidity is positive, indicating that as humidity increases, AQI increases.
- The coefficient for wind speed is negative, indicating that as wind speed increases, AQI decreases.
- The coefficient for the odd-even scheme is positive, indicating that when the odd-even scheme is in effect, AQI is higher than when it is not in effect. (Not as per Hypothesis, see conclusion for the explanation)

The model has an R-squared value of 0.6, indicating that 60% of the variation in AQI can be explained by the independent variables included in the model. The adjusted R-squared value is 0.56, indicating that 56% of the variation in AQI can be explained by the independent variables after adjusting for the number of variables in the model. The F-statistic and P-values are also significant, indicating that the model as a whole is significant.

The model was also tested for autocorrelation, heteroskedasticity, Multicollinearity, and normality of residuals. The test for heteroskedasticity and Multicollinearity showed that there is no evidence of heteroskedasticity or multicollinearity in the residuals of the model. The test for the normality of residuals showed that the residuals are normally distributed. And the test for autocorrelation of order 1 showed

that our data doesn't suffer from this problem. (See Appendix)

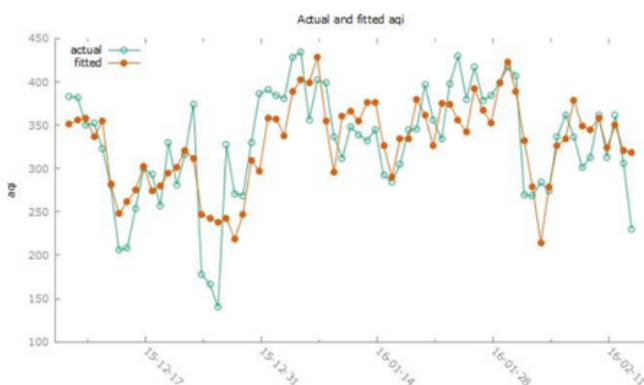
Figure 2: Regression Line



Source: Authors' calculation

Overall, the results of the model show that petrol price, diesel price, temperature, humidity, wind speed, and odd-even scheme have a significant impact on AQI in Delhi. The model explains 64% of the variation in AQI and is a good fit for the data.

Figure 3: Graph Showing Actual and Fitted Values of The Model



Source: Authors' calculation

5.1 POLICY RECOMMENDATIONS

Delhi's air pollution has been a persistent problem for many years, and it is clear that a multifaceted approach is needed to effectively address this issue.

One of the key ways to reduce pollution in Delhi is through the implementation of measures to reduce acid rain. Acid rain is caused by emissions of sulfur and nitrogen oxides, which can have a detrimental effect on the environment and human health. By implementing measures to reduce these emissions, we can help to reduce the acidity of rain and improve air quality in the city.

Another important strategy for reducing pollution in

Delhi is the development of elevated road corridors. These corridors can help to reduce congestion on the roads and reduce the number of vehicles on the road, which in turn can help to reduce emissions. Additionally, connecting different parts of the city with metro rail can provide a sustainable transportation option that can help to reduce pollution in the city.

Improving public transportation that runs on CNG is another important strategy for reducing pollution in Delhi. CNG is a cleaner burning fuel than gasoline or diesel and can help to reduce emissions from public transportation. Furthermore, using alternative fuels based on Jethropha, mustard, and Sarso plants can help to reduce the dependence on fossil fuels and decrease pollution.

Investing in renewable energy is another key way to reduce pollution in Delhi. This can include investing in solar and wind power, which can help to reduce the need for fossil fuels and decrease emissions. Additionally, investing in electric vehicles can help to reduce the number of vehicles on the road and decrease emissions from transportation.

Reducing industrial emissions by shifting industries out of Delhi and taxing private vehicles can also effectively reduce pollution in the city. This can be achieved by implementing appropriate land allocation policies, reducing diesel-run vehicles, and investing in climate-smart goods such as electric vehicles, renewable energy, and public transportation running on CNG. Furthermore, improving the city's green cover can help absorb carbon emissions and improve air quality.

Increase enforcement: The model suggests that the odd-even policy positively reduces air pollution in Delhi. However, the impact is not as significant as expected. One reason for this could be weak enforcement of the policy. To improve the effectiveness of the policy, enforcement measures such as fines or penalties for violators should be increased.

Target high-pollution areas: The model shows that the odd-even policy has a greater impact on reducing air pollution in areas with higher pollution levels. To improve the effectiveness of the policy, the government should target high-pollution areas and

implement stricter measures such as carpooling or car-free days.

Overall, it is clear that a comprehensive approach is needed to effectively address the problem of pollution in Delhi. This can include a combination of strategies such as reducing acid rain, developing elevated road corridors, connecting different parts of the city with metro rail, improving public transportation running on CNG, using alternative fuels, investing in renewable energy, reducing industrial emissions, taxing private vehicles, appropriate land allocation policies, reducing diesel-run vehicles, investing in climate-smart goods, and improving green cover in the city.

6. CONCLUSION

In conclusion, our regression equation for 1st round shows that the odd-even policy has a positive coefficient, which suggests that it increases the Air Quality Index (AQI) in Delhi. However, this result should be interpreted with caution as it does not necessarily mean that the policy is ineffective in reducing pollution. And for 2nd it is clear from Tables 7-13, indicated by the red arrows, that there is an increase in the concentration of pollutants at most of the monitoring locations during the odd-even periods when compared to the pre-odd-even period. (See Appendix for tables)

In practice, the odd-even policy may not have had a significant impact due to several exemptions given during its implementation, such as for women, two-wheelers, and student-driven vehicles, among others.

APPENDIX

A.1 Diagnostic tests:

- **White's test for heteroskedasticity:**
 - Null hypothesis: Heteroskedasticity is not present in the residuals.
 - Test statistic: LM = 30.5394
 - p-value: 0.134536
 - Interpretation: The p-value is greater than 0.05, which means we fail to reject the null hypothesis. This suggests that there is no strong evidence of heteroskedasticity in the residuals.
- **LM test for autocorrelation up to order 1:**
 - Null hypothesis: There is no autocorrelation in the residuals.
 - Test statistic: LMF = 3.71732

These exemptions meant that a significant number of vehicles were not subject to the restrictions imposed by the policy, diluting its potential impact. Additionally, the policy was only implemented for short periods of time, such as during the winter months when pollution levels in the city are at their highest. This may not have been long enough to positively reduce pollution levels, as the policy would need to be implemented consistently over an extended period of time to have a meaningful impact. Furthermore, people started shifting their travel schedules to beat the 8 am - 8 pm restrictions imposed by the policy, and because of the odd-even policy, people started buying or using two cars, which defeated the purpose of the policy.

However, it's worth noting that air pollution in Delhi is due to multiple factors and this policy alone cannot solve the problem. To address the underlying problem of air pollution in Delhi, it would be necessary to take a comprehensive and integrated approach to multiple sources of pollution. This may include measures to reduce emissions from vehicles, industrial sources, and other sources of pollution, as well as measures to improve energy efficiency and promote sustainable transportation options. Additionally, addressing other factors that contribute to pollution in Delhi, such as the price of fossil fuel, would also be necessary to see a significant reduction in pollution levels in the city. The government must take a comprehensive approach and consider all the factors that contribute to the pollution problem in Delhi. The success of any policy aimed at reducing pollution in the city will depend on its ability to address the root causes of the problem and not just its symptoms.

- p-value: 0.0585092
- Interpretation: The p-value is greater than 0.05, which means we fail to reject the null hypothesis. This suggests that there is no strong evidence of autocorrelation in the residuals up to order 1.

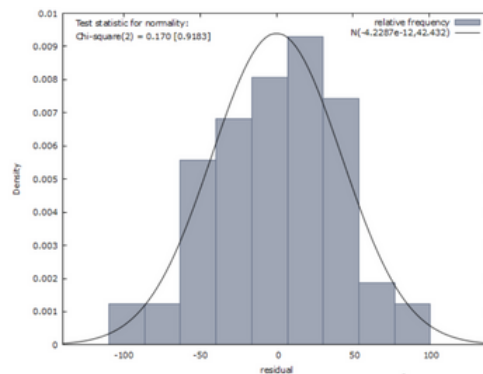
• **Test for normality of residuals:**

- Null hypothesis: The error term is normally distributed.
- Test statistic: Chi-square (2) = 0.170366
- p-value: 0.918344
- Interpretation: The p-value is much greater than 0.05, which means we fail to reject the hypothesis. This suggests that the error term is normally distributed, which is an important assumption for the validity of the OLS regression model.

• **Multicollinearity Statistics:**

- Using Variance Inflation Factors
- Minimum possible value = 1.0
- Values > 10.0 may indicate a collinearity problem

Figure 4: Graph Showing Frequency Distribution for Residuals



Source: Authors' calculations

Table 6: Multicollinearity Statistics

Variables	Variance Inflation Factors(VIF)
Petrolps	3.707
Dieselp	1.811
TemperatureAF	1.228
Humidity	1.228
WindSpeedmph	1.109
oddevendummy	2.839

Source: Authors' calculations

A.2. Second Round Odd Even Policy Analysis:

The data collected from these 17 stations for the entire month of April 2016, which includes both pre-odd-even days (April 1-14) and odd-even days (April 15-30), are presented in Tables 7 to 13 below:

Table 7: PM_{2.5} µg/m³

Stations	PRE ODD EVEN			DURING ODD EVEN		
	Max	Min	Average	Max	Min	Average
DMS Shadipur	135	111	126	146	103	123
NSIT Dwarka	147	96	121	192	103	137↑
IHBAS Dilshad Garden	182	92	143	157	97	121
ITO	147	46	87	252	76	143↑
DCE	188	49	95	190	78	145↑
Pitampura	82	55	69	NA	NA	NA
Nizamuddin	106	28	63	189	74	112↑
Sirifort	79	33	56	201	49	99↑
Shahzada Bagh	62	33	45	249	57	111↑
Janakpuri	115	49	74	328	124	182↑
Shadhara	NA	NA	NA	85	43	63
Parivesh Bhawan	63	32	45	151	42	87↑
DPCC Stations						
R.K. Puram	137	68	102	126	126	156↑
Mandir Marg	83	39	57	126	126	85↑
Punjabi Bagh	123	38	66	126	126	107↑
Anand Vihar	222	46	130	126	126	174↑
Average	125	54	85	190	75	123↑

Note: NA indicates non availability of Data

Source: Authors' calculations

Table 8: PM₁₀ µg/m³

Stations	PRE ODD EVEN			DURING ODD EVEN		
	Max	Min	Average	Max	Min	Average
Pitampura	173	89	132	414	217	271↑
Nizamuddin	236	189	206	421	206	303↑
Sirifort	405	270	316	696	279	434↑
ShahzadaBagh	300	253	276	464	257	361↑
Janakpuri	324	226	255	423	191	304↑
Shadhara	441	246	343	701	235	387↑
Parivesh Bhawan	260	194	226	411	241	311↑
ITO BSZ Marg	199	120	146	389	170	270↑
Average	292	198	238	490	225	330↑

Source: Authors' calculations

Table 9: CO µg/m³

Stations	PRE ODD EVEN			DURING ODD EVEN		
	Max	Min	Average	Max	Min	Average
DMS Shadipur	1264	423	776	1801	643	1191↑
NSIT Dwarka	949	371	575	1493	626	942↑
IHBAS Dilshad Garden	740	466	584	991	478	640↑
DPCC Stations						
R.K. Puram	2754	497	1209	4194	818	2308↑
Punjabi Bagh	2645	611	1312	3088	769	1588↑
Average	1670	474	891	2313	667	1334↑

Source: Authors' calculations

Table 10: NO₂µg/m³

Stations	PRE ODD EVEN			DURING ODD EVEN		
	Max	Min	Average	Max	Min	Average
DMS Shadipur	72	36	51	87	38	66↑
NSIT Dwarka	26	12	18	39	13	23↑
IHBAS Dilshad Garden	42	21	33	78	26	52↑
Pitampura	41	31	37	84	21	48↑
Nizamuddin	47	43	45	83	31	55↑
Sirifort	48	47	47	72	31	54↑
ShahzadaBagh	61	51	55	95	46	65↑
Janakpuri	57	47	52	75	42	52
Shadhara	66	56	60	63	31	49
PariveshBhawan	35	23	28	72	28	46↑
ITO BSZ Marg	66	38	57	112	35	74↑
DPCC Stations						
R.K. Puram	109	50	69	138	45	87↑
Mandir Marg	66	25	41	102	27	59↑
Punjabi Bagh	96	56	80	131	59	91↑
Anand Vihar	109	50	82	163	67	109↑
Average	63	39	50	93	36	62↑

(Source: Authors' calculations)

Table 11: SO₂ µg/m³

Stations	PRE ODD EVEN			DURING ODD EVEN		
	Max	Min	Average	Max	Min	Average
DMS Shadipur	30	13	22	38	14	23↑
NSIT Dwarka	19	9	13	24	3	11
IHBAS Dilshad Garden	17	8	13	18	9	13
Pitampura	5	4	5	31	4	17↑
Nizamuddin	4	4	4	15	5	8↑
Sirifort	4	4	4	26	5	10↑
ShahzadaBagh	9	6	7	25	9	14↑
Janakpuri	5	4	4	20	7	11↑
Shadhara	12	7	9	30	7	18↑
PariveshBhawan	29	5	16	50	14	31↑
ITO BSZ Marg	17	7	13	37	6	17↑
DPCC Stations						
R.K. Puram	74	21	47	62	28	47
Mandir Marg	29	13	21	81	14	38↑
Punjabi Bagh	58	19	31	62	16	43↑
Anand Vihar	118	18	39	69	11	36
Average	29	9	16	39	10	34↑

(Source: Authors' calculations)

Table 12: O₃ µg/m³

Stations	PRE ODD EVEN			DURING ODD EVEN		
	Max	Min	Average	Max	Min	Average
DMS Shadipur	72	38	52	77	23	60↑
NSIT Dwarka	61	35	xa	107	21	73↑
DPCC Stations						
R.K. Puram	117	38	89	177	54	114↑
Punjabi Bagh	114	63	79	137	51	100↑
AnandVihar	31	15	24	61	12	45↑
Average	79	38	59	112	32	78↑

(Source: Authors' calculations)

Table 13: benzene µg/m³

Stations	PRE ODD EVEN			DURING ODD EVEN		
	Max	Min	Average	Max	Min	Average
DMS Shadipur	4	2	3	5	1	3
NSIT Dwarka	1	1	1	2	1	1
DPCC Stations						
R.K. Puram	6	2	4	8	2	5↑
Punjabi Bagh	1	0	1	1	0	1
AnandVihar	36	9	19	26	2	16
Average	10	3	6	8	1	5

(Source: Authors' calculations)

REFERENCES

1. Centre for Science and Environment. 2016. "Impact of Odd-Even Car Restriction on Air Quality and Mobility in Delhi."
2. Indian Institute of Technology Delhi. 2016. "Impact of the Odd-Even Vehicle Rationing Policy in Delhi on Air Quality and Traffic Congestion."
3. World Health Organization. 2018. "Ambient (Outdoor) Air Quality and Health."
4. Ministry of Road Transport and Highways. 2019. "Road Transport Yearbook 2018."
5. Government of National Capital Territory of Delhi. 2016. "The Delhi Maintenance and Management of Parking Rules, 2016."
6. Government of National Capital Territory of Delhi. 2016. "The Delhi Traffic Police Act, 1978."
7. World Health Organization. 2018. "Key Fact in the News."
8. IQAir AirVisual. 2018. "World Air Quality Report: Region and City PM2.5 Ranking."
9. Goel, D., and S. Gupta. 2015. "Delhi Metro and Air Pollution." Centre for Development Economics, Working Paper No. 229.
10. Goyal, S. K., S. V. Ghatge, P. S. M. T. Nema, and S. M. Tamhane. 2006. "Understanding Urban Vehicular Pollution Problem vis-a-vis Ambient Air Quality—Case Study of a Megacity (Delhi, India)." *Environmental Monitoring and Assessment* 119 (1-3): 557-569.
11. Chandrasiri, S. 1999. "Controlling Automotive Air Pollution: The Case of Colombo City." EEPSEA Research Report Series/IDRC. Regional Office for Southeast and East Asia, Economy and Environment Program for Southeast Asia.
12. The Gazette of India, Part III – Section 4, NAAQS CPCB Notification. 2009.
13. Economic Survey of Delhi. 2004. Planning Department, Government of National Capital Territory of Delhi, 6th level, New Delhi (India).
14. Air Quality Trends and Action Plan for Control of Air Pollution from Seventeen Cities, CPCB – NAAQM Series (NAAQMS/29/2006 – 07).
15. Air Quality Bulletin – January 2016. Air Lab, CPCB. Accessed http://www.c.nic.in/AQI_Bulletin_Jan2016_AirLab.pdf.
16. Sindhwani, R., and P. Goyal. 2014. "Assessment of Traffic-Generated Gaseous Particulate Matter Emissions and Trends over Delhi (2000 – 2010)." *Atmospheric Pollution Research* 5: 438-446.
17. Economic Survey of Delhi Report 2014 – 15.
18. Anfossi, D., G. Brusasca, and G. Tinarelli. 1990. "Simulation of Atmospheric Diffusion in Low Windspeed Meandering Conditions by a Monte Carlo Dispersion Model." *II Nuovo Cimento C* 13 (6): 995-1006.
19. Air Quality Status and Trends in India, CPCB – NAAQM Series (NAAQMS/14/1999 – 2000).
20. Sharma, A. R., K. Kharol, K. V. S. Badrinath, and D. Singh. 2010. "Impact of Agriculture Crop Residue Burning on Atmospheric Aerosol Loading – A Study over Punjab State, India." *Annales Geophysicae* 28: 367-379.

21. National Air Quality Index, CPCB – CUP Series (CUPS/82/2014 – 15). Envis Centre CPCB. "Air Pollution in Delhi: An Analysis."
22. Central Pollution Control Board. "Manual Monitoring." Accessed at <https://cpcb.nic.in/manual-monitoring/>.
23. Pollution Control Board. "Automatic Monitoring Data." Accessed at <https://cpcb.nic.in/automatic-monitoring-data/>.

ANALYSING THE SELF-HELP GROUP BANK LINKAGE PROGRAM IN INDIA FROM 2013-2014 TILL 2019-2020: A CASE STUDY ANALYSIS OF NORTH EASTERN INDIA

OJASVI GHAI*

CHRIST (Deemed to be University), Bangalore

Abstract

In 2015, The financial Insights Survey pointed out that the correlation between access and use of bank accounts in India is 0.59. Historically, access to credit for the poor in India has been low due to constraints like the presence of collateral and high interest rates. Due to institutional variety, regional disparities in the access and the use of bank accounts also exist. This study explores the low access to bank accounts and provision of credit in North East India against the backdrop of a high literacy rate. Through a case study analysis of the Self Help Group Bank Linkage Program in North East India, the study investigates the state of the program in North East India and poses the question, under what conditions can participation in the Self Help Group Bank Linkage Program increase? Secondary data is used for research and analysis.

JEL Classification: G21, G28, I24, I38, J16, P43, P48

Keywords: Micro finance, Self Help Group Bank Linkage Program, Financial Inclusion, Financial Literacy

1. INTRODUCTION

Access to basic financial services is essential for sustainable development. In terms of outreach and client base, India has the largest microfinance program in the world, the Self Help Group Bank Linkage Program. However, concomitantly, 56% of the debt of Indian households is unsecured, signifying that a disproportionately large percentage of Indian households rely on informal and non-institutional sources of lending (Reserve Bank of India, 2017). Poorer households hold disproportionately high levels of unsecured debt. The financial inclusion data released by the World Bank reflects that in the year 2017-2018, only 8.1% of Indians borrowed from financial institutions or used credit cards, as opposed to 32.7%. Indians, who borrowed from their friends and family (The World Bank, 2018). Further, this data leads to miscounting of the dismal situation. Calculation of the data excludes the northeastern states and remote islands as they represent less than 10% of the population. This leads to miscounting because nearly all loans that originate in northeastern states of India, originate from unsecured debt, through non-institutional sources (Reserve Bank of India, 2017).

the backdrop that the literacy rate in northeastern states is among the highest levels in the country (Mazumdar, 2020). Northeast India includes Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim. The situation of inadequate credit access in northeastern India and across states is worse than in other parts of the country. Evidently, North Eastern India has a credit-to-deposit ratio of 41%, in comparison to 44.4% credit-deposit ratio in Eastern India, 90% credit-deposit ratio in Western India and 93.2% credit-deposit ratio in Southern India (Reserve Bank of India, 2017). Moreover, the region is known for political instability (Datta, 2001) and fares the lowest with respect to parameters like the average number of factories per 1000 people (NSO, 2017) and entrepreneurship. People in the northeast parts of India depend primarily on the agriculture sector, which underscores the importance of proper access to credit. Lower per capita income and a weak industrial base are termed to be the reasons behind the low credit deposit ratio in North Eastern India (Reserve Bank of India, 2019), however, even in terms of the number of Self Help Groups, the number is lowest in North Eastern India (Kumar & Golait, 2009).

This issue of lack of financial inclusion and low Self Help Groups in North Eastern India is puzzling given

*Author's email address: ghaiojasvi14@gmail.com

Policy interventions targeted towards the poor in the form of microfinance leads to greater availability of credit (Field & Pande, 2008). Credit markets are essential in the ownership of wealth. In 2006, Deere & Doss pointed out that poverty in terms of assets signifies poverty for a long time as compared to poverty created due to lack of income. It is thus, important to investigate the reason behind the dismal state of microfinance in North East India. The study begins by providing an evolution of microfinance in India. In the following sections, it presents a review of the literature and further dwells into the case study analysis of Self Help Group Bank Linkage Program in North East India.

Evolution of Microfinance in India

In order to enhance access to finance services, India followed the approach of offering subsidised rural credit programs. The Integrated Rural Development Program is an example of the same, however, by 1989, repayment rates fell below 60% and by 2001, they had come down to 31% (Basu & Srivastava, 2005). In 1984–1985, an NGO named MYRADA first initiated Self Help Groups (Kubati, 2021). In 1976, Muhammad Yunus introduced the concept of microfinance in Bangladesh through establishing a Grameen Bank. The National Bank of Agriculture and Rural Development started the concept of microfinance in India by building on the idea laid by Muhammad Yunus in Bangladesh, thus, linking Self Help Groups that are formed and nurtured by NGO's with the Banks. The Self Help Group Bank Linkage Program was initiated as a pilot project in 1992. An overarching theme of the program is to promote financial inclusion by delivering financial services like credit at affordable costs to the poor. Through the Self Help Group Bank Linkage Program, the market-based strategy of providing microfinance was adopted. According to Satish 2005, the Reserve Bank of India provided instructions to commercial banks in 1996 that activities conducted by Self Help Groups should take centre stage under their priority lending portfolio. In 2005, the Reserve Bank of India adopted financial inclusion as a policy objective.

The Self Help Group Bank Linkage program is a dominant component of microfinance in India that is implemented by Cooperative Banks, Regional Banks and Commercial Banks. It comprises Self Help

Groups having 10–20 members and provides financial services to the people, including credit, mobilising savings and insurance.

The Self Help Group Bank Linkage program is a dominant component of microfinance in India that is implemented by Cooperative Banks, Regional Banks and Commercial Banks. It comprises Self Help Groups having 10–20 members and provides financial services to the people, including credit, mobilising savings and insurance. However, since 2008, the Microfinance Institutions in India complement the model of SHG-BLP. Microfinance Institutions include profit-driven NBFC's and socially responsible NGOs and they charged comparatively higher interest rates (Paul & John, 2010). While microfinance was largely self-regulated earlier, in the 2000s, it became more regulated and India witnessed the 2011 crisis in Andhra Pradesh, evinced by the overindebtedness of the clients and regulatory measures by the state government (Mader, 2013). The developments provided evidence for the claims of loss of moral responsiveness in microfinance (Hulme & Maitrot, 2014). In 2012, a circular by NABARD acknowledged the strengths and drawbacks of the Self Help Group Bank Linkage Program and made structural changes to the existing program in order to launch SHG-2 (NABARD, 2012).

2. LITERATURE REVIEW

Joseph Schumpeter, in 1911 provided the theoretical foundation regarding the importance of financial intermediaries and their role in enhancing entrepreneurship, leading to economic growth and technological innovation. The percentage of credit provided to entrepreneurs is positively correlated to economic growth as it leads to higher capital accumulation and improved efficiency with which economies use capital (King & Levine, 1993). While access to credit is often seen in terms of businesses that lead to higher profits and have the ability to provide collateral, there is disagreement on whether microfinance is beneficial for poverty alleviation. Fouillet, 2010 points out the extensive body of literature that monitors the development of the microfinance sector in India.

A second strand of literature accesses the impact of microfinance on poverty and empowerment. On one

hand it is argued that microfinance has led to poverty reduction (Ramath & Preeti, 2014; Mathu, 2021), another strand of thought argues that microfinance institutions cause vulnerability and financial instability for the poor (Ghosh, 2013). The argument is substantiated by the claim that the profit orientation of micro-financial institutions leads to wrong incentives and peculiar risk management. Sangwan S. & Nayak N. (2019) further argue that despite the growth of SHG and MFI, the less developed sector remains excluded and inter-regional disparities persist.

In developing countries like India, high-interest rates are not the primary factor because of which people do not borrow from formal credit sources (Duflo & Bannerjee, 2010). Tripathi, 2013, added to the literature by conducting a mapping analysis and showed that the spread of microfinance through the number of self-help groups did not happen evenly. Linggi et al., 2022, contribute to literature by looking at the evolution of microfinance in India and posit that the regional distribution of microfinance in India makes it essential to focus on the self-help group bank linkage program. Das, 2013, presents a sectoral analysis and finds that though the Self Help Group Bank Linkage Program has performed satisfactorily in Southern States, it has not done so in North Eastern States. However, literature pertaining to North Eastern states (Nath & Kumar, 2012) realises the importance of the SHG programmes, however, studies do not address the role of financial literacy, caste and institutional factors in the effectiveness the Self Help Group Bank Linkage Program in North Eastern India.

This study analyses regional disparity and frames a tentative hypothesis that states that in order to achieve a higher number of self-help groups leading to greater economic growth in North Eastern India, it is important to focus on financial literacy along with changing the societal structure of institutional norms, especially for women in terms of occupation and exogamy in the region. In the case of developing countries like India, higher education is said to lead to higher literacy and financial literacy (Abel, Mutandwa & Roux, 2018). However, this study explores the case study of northeastern India to depict how contrary to the said belief, high literacy doesn't imply high levels of financial literacy. Therefore, specific policy interventions to enhance financial

literacy and other institutional factors have a significant impact on financial inclusion of women.

3. CASE STUDY ANALYSIS - SELF HELP GROUP BANK LINKAGE PROGRAM OF NORTH EASTERN INDIA

The Self Help Group Bank Linkage Programme is a dominant component of microfinance in India that is implemented by Cooperative Banks, Regional Banks and Commercial Banks. It comprises Self Help Groups having 10-20 members and provides financial services to the people like credit, mobilising savings and insurance.

While the program is the largest in the world and is considered as a success story, when analyzed through a critical lens, it becomes evident that the outreach of the Self Help Group Bank Linkage program at the grassroot level in North Eastern India, as evident from the table below, is dismally low. The study addresses this issue against the puzzling backdrop of high levels of literacy in north-east India. The time period 2013-2014 is considered because it subsumes the effects of the structural change that took place in 2006-2007 and goes up to 2019-2020, covering the pre pandemic years.

Table 1: Regional Statistics on Self Help Group Bank Linkage Program in India

Regions	% of Self Help Groups	% of Loans to Self Help Groups
Northern	6.6	3.8
Central	11.7	6.7
Southern	48.2	71.4
Western	10.8	5.9
Eastern	19.3	10.7
North Eastern	3.4	1.5

Source: NABARD, Adapted from Kumar & Golait, 2009

In terms of demography, according to Census data, North East constitutes 3.78% of the total population of the country. The average literacy rate of the region is 78.5% while that of the country is 73% (ibid). However, alarmingly, as shown in the table below, North eastern states have the lowest levels of financial literacy in the country. For instance, Mizoram, despite having the highest literacy rate in the country at 77% has the lowest financial literacy at 6%. This depicts that high levels of literacy rates do

not imply high levels of financial literacy. Against this backdrop, the amount being disbursed through the Self Help Group Bank Linkage Program in States like Mizoram and Manipur are among the lowest in the country with no amount being disbursed in Category II districts for a majority of northeastern states.

Table 2: Amount disbursed for Self Help Group Bank Linkage Program in India, Literacy rate and Financial Literacy rate in Northeastern India

State	Amount Disbursed (Category I District) Self Help Group Bank Linkage Program (Rs in Lakh)	Amount Disbursed (Category II District). Self Help Group Bank Linkage Program (Rs in Lakh)	Literacy Rate	Financial Literacy
Arunachal Pradesh	250245.41	17803	55	10
Assam	618.89	37.99	61	20
Manipur	5.58	NA	69	36
Meghalaya	68.55	NA	60	24
Mizoram	7.86	NA	77	6
Nagaland	22.6	NA	68	8
Sikkim	53.08	NA	73	8
Tripura	183.73	0.28	67	21

Source: *Indiastat. State-wise Amount of Interest Subvention (I.S.) Disbursed to Self Help Groups (SHGs) in India (2013-2014 to 2019-2020)*

Knowledge regarding financial services is essential for financial inclusion (Barua & Sane, 2014). Self Help Groups Bank Linkage Programme caters to the problem of low access to institutional finance and bank credit by poor people living in rural areas. The program identifies that besides limited outreach and coverage, the lack of an effective credit delivery mechanism for the poor is the main reason behind the lack of access to institutional finance (DAY-NLRM, 2017). However, the analysis conducted in this study suggests that policy measures focused on enhancing financial literacy in the region is the key. Moreover, through an institutional lens, it is essential for the Self Help group bank linkage program to reach the underprivileged people living in rural areas with greater involvement of the Panchayati Raj system (Karmakar, 2009). To fulfill the motive of financial inclusion, apart from opening bank accounts, it is important for banks to put in more effort and ensure that the self-help groups reach a stage where they become independent (Dev, 2009). Dev, 2009 shows that it is evident through the NSS data that in northeastern India, scheduled Tribes have higher reliability on informal credit.

A critical analysis of the levels of informal debt in northeastern states shows that since the northeast region has the highest tribal community population in the country, therefore the scheduled cast farmers have higher informal debt. This leads to a greater scope of microfinance in the states which is not being realised to its potential.

Out of a minimum requirement of 5 women to form a self-help group in North Eastern India, the President, Secretary and Treasurer are required to be literate. In order to be registered, the Self Help group must follow Panchtantra, according to which, there should be regular meetings, regular savings within groups, internal lending based on demand, timely repayment of loans and proper books of accounts (Reserve Bank of India, 2021).

Maintaining proper books of accounts requires skill training sessions for the women. The savings-led microfinance model seeks to promote regular savings and conducts training sessions, however, as evident in a study done in the Karbi Angong District of Assam, women in tribal communities are not encouraged to participate due to their dependable nature, especially due to institutions created after marriage (Das, 2011).

This is also evident in women's work in the Naga society, where the sexual division of labour leads to women doing more household chores (Shimray, 2004). Opening of savings account for the scheme also requires KYC process of the women. During several instances, the Reserve Bank of India has instructed banks to simplify their KYC process (Karmakar, 2019), in order to ensure that maximum people get registered.

Therefore, demand side as well as supply side measures, which include disbursement of adequate funds for Category II districts are essential in order to strengthen the Self Help Group Bank Linkage Program in North Eastern region. It is essential to strengthen the institutional norms with respect to decision-making power and management of wealth to enhance financial inclusion and the participation of women.

4. CONCLUSION

The study set out to answer the question, “Under what conditions can participation in the Self Help Group Bank Linkage Program increase?”. It found that reducing the structural gap with respect to financial literacy and strengthening institutional measures like effective credit delivery mechanisms, KYC processes and decision-making power of the marginalised are required to increase participation in the Self Help Group Bank Linkage Program in the North Eastern Region. Moreover, heterogeneity among states requires for decentralized policy interventions based on the specific demography and institutional variety of the region. For example, the tribal population living in Naga and smaller districts of Mizoram and Manipur require greater financial

education and empowerment. Adequate inclusion of the people and an increase in the number of Self Help Group Bank Linkages Programs created in North East India will facilitate the shift from an agricultural economy and reduce the burden of poverty in the region. Therefore, the Self Help Group Bank Linkage program should be strengthened in North Eastern region by the inclusion of financial literacy in educational curriculums, skill training sessions for tribal communities and evolving institutional norms of patriarchy in order to increase the demand for Self Help Groups. Greater money allocation for the program even for smaller districts and hilly areas in North Eastern India and increased involvement of banks in order to register unregistered Self Help Groups is required to increase financial inclusion in the region.

REFERENCES

1. Abel S., Mutandwa L. & Roux P.L. (2018). A Review of Determinants of Financial Inclusion. *International Journal of Economics and Financial Issues*.
2. Bagli S. (2017). A Study of Multidimensional Poverty in Northeast India. *Inequality, Poverty and Development in India*
3. Barua R. & Sane R. (2014). Repayment in microfinance: The role of financial literacy and caste. *Indian Statistical Institute*.
4. Basu P., & Srivastava P. (2005). Scaling-Up Microfinance for India's Rural Poor. *World Bank Policy Research Working Paper No. 3646*.
5. Das S.K. (2011). Women empowerment and Self Help Group: An analytical study of constraints in Karbi Anglong District of Assam. *Journal of North East India Studies*.
6. Datta S. (2001) *What ails the Northeast: An Enquiry Into The Economic Factors*. Strategic Analysis.
7. DAY-NLRM (2017). *A Handbook on SHG-Bank Linkage*. Ministry of Rural Development. Government of India.
8. Deere C. & Doss C. (2006). *The Gender Asset Gap. What do we know and why does it matter?* Taylor & Francis online.
9. Duflo E. & Bannerjee A. (2010). Giving credit where it is due. *Journal of economic perspectives*.
10. Fouillet, C. & Augsburg, B. Spread of the Self-Help Groups Banking Linkage Programme in India (October 16, 2008). *International Conference on Rural Finance Research, Moving Results, FAO and IFAD, Rome, March 19-21, 2007*.
11. Field E. & Pande R. (2008) Payment Frequency and Default in Microfinance: Evidence from India. *Journal of European Economic Association*.
12. Ghosh, J. (2013). Microfinance and the challenge of financial inclusion for development. *Cambridge Journal of Economics*, 37(6), 1203-1219.

13. Hulme, D., & Maitrot, M. (2014). Has Microfinance Lost Its Moral Compass? *Economic and Political Weekly*, 49(48), 77–85.
14. Karmakar S. (2019). Financial Inclusion: Reasons for financial exclusion and re-engineering of strategies to address such issues in North East India. *A Peer-Reviewed International Journal of Humanitis and Social Sciences*.
15. Karmakar, K. G. (2009). Emerging Trends in Microfinance. *Economic and Political Weekly*, 44(13), 21–24.
16. King R.G. & Levine R. (1993). *Finance and Growth: Schumpeter must be right*. Oxford University Press.
17. Kumar A., Sonkar V.K. & Saroj S. (2020). Access to Credit in Eastern India. Implications for the Economic well being of Agricultural Households. *Economic and Political Weekly*.
18. Kumar P. & Golait R. (2009). Bank Penetration and SDG–Bank Linkage Programe: A critique. Reserve Bank of India.
19. Linggi A. et al. (2022). Financial Inclusion in Microfinance–A Case of North East India. *East African Scholars Journal of Economics, Business and Management*.
20. Mader P. (2013). *Rise and Fall of Microfinance in India: The Andhra Pradesh Crisis in Perspective*. Wiley Online Library
21. Mathu N. (2021). Progress of Self-help Group Bank Linkage Program in India. *Shanlax International Journal of Economics*.
22. Mazumdar L. (2020). Digitised Learning in North East India. *Economic and Political Weekly*.
23. NABARD (2012). SHG2: Revisiting the SHG Bank Linkage Program.
24. Nath S.G. & Kumar D.D. (2012). Micro-finance, self help groups (SHG) and the Socio-economic development of rural people (A case study with special reference to Lakhimpur district of Assam). *Journal of Research in Business Economics and Management*.
25. P. Satish. (2005). Mainstreaming of Indian Microfinance. *Economic and Political Weekly*, 40(17), 1731–1739.
26. Ramanath & Preeti (2014). Micro-finance in India–For Poverty Reduction. *International Journal of Research and Development – A Management Review*.
27. Reserve Bank of India (2017). Report of the Household Finance Committee. Reserve Bank of India.
28. Reserve Bank of India (2019). Drivers of Credit Penetration in Eastern India. *Reserve Bank of India Bulletin*.
29. Reserve Bank of India (2021). Financial Literacy by FLCs (Financial Literacy Centres) and rural Branches – Policy Review. Reserve Bank of India.
30. S. Mahendra Dev. (2006). Financial Inclusion: Issues and Challenges. *Economic and Political Weekly*, 41(41), 4310–4313.
31. Schumpeter J. (1911). *The Theory of Economic Development*. Harvard University Press, Cambridge.
32. Shimray U.A. (2004). Women’s work in Naga society: Household work, Workforce Participation and Division of Labour. *Economic and Political Weekly*.
33. The World Bank (2018). *Financial Inclusion Data*. The World Bank.

THE INDIAN MIDDLE CLASS: AN EMPIRICAL EXPLORATION

ABHIRAM LOKANATHAN*

Shri Ram College of Commerce, University of Delhi

Abstract

The paper quantitatively investigates the Indian populace belonging to the middle of its income distribution. The concept of the middle class, its qualitative transformation over history, and existing quantifications of a middle class are analyzed to arrive at a suitable definition for a middle class. Allied aspects of the middle-income class were looked into at the household level by analyzing the nutritional, educational and occupational features. Using the 68th round of the National Sample Survey, the consumption expenditure of households was used to earmark households as middle-class households. The status of education, gender disparity, nature of occupation and rural-urban differences between households that are similar in income was studied. The Indian middle class was found to be a much larger and less representative class than presumed. It has sustained better progress in some aspects of development, and this group of households 'who shall never be poor and yet never rich' does hold some potential in India's growth story.

JEL Classification: D63, I32, O53, R20

Keywords: Indian Middle Class, Monthly Per Capita Consumption Expenditure, Bourgeoisie

1. INTRODUCTION

The concept of a middle class requires no introduction. While considering a country's income distribution, it is mathematically self-evident that a class of citizens shall lie in its middle. The term middle class may refer to a group with shared values or views, but it is often intended to refer to those who fall within a particular range of incomes (Cashell, 2008). Much of our perception of a contemporary middle-class household stems from the conception of the American middle class—characterized as a four-member family with a working father and a home-making mother and school-going children, all living in a suburban villa. While this group has existed in the U.S. for decades now, they seldom represent what a middle class is in contemporary times.

This group's role in the economy is also of paramount importance. Birdsall et al. (2010) consider the middle class the backbone of market economies

and the phase of globalization, while Easterly (2001) finds nations with a larger middle class to grow faster. The fact that this is a class of individuals who are neither poor nor rich makes their role in the progress and development of an economic society enticing.

While the crude conception of a middle class begins with Marx, the idea of a not-rich-not-poor group goes back to Aristotle. He saw them as obedient members of society who would not oppose the law and would lead it to prosperity. But the middle class has been observed to be the flagbearers of social change over the years, with the most notable event being the French Revolution – a *bourgeois*-led revolution¹. Thus, the middle class becomes the educated group of rational beings best fitted to pull a society to prosperity and progress.

Unlike the poor, the middle class is seldom defined². The attributes, economic nature, and size of this group were never contemplated. The middle, especially in India, is generally overlooked and

*Author's email address: abhiramlokanathan16@gmail.com

¹Bourgeois in French means the middle class.

²Anyone living below USD 2.15/day at 2017 PPP is universally proposed as poor by the World Bank.

ignored (Bagga, 2020). And they are known for their self-identified deprivation³. The period from 2004–05 to 2011–12 in India has not only been remarkable in terms of expansion in new middle-class size, but this growth has also been geographically and socially inclusive (Krishnan & Hatekar, 2017).

Thus, this paper explores middle-class households, identifying them to begin with, and then explaining their attributes. The following section reviews the existing literature on the middle class, followed by an empirical study to estimate the middle class's size. After that, the objectives and methodology have been briefly described. The empirical exploration of the Indian middle-income class, their size, characteristics, achievements and aspirations, and the findings have been discussed before concluding and discussing the scope for further studies.

2. LITERATURE REVIEW

The set of existing literature in the domain of the middle class has been studied extensively in this section. Special efforts have been given to learning the historical evolution of the middle class by studying them through Aristotle's *mesoi*, the early-modern European *Bourgeois*, the Marxian Petty *Bourgeoisie* and the contemporary American middle class.

First, the theoretical diction in this matter, specifically the works by Aristotle and Marx and the conception of a *Bourgeois* and the American middle class, was explored. Then, the empirical studies on the middle class were studied, and a disunity among the experts in determining the defining characteristics of the middle class was observed.

2.1. NOTIONS ON THE MIDDLE-CLASS OVER THE YEARS

Aristotle (384 BC – 332 BC) was the first to acknowledge the existence of a middle-income class in society. His notion of social structure rises from Solon's classification of land ownership and affirms that '*virtue can be practised with moderate resources*'

(Rocher, 2021). He defines this 'moderately endowed' class as the *mesoi*⁴ – the '*moderately well-to-do peasant, capable of fighting as a hoplite*' (Aristotle, 350 BCE, 1905). Calling this group as 'many' or 'people', he merely accredits the virtues of the middle class and fails to objectively propose their pecuniary characteristics. But, he doesn't fail to forge the *mesoi*'s role in society. He identifies theirs as a very high trait in the virtue of the citizen. Unlike the “over-handsome, over-strong, over-noble and over wealthy”, rich or the “over-poor, over-weak and utterly ignoble” poor, *mesoi* never indulge in violence and roguery. They are neither greedy nor envious and know how to govern and be governed as free citizens.

In short, Aristotle's *mesoi* are the most desirable members of the democratic city-states in Aristotelian times (Aristotle, 1905; Glassman, 1995). They respect the law. Unlike the debased poor or arrogant rich, they are the actual choice makers choosing the rulers. While some states can be democracies of the poor and others may be oligarchies of the rich, only a *meso polieata* shall thrive due to the distinct features of its ruling group⁵. Thus, for the political system to reach a long-term equilibrium, the *mesoi* shouldn't degenerate to join the poor or grow too powerful to ebb the rich (Rocher, 2022).

The middle class rose to their superstardom by the 17th–18th centuries, especially with the English Glorious Revolution of 1688 and the French Revolution of 1789 (Tripp, 1994; Clay, 2014). The now famous term '*Bourgeois*' came to refer to the middle class in this period⁶. Still, it generally denoted the newly risen class of educated individuals who were "*ambitious yet politically and socially frustrated*" (Clay, 2014).

John Locke was the first proponent of this class's social power in driving social order and turning the tide of history to their benefit. His ideas saw England going from a monarchy to totalitarianism to a parliamentary monarchy, steered by a revolution of the intellectually rich. These ideas also significantly contributed to the French revolutionary thinkers such as Rousseau, Marat and Montesquieu.

³Because they are desperate to be rich someday and hence, lament their inability to be flamboyant. The cliché statement “*Hum toh middle class hai*” (we are [the unfortunate] middle class) has also found a reference in popular culture.

⁴Meaning, 'people of the middle'

⁵*meso polieata*: a state ruled by the middle class.

⁶The term meant a town dweller of pre-revolutionary feudal France

Despite all the existing diction, no one has ever discussed class as profoundly as Marx. He was also one of the premiers to term the French Revolution a bourgeois revolution. However, the Marxian interpretation of a bourgeois, at least in his later writings, is different from the conventional notion seen above, in the sense that Marx identifies a *Bourgeoisie* as the class that owns the means of production in a capitalist society. Thus, the modern interpretation of the bourgeoisie differs from the 18th century interpretation of the same term (revolution, n.d.). Marx's bourgeoisie is undoubtedly the affluent class, and the group with the 'middle class-esque' character might be a part of the proletariat. Hence, for Marx, the middle becomes a *transitional class* comprising individuals who "*control money capital ... [and] lack the investment necessary for accumulating surplus value, but need not sell their physical labour to survive*" (Aslany, 2019).

Marx praises the middle class for having "*created enormous cities ... [and] rescued a considerable part of the population from the idiocy of rural life*" apart from having "*pitilessly torn asunder the motley feudal*" and "*drown the heavenly ecstasies of religious*" (Marx & Engels, 1848). Like Aristotle, Marx also points to the dynamics of this non-resource-owning and non-labour supplying middle-class. Claiming that the lower-middle class's capital shall not fit modern industrial society's needs. At the same time, the richer bourgeois faction shall grow up to become a supplementary part of the bourgeoisie class.

Thus, Marx proposes that in a modern (and also capitalist) society, the middle class shall fluctuate into proletariat and bourgeoisie, ultimately ceasing to exist. Nevertheless, like many of Marx's predictions, the middle class has not 'died out' since modern capitalist tendencies work disproportionately across countries. While they have lost their edge in some nations, they are numerically and politically dominant in others (*Petite Bourgeoise*, n.d.).

Despite all the historical interpretations the middle class has been subjected to, the contemporary times' middle class can be seen as very different from all these conceptions. The concept of the middle class in the current set-up stems from the Post-Fordist

American society. A middle-class man is an embodiment of the self-fulfilling capacity of the American dream. The notion of a middle-class household is that of someone with an (inherent) capacity to climb up the social ladder and become wealthier and more successful.

The American way (of capitalism, democracy and mass production) proved to be befitting the middle-class aspiration as it could give them access to "*more choices, better quality, liberty and rights*" (Swain, 2020). They also exhibit a subject of passion, a realization that working fulfils the self, leading to personal development and growth without material outcome (Farrugia, 2019). Mills (1969) attributes the growth of the middle class to the expansion of white-collar occupation through the rise of big business and big government, the consequent trend of modern social structure and the steady growth of bureaucracy.

The middle class is also responsible for pushing the economy further through its walk, like the middle class (Bledstein, 2001)⁷. The qualities of a middle-class, bootstrap mentality - to rise from nothing into something - and ownership of property (as the first instance of attainment), as identified by *Elements of the American Dream* (n.d.), still define the middle class to a great extent.

Thus, the middle class has historically played a critical role in the economy by pulling the socio-political and economic systems forward through their ambitions, aspirations and effort. Even the conventional Indian belief considers the Indian Middle class to be at par with their American counterparts and expects it to play these roles. This conception shall be taken forward further in this paper and serve as our definition/conceptualization of the Indian middle class.

2.2. ONE MIDDLE CLASS - MANY DEFINITIONS

In any empirical study, the premises constructed play a critical role. For this, arriving at a precise definition for the middle class is crucial. However, a commonly agreed upon working definition has always been debated among the stalwarts in this domain. The identification of a class, especially the middle

⁷Middle-class walk- shop at the same stores, go to the same schools, enter the same professions, work out at the same clubs, patronize the same doctors, purchase the same commodities, and aspire to the same lifestyle.

class, can be taken as a heuristic device⁸. Unfortunately, numerous studies have found self-identification to be intransitive in the case of the middle class (Vaishnav et al., 2017; New York Times, 2005). Some studies have even attempted to demarcate the middle class through their consumption pattern. Krishna & Bajpai (2015) were the premiers defining a middle class by the ownership of assets such as cars, two-wheeler, air conditioners, and ceiling fans inter alia⁹. Aslany (2019) goes further in this regard and finds a multidimensional definition for the middle class. Households are weeded out based on their threshold income, education, social network, housing, etc., and then calling the households that remained in the middle class. Similarly, Nayab (2011), in his study of the middle class in Pakistan, utilized the method of Principal Component Analysis to condense multiple indicators of living quality to arrive at an index score and then identify those lying in the middle for further research.

Most studies have proceeded by identifying specific characteristics of the household, such as its income or consumption. And as mentioned earlier, middle-class welfare has always been outside the policy sphere; therefore, no official definition exists. Various experts have proposed various definitions for a middle class, with some defining the bounds based on the relative position of income while others are on absolute

income levels. The variety, and disunity, among the existing studies defining the American middle class, can be seen from the representation in fig. 2.2.1 below.

The most popular income-based definition has been given by Banerjee & Duflo (2008). They defined an Indian middle-class household with a daily per capita expenditure of USD 6 to USD 10 in Purchasing Power Parity terms. Unsurprisingly, they also find that the middle class consists of households engaging in fruit and vegetable vending, selling milk and collecting errands. The National Council of Applied Economic Research (2010), gives a mildly different interpretation of the middle class, calling them the households earning between INR 200,000 and INR 100,000 in 2001 prices. It translates approximately to USD 12 to USD 20 in 2001 PPP terms, meaning that the Indian middle class may be almost at par with their American counterparts in terms of economic power. Interestingly enough, these studies also imply that someone who will be middle class in a developing state would be poor as per the standards of the rich and developed world.

On the contrary, the latter set of definitions looks at households in terms of their relative position within their country. Thurow (1987), the premier in this regard, defines the U.S. middle class as those falling between 75% and 125% of the median income.

Figure 2.2.1: American Middle Class, as defined by 12 different studies



Source: Reeves et al., 2018.D

⁸The socioeconomic behaviour of households does not follow a single-shot formula. Therefore, classes cannot be seen descriptively- in terms of averages. But terming them based on wealth concentration, political aspirations or self-identification is also seen to be unidimensional. For further details see Sterns (1979).

⁹Items typically households who own consumables that a poor household shall never have

Similarly, Salverda & Jong (2017), classify the Dutch middle class as earning between 60 per cent and 200 per cent of the national median income. However, the definition by Pew Research Centre (2015) of any household that expends greater than two-thirds but less than twice the median consumption spending of all the country's households remains the most popular. Apart from varying bounds set by various definitions, none of the studies significantly depart in their rationale or approach. Nonetheless, the fact that different definitions lead to hugely different upper and lower bounds of income means that we shall also reach hugely different middle-class sizes (a fact clarified even by fig 2.2.1).

In the case of the multidimensional and self-reporting-based indicators, the studies arrived at bolstered results without many insights. The data required for these studies were highly granular and thus difficult to obtain. Hence such a methodology was ignored for our study. The definitions based on absolute income levels were also felt to be of little use in the context of India. As noted by Banerjee & Duflo (2008), the lower income bound for the middle class in many developing countries falls above the 80th percentile and even the 90th percentile! Hence, a constrained definition was also ruled out.

A careful study of deciles and quintiles allows for comparing distribution in different societies by estimating the shares of national wealth and income going to each group (Piketty, 2013; Ricci, 2020). Thus, our study takes the meaning of the middle class literally, considering households lying in the middle of the income distribution. The definition is based on relative income levels proposed by Pew Research Centre (2015).

3. OBJECTIVES

From the review of the existing literature, it is clear that the role the middle class plays in an economy is not negligible. From maintaining political stability

(Aristotelian Middle class) to directing historical evolution (Lockean middle class) to pull the economic engine forward (Easterly's middle class), this group plays a very significant social, political and economic role. The middle class, in this sense, becomes the group of households with stable jobs, good education and abstaining from violence. The near neglect of this group from the policy sphere, especially in a bustling economy like India, is problematic. It is also relevant to study the middle class' status in India since most studies have limited themselves to calculations of the headcount of the income middle class with little progress beyond that. The defining characteristics of the income middle class, their achievements in life and the dreams and aspirations that arise out of this all remain largely unknown. Hence, this paper shall attempt to decipher these aspects of India's Income middle class through an expository approach. The analysis attempts to answer the following questions:

- i. What income bracket sets the bound for the income middle class in India?
- ii. What are the defining attributes of this income group? Is there a disparity being observed within these households?
- iii. How do the findings concur with earlier analyses?

4. METHODOLOGY

4.1. DATA

This 68th Round National Sample Survey Household Consumption Expenditure data was used since it was the most recent and comprehensive data containing information at the household level¹⁰. The dataset contains the details about the location of residence, the industry of occupation, ownership of assets, type of dwelling, level of education, etc., of over 2,83,059 individuals from 1,01,662 households (NSS, 2011a). To segregate households based on income, we consider the Households' Monthly Per capita Consumption Expenditure for a Mixed Reference Period (MPCE-MRP)¹¹.

¹⁰Expenditure in the country during the period from 2011-12. The dataset provides information on the households' expenditure on food, durables, health and education, among other things, along with insights into health, nutrition, education and fertility. This has been collected from a nationally representative, a cross-sectional panel of the Indian populace. NSSO has employed a multistage stratified random sampling of stratifying 7469 rural and 5268 urban areas in the 28 states and 7 Union Territories of India (as in 2012).

¹¹MPCE reports the total of the monetary values (actual and imputed costs) of all items (except housing) consumed by the household on domestic account during the reference period (NSS, 2011b), and MRP refers to the fact that the MPCE measures consumption of five low-frequency items (clothing, footwear, durables, education and institutional health expenditure) over the previous year, and all other items over the previous 30 days (Gaur & Rao, 2020).

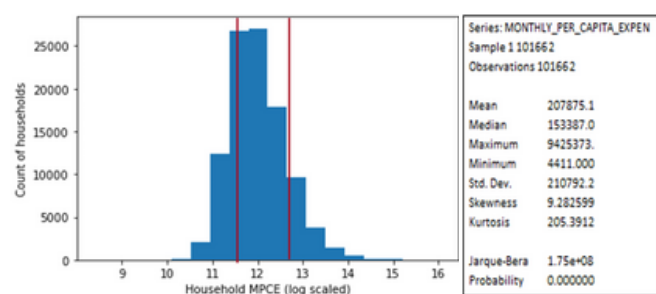
4.2. STATISTICAL ANALYSIS

All calculations and plots were performed using Pandas and matplotlib.pyplot libraries on Python. Further, specific variables were chosen to define various characteristics of the households. We analyse the effect and interplay of various factors in the middle-class population to observe the economic, occupational and social features of middle-class households and the rural-urban differential. An attempt was also made to illuminate the households' nutrition, health and education achievements. Given that the paper's primary objective has been to provide a realistic picture, only descriptive statistical techniques are employed. Advanced statistical techniques have been deliberately overlooked.

5. FINDINGS

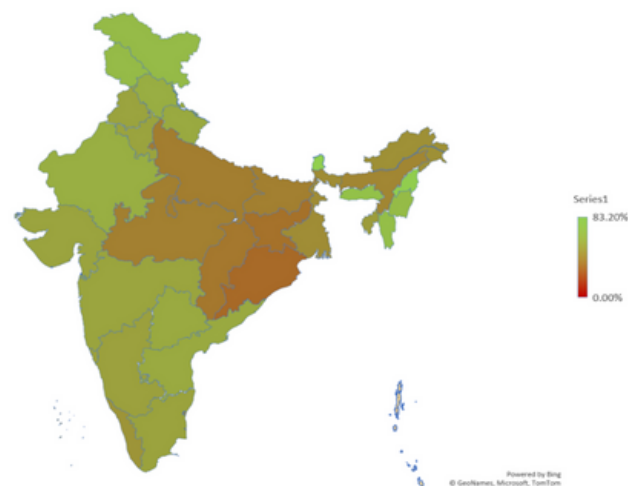
Figure 5.1 below has been derived from the data of Monthly Per Capita Consumption Expenditure data, and the income distribution thus attained has a median value of INR 153,387. Accordingly, a middle-class household was found to have an MPCE between INR 102,258 and INR 306,774, implying that around 61.1% of India's households qualify as income middle-class households. The size of the middle class thus estimated is used for further analyses. It is critical to note that the income thresholds in terms of MPCE alone fail to give us significant insight as they comprise all households' monetary and non-monetary expenditures. Hence, the value of MPCE has not been used for drawing further insights.

Figure 5.1: Income distribution of Indian households and descriptive statistics



Source: Author's elaboration

Figure 5.2: State-wise distribution of Middle-Class size



Source: Author's elaboration

Figure 5.2 above shows an almost uniform distribution across the states in the distribution of middle-class populations. The Eastern states, expectedly, tend to have a lower number of middle-class households. On the other hand, the northeastern states have the most significant number of middle-class households. The belt of wealthy states, vis. Maharashtra, Gujarat, Haryana, and Punjab comparatively have lesser middle-class households. The state of Sikkim has the highest middle-class population at 83.20 per cent, while the state of Odisha has the lowest population of the middle class at 42.55 per cent. The proportion of the middle class in Indian states varies around a mean value of 62.01 per cent with a variance of 0.011.

With the insight into the number of households in India that can fall into the bracket of income middle class, we move on to find the household's characteristics and the rural-urban differential. In the urban areas, the middle class comprises 58.16 per cent of the total households. Around 69.34 per cent of them own their own houses and have an average of 4.4 members. Minorities such as Muslims are seen to have a greater propensity (at 63.12 per cent) to fall into the middle-income bracket. More importantly, most of the urban middle-class households (57.7 per cent) are non-salaried and are either self-employed (running petty shops, rickshaw driving or similar) or wage-earning (engaged in the informal sector). The households, on average, do not consume three full meals a day¹².

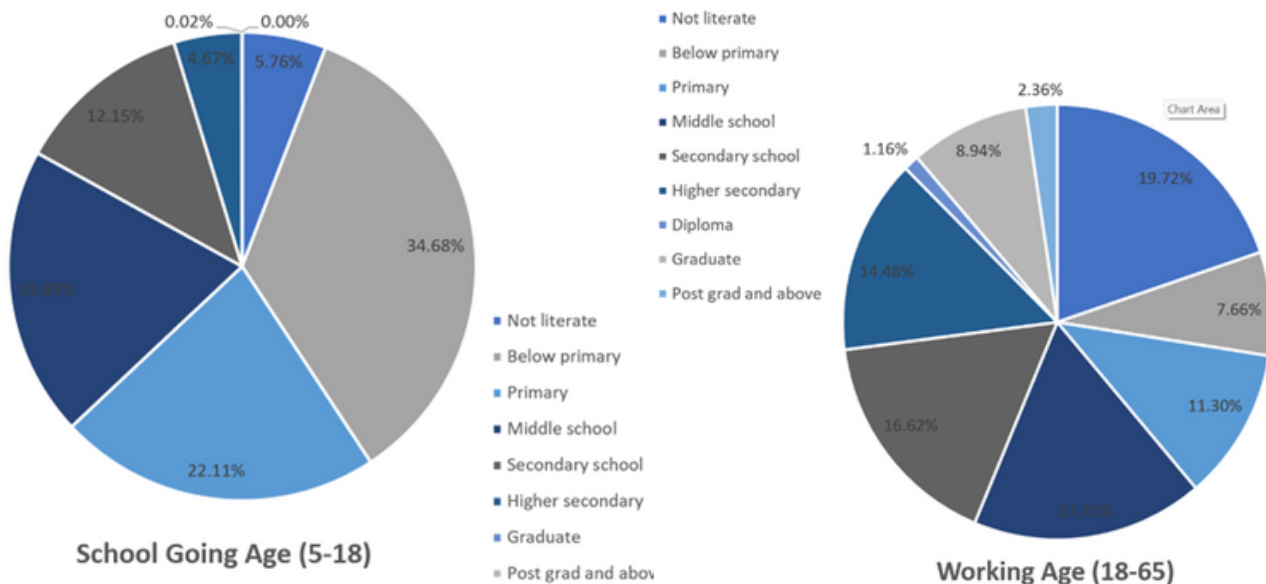
¹² Meals contain only those foods taken by an individual, comprising primarily of cereals but satiating the minimum required nutrition and excluding high tea, snacks and *nashta*.

On the other hand, rural households comprise around 63.17 per cent of the rural population. 94.61 per cent of them have property of their own, with an average of 4.6 members. Among rural minorities, Christians have a greater propensity (70.69 per cent) to be in middle-class households. Similar to findings in urban areas, rural households are also noted for being majorly non-salary earning, at 74.69 per cent. 55 per cent are agriculturalists (largescale farmers) or are self-employed in non-agricultural activities (such as shopkeeping, truck driving, etc.). Like their urban counterparts, the rural middle class also doesn't have three meals daily on average.

The middle class is also seen to be attaining more significant levels of education, thereby becoming to befit the French bourgeois. While the members of a

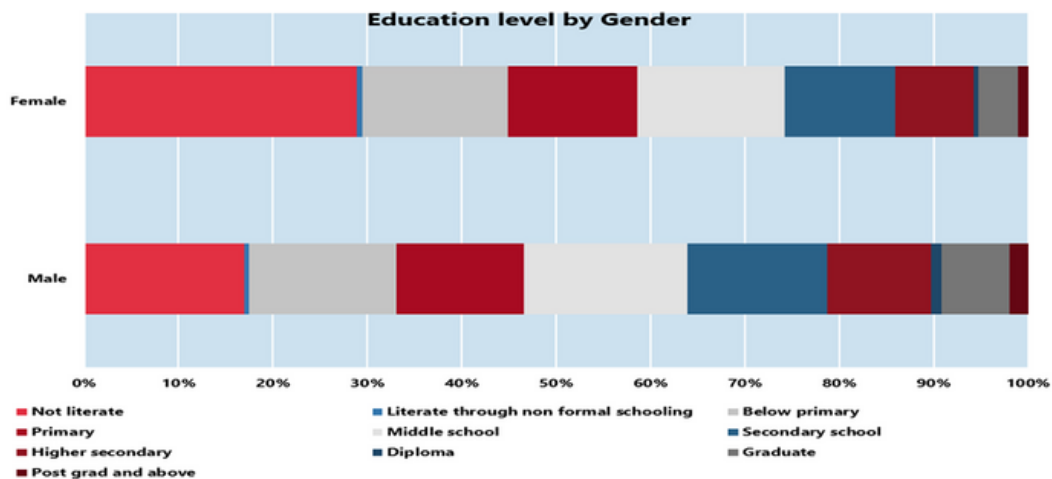
middle-class households of working age have not gained much education, the school-going aged children are noted to be attending schools. Most school-going age members are seen to have attended at least some schooling, with over 50 per cent of the children having attended more than primary schooling. It is a positive sign for the future of the middle class. The transformation of India into a knowledge economy can well be geared toward the middle class. Unsurprisingly, the educational attainment of the working age shows a bleak image. While about 20 per cent have never seen the school, only slightly more than 11 per cent have attained a college degree. Middle-class households are also noted to have a lesser level of gender inequality, especially regarding educational attainment and household participation.

Figure 5.3: Educational attainment of middle-class households



Source: Author's elaboration

Figure 5.4: Educational level by gender of middle-class members

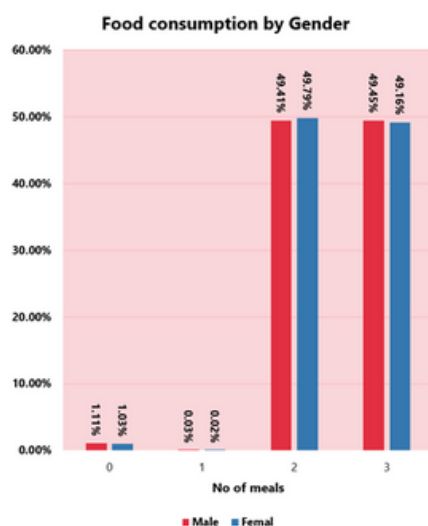


Source: Author's elaboration

While many females (28.89 per cent) are still noted to be illiterate against 16.91 per cent of men, almost equality is observed at levels of schooling with almost the same number of males (45.64 per cent) and females (41.05 per cent) attending primary, middle and secondary school. A strong skew in favour of males is then again noted in higher education levels, with the proportion of women (4.18 per cent) with an undergraduate degree falling to almost half the level of middle-class men (7.26 per cent) with an undergraduate degree. Given the U-shaped relation between education and Female Labour force Participation¹³, more females enter the job market upon education beyond schooling. The marginal attainment of school education of females shall go wasted, since, women with just a school education tend to be completely out of the job market.

An almost equality is also observed regarding the number of meals consumed by men and women. The number of women taking two meals a day exceeds that of men only by a meagre 0.38 percentage points. Similarly, the number of men taking three meals exceeds women only by 0.29 percentage points. While these findings are largely inconclusive, they do provide a shred of possible evidence for a comparatively better position for females in middle-class households.

Figure 5.5: Gender-wise consumption of meals



Source: Author's elaboration

6. DISCUSSION & CONCLUSION

From our analysis, it is clear that the Indian middle class is not precisely as perceived. Given the sheer amount of this group, we may conclude that the middle class has an untapped potential within itself¹⁴. Their almost uniform distribution across the states also tells us that the middle class ought to be a deciding factor in various affairs of each state. The levels of education attained by this group in totality are worth to be mentioned. Even uneducated and illiterate parents are seen to be sending their children to schools. The study also reveals that the Indian middle class is not composed of an overwhelming majority of skilled workforce but of labourers and non-skilled workers. The absence of factory-going men, like in the case of the American middle class, is visible here, with income opportunities being tapped in from other avenues. With the number of school-going children rising, it also becomes necessary from policymakers' end to ensure that these students go up to college and gain education to become skilled labour force.

The relative absence of gender segregation within middle-class households also throws a positive light on the efforts in this regard. With certain evidence of a better position for women in these households, we are safe to say that women will also end up securing better education. We may see greater participation of middle-class females in social life, contributing to a higher FLPR. Apart from income, the middle class is also seen as sufficiently wealthy to own property—mostly inherited (especially in rural areas). Hence, the role that bequeaths and inheritances play in the income security of these households needs to be explored further.

However, the nutrient intake and balance of the households remain a matter of concern. The case of not eating three meals a day cannot be seen lightly¹⁵. Even though clarity is required on the meal timings, the inability of the households to have three full

¹³See Desai (2016)

¹⁴It is admitted that the size is indeed impacted by the definition in use. As discussed earlier, we know that a modern middle class, ideally, have the attributes of the American middle class. Hence, I used the most ideal definition, from the American context, and used it for India. This could help us to see if the Indian middle class does show the ideal 'middle class' characteristics.

¹⁵While contemporary researchers cite the sufficiency of 2-3 meals a day, it is important to note that the timing and nutritional completeness of the meal, inter alia, have a significant impact on overall health. This makes three square meals spread through the day necessary for better metabolism. For details, one can refer; Paoli, A., Tinsley, G., Bianco, A., & Moro, T. (2019). The Influence of Meal Frequency and Timing on Health in Humans: The Role of Fasting. *Nutrients*, 11(4), 719. <https://doi.org/10.3390/nu11040719>

meals despite earning sufficient income is counterintuitive. Unlike the poor, whose primary objective of nutrition is sustenance, a middle class's primary objective in nutrition must be that of having a nutrient-rich, balance diet. This also necessitates further foray into what the middle class is eating. Nonetheless, seeing that the middle class is just eating twice a day, can be directly linked to their nature of work. As seen above, most middle-class households are engaged in self-employed activities, so they seem to be skipping their afternoon meals to work a bit more and earn a few more dimes. This also suggests that an increase in income (which pushes the household into the middle class's bracket) still doesn't translate into freedom to have healthy meal. As this income is non-certain and agents find themselves better off, income wise, by skipping a meal.

7. LIMITATIONS AND SCOPE FOR FURTHER RESEARCH

It is realized that the chosen definition of the Middle class had loosely impacted the perspectives of the paper. The paper endeavoured to throw more light into the day-to-day life of the 'not-poor-but-not-rich' group of households in the country that has found many mentions in daily conversations and pop culture. The perspectives covered in the paper were also chosen to give a comprehensive perspective on the entire income group. However, much scope lies in exploring each of the considered variables into separate works utilizing regression analyses to prove inter-causality. Additionally, the definition of the middle class needs to be expanded and developed beyond income-based measures into multidimensional definitions accounting for temporal analysis revealing the transformations this class has witnessed over the years of economic development in India.

REFERENCES

1. Aristotle. (1905). *Aristotle's Politics*. Oxford: Clarendon Press,
2. Aslany, M. (2019). The Indian middle class, its size, and urban-rural variations. *Contemporary South Asia*, 27(2), 196–213. <https://doi.org/10.1080/09584935.2019.1581727>
3. Banerjee, A. V., & Duflo, E. (2008). What is Middle Class about the Middle Classes around the World? *Journal of Economic Perspectives*, 22(2), 3–28. <https://doi.org/10.1257/jep.22.2.3>
4. Birdsall, N., Graham, C., & Patinate, S. (2000). Stuck In The Tunnel: Is Globalization Muddling The Middle Class? In Brookings. Center on Social and Economic Dynamics. <https://www.brookings.edu/wp-content/uploads/2016/06/midclass.pdf>
5. Bledstein, B. J., & Johnston, R. D. (2001). *The Middling Sorts*. Routledge.
6. Bourgeois/Bourgeoisie · LIBERTY, EQUALITY, FRATERNITY: EXPLORING THE FRENCH REVOLUTION. (n.d.). <https://revolution.chnm.org/d/1066>
7. Class Matters - Social Class in the United States of America - The New York Times. (2005, May 15). <https://archive.nytimes.com/www.nytimes.com/indexes/2005/05/15/national/class/index.html>
8. Clay, L. R. (2014). *The Bourgeoisie, Capitalism, and the Origins of the French Revolution*. Oxford Handbooks Online. <https://doi.org/10.1093/oxfordhb/9780199639748.013.002>
9. Desai, S. (2015). Demographic deposit, dividend and debt. *The Indian Journal of Labour Economics*, 58(2), 217–232. <https://doi.org/10.1007/s41027-016-0020-9>
10. Easterly, W. (2001). The Middle-Class Consensus and Economic Development. *Journal of Economic Growth*, 6(4), 317–335. <https://doi.org/10.1023/a:1012786330095>

11. Elements of the American Dream. (n.d.). The Simpsons and Family Guy on the American Dream. <https://animatedsatire.weebly.com/elements-of-the-american-dream.html>
12. Farrugia. (2019). How youth become workers: Identity, inequality and the post-Fordist self. *Journal of Sociology*, 55(4), 708–723. <https://doi.org/10.1177/1440783319865028>
13. Gaur, S., & Rao, N. S. (2020). POVERTY MEASUREMENT IN INDIA: A STATUS UPDATE. Ministry of Rural Development. https://rural.nic.in/sites/default/files/WorkingPaper_Poverty_DoRD_Sept_2020.pdf
14. Glassman, R. M. (1995). *The Middle Class and Democracy in Socio-Historical Perspective* (1st ed.) [English]. E J Brill. https://books.google.co.in/books?id=wJDLkxHy_tsC&lpq=PP6&pg=PP1#v=onepage&q&f=false
15. Krishna, Anirudh and Devendra Bajpai (2015): "Layers in Globalising Society and the New Middle Class in India: Trends, Distribution and Prospects," *Economic & Political Weekly*, Vol 50, No 5, pp 69–77.
16. Krishnan, S., & Hatekar, N. (2017). Rise of the New Middle Class in India and Its Changing Structure. *Economic and Political Weekly*, 52(22) : (40–48). https://www.researchgate.net/publication/317345165_Rise_of_the_New_Middle_Class_in_India_and_Its_Changing_Structure
17. Marx, K., & Engels, F. (1848). *Manifesto of the Communist Party* [German]. In *The Communist Manifesto*. [https://www.marxists.org/archive/marx/works/1848/communist-manifesto/\(Original work published 1847\)](https://www.marxists.org/archive/marx/works/1848/communist-manifesto/(Original%20work%20published%201847))
18. Mills, C. W. (1968). *White Collar: The American Middle Classes* [English]. Oxford University Press, USA.
19. National Sample Survey Organisation. (2011). *Instructions to Field Staff, Vol. I: NSS 68th Round*. Ministry of Statistics and Programme Implementation.
20. National Sample Survey Organisation. (2011). *Key Indicators of Household Consumer Expenditure in India*. Ministry of Statistics and Programme Implementation.
21. Nayab, D. (2011). Estimating the middle class in Pakistan. *The Pakistan Development Review*, 50(1), 1–28. <http://arks.princeton.edu/ark:/88435/dsp01gb19f8047>
22. petite bourgeoisie. (n.d.). Oxford Reference. <https://www.oxfordreference.com/view/10.1093/oi/authority.20110803100320389>
23. Pew Research Centre. 2015. "The American Middle Class Is Losing Ground: No longer the majority and falling behind financially." Washington, D.C.: December.
24. Piketty, T. (2014), *capital in the twenty-first century*. Cambridge, MA: Harvard University Press.
25. Reeves, R. V., Guyot, K., & Krause, E. (2022, March 9). A dozen ways to be middle class. Brookings. <https://www.brookings.edu/interactives/a-dozen-ways-to-be-middle-class/>
26. Ricci, C. (2020) How to measure the middle class: approaches from economics, in DASTU Working Paper Series, n. 04/2020 (LPS.11).
27. Salverda, W., & Jong, E. de. (2017). *The Dutch middle class in times of growing income inequality 1990–2014*. Amsterdam Institute for Advanced Labour Studies. <https://aias.s3-eu-central-1.amazonaws.com/website/uploads/1489657555757WP-171---Salverda,-De-Jong.pdf>
28. Sancho Rocher, L. (2022). Aristóteles y la posibilidad de una mése politeía. *Araucaria*, 49, 330–351. <https://doi.org/10.12795/araucaria.2022.i49.17>

30. Sterns, P. N. (1979). The Middle Class: Toward a Precise Definition. *Comparative Studies in Society and History*, Vol. 21(No. 3), 377–396. <https://www.jstor.org/stable/178535>
31. Swain, S. (2020). WINNING OVER: THE STATES' TAKE. *ARTHA*, 45–48. <https://www.ecosocrcc.com/artha/2020.pdf>
32. Thurow, L. C. (1985). A Surge in Inequality. *Scientific American*, 256(5), 30–37. <https://www.jstor.org/stable/24979382>
33. Tribune News Service. (2020, May 6). â Interests of middle-class being ignoredâ . Tribune India News Service. <https://www.tribuneindia.com/news/amritsar/interests-of-middle-class-being-ignored-81027>
34. Tripp, T. (1994). An outline of philosophy. 6. John Locke. Marxists. <https://www.marxists.org/history/australia/1970/philosophy6.html>
35. Vaishnav, M., Sircar, N., & Kapur, D. (2017, November 24). Three Economists Went Around India Asking: Do You Call Yourself Middle Class? Carnegie Endowment for International Peace. <https://carnegieendowment.org/2017/11/24/three-economists-went-around-india-asking-do-you-call-yourself-middle-class-pub-74828>

EXPLORING THE PROBLEMS AND SOLUTIONS OF ATTITUDE-BEHAVIOUR GAP IN SUSTAINABLE CONSUMPTION

ANJALI BHARDWAJ, ANNIE SHRESTHA, SHRUTI GAUBA*

Indraprastha College for Women, University of Delhi

Abstract

Sustainable consumption refers to the judicious use of materials, products, energy, and immaterial services that minimise negative impacts on our environment. The Value-Belief-Norm (VBN) theory explains the influence of human values on behaviour in environmental issues. Nudges have been known to encourage people to make certain decisions without using coercion. This paper attempts to find out if behavioural interventions help increase pro-environmental choices in a sample with similar values, beliefs, and attitudes towards environmentalism. Moreover, we aimed to see to what extent attitudes fail to be reflected in consumer behaviour. Primary data was collected from the urban and educated population in the Delhi-NCR region in India and Kathmandu in Nepal. The survey was divided into two parts: a market simulation for observing consumer behaviour and a questionnaire to assess participants' attitudes towards environmental issues and sustainable consumption. The sample was divided into one treatment and one control group, wherein the former was exposed to behavioural interventions in the market simulation. The study concludes with 95% confidence that the tested interventions have encouraged participants in the treatment group to choose more sustainable products than members of the control group. Based on these observations, this paper also suggests behavioural policies that can be implemented to reduce the attitude-behaviour gap in the context of sustainable consumption, thus contributing to helping India achieve its sustainability goals.

JEL Classification: D120, D910, Q580

Keywords: sustainable consumption, values belief norm theory, behavioural interventions, market simulation, environmental impact

1. INTRODUCTION

Every purchase of a product or service has an environmental impact and implications. Sustainable consumption is the practice that minimises negative impacts on the environment, ensuring that the present generation's consumption does not compromise the future generation's opportunity to consume. Each purchase contributes to a more or less sustainable pattern of consumption. While considering what to purchase, individuals engage in a complex process of decision-making that can be motivated and demotivated by multiple factors.

A significant body of knowledge has identified motivators for consumption, especially those of a sustainable nature. The Theory of Planned Behaviour (TPB), Norm-Activation Theory (NAT), and VBN (Value- Belief-Norm) are the main theories applied in research on environmental behaviour. First established by Stern et al., the VBN framework presents the influence of human values on behaviour in issues related to the environment. Stern (2008, p. 366) stated that behaviour is triggered "when an individual comes to believe that a personal value is threatened and that he or she can relieve that threat by appropriate action".

Corresponding author's email address: shrutigau04@gmail.com

Many studies have empirically validated the variables of the VBN framework. Researchers have used the framework to predict pro-environmental behaviours, but only a few have suggested that social norms, which oblige people to act in a certain way, contribute minimally to affecting such behaviours. In the Indian context, however, Kala & Sharma (2010) have found that social and cultural norms are highly influential in having a pro-environmental attitude. This paper attempts to find out if behavioural interventions help increase pro-environmental choices in a sample with similar values, beliefs, and attitudes towards environmentalism. These behavioural interventions include positive positioning of products, labelling, the bandwagon effect, and information provision. Moreover, we aimed to see to what extent attitudes fail to be reflected in consumer behaviour while also accounting for social norms as an extension of the VBN framework. The rest of the paper is structured in the following manner: Section 2 provides an overview of the existing literature on sustainable consumption and behavioural interventions. Section 3 entails the research methodology, segueing into the details of the study population, study 5 materials, and analysis procedures. Section 4 includes a detailed discussion of the results and observations, and lastly, Section 5 concludes the study. The references for this paper, followed by the Appendix section, can be found at the end.

2. LITERATURE REVIEW

2.1 VALUE BELIEF NORM FRAMEWORK

In India, Francis and Sarangi (2022) used the Value Belief Norm framework, showing that awareness of current environmental problems is positively correlated with higher literacy rates. Surprisingly, millennials from big cities were found to be less engaged in sustainable consumption and have a lower willingness to sacrifice than millennials from smaller cities. Wang et al. (2021) illustrate in their study that individuals do not necessarily decide to consume sustainably based on their attitudes. Several other factors also influence sustainable consumption intentions, like high prices, the inaccessibility of products, inexperience with green consumption, and a lack of trust in the products' quality.

Significant work has been done with the utilisation of a choice-based approach to environmental behaviour. Rokka and Uusitalo (2008) use the framework and conclude that price, packaging feasibility, and brand were important product attributes in the consumer's choice in the mentioned order. Antonetti and Maklan (2014) aimed to study whether pride and guilt can influence the choices consumers make while purchasing sustainable products and went on to explain why this may or may not be the case. The study found that feelings of guilt and pride, activated by a single consumption episode, can regulate sustainable consumption by affecting consumers' general perceptions of effectiveness. After experiencing guilt or pride, consumers see themselves as the cause of relevant sustainability outcomes. Grebitus et al. (2020) conclude that environmental concerns did not play a huge role in consumers' decision-making; instead, cost and convenience did. Introducing a nudge, i.e., giving pro-environmental decision guidance, to make environmentally friendly choices did modestly improve consumers' choices.

2.2 NUDGES

Nudges and other behavioural interventions have been implemented in many studies to encourage environmentally friendly consumption behaviour. Vigours (2018) introduced four types of nudges: self-nudges, choice architecture, social norms, and pre-commitments. While 6 nudges can support consumers in making decisions that align with their intentions, they can also be used to manipulate them. Bolos et al. (2019) use the Lancaster Utility Model, Nudging Interventions, and goal-based theory. Their study points out that cognitive and behavioural nudges have to be implemented in food waste reduction campaigns to encourage consumers to choose food with cosmetic imperfections and avoid food waste. Berger, M., et al. (2020) observed which digital nudges are effective in online food shopping contexts regarding the promotion of ecologically sustainable food choices. Their findings show that solely emphasising sustainable product options based on a topic unrelated to sustainability had adverse effects on shopping behaviour. Theotokis and Manganari (2014) studied the effect of changing the default options available to individuals through the model of choice architecture.

The study showed that the opt-out default policy is more effective than the opt-in policy because it increases anticipated guilt. This effect was observed to be stronger for consumers who are less conscious of the environment. The study also showed that a forced-choice policy is more effective than an opt-in policy but not significantly more effective than an opt-out policy. People might be motivated to act responsibly, but there may be barriers to doing so for many reasons. Choi and Ng (2011) conducted a study to find out the micro-purchase decision process of consumer technology products for green consumers. "Green consumers" in their interviews expressed that the major barriers to buying green products were a lack of information about the green products and a lack of time to put in the effort to find the information.

3. RESEARCH METHODOLOGY

3.1 PARTICIPANTS

A combination of snowball and convenience sampling methods was used to obtain a sample population willing to participate in this research. The sample was randomly split into control and treatment groups with the help of the statistical tool STATA. Participants had registered themselves via a Google form soliciting their participation. The form informed them about the purpose of the research, collected demographic and contact details, and assured confidentiality of their personal information. The study population included educated people from the Delhi NCR region in India and Kathmandu in Nepal, with education levels of high school or higher. A total 7 of 122 individuals registered voluntarily to participate in the research survey. 61 participants filled out the control group questionnaire, and 61 participants filled out the treatment group questionnaire. 96% of the sample belonged to a young age group of 18 to 30 years old and were non-working students.

3.2 RESEARCH INSTRUMENT

To observe consumer behaviour, part one of the survey questionnaires began with a simulation market of four products: toothbrushes, t-shirts, oatmeal biscuits, and stationery pouches. The products displayed were made as standard as possible

to minimise the effect of tastes and preferences on purchase decisions. Further, real prices and details of the products were provided in the simulation to replicate their real purchasing decisions as closely as possible. Both the treatment and control groups participated in the simulation, but the former was also exposed to four behavioural interventions, one in each product market. These interventions included positive positioning of the sustainable product(s), product labelling, i.e., labels displaying the environmental impact of products, the bandwagon effect or herd mentality, and information provision. Participants were asked to decide which of the displayed products they would purchase given their actual income.

Part two of the survey questionnaire employed the VBN model, which predicts pro-environmental behaviour. A five-point Likert-type scale was used to account for the importance of each value and the respondent's agreement with the beliefs and norms. Each item was assigned a value from 1 to 5, which corresponds to the five levels of agreement, ranging from "strongly Disagree" to "Strongly Agree", and from "Not Important" to "Very Important". This segment of the questionnaire was the same for both the treatment and control groups.

3.3 ANALYSIS

The responses of the participants on the Likert scale were recoded into numeric form using MS Excel. In the market simulation section, a sustainable purchase was denoted by 1, and a non-sustainable purchase was denoted by 0. Thus, one participant could get a maximum score of 4 by 8 purchasing one sustainable product in each product category. In the values, beliefs, and norms sections, the scales from "Strongly Disagree" to "Strongly Agree" and "Not Important" to "Very Important" were recoded as numbers from 1 to 5. All statements were positively framed. Hence, a larger number on this scale indicated a more environmentally conscious attitude. The total number of sustainable purchases made was calculated for each participant and expressed as a percentage of the maximum number of sustainable purchases possible. Similarly, the scores in the values, beliefs, and norms sections were totalled and expressed as a percentage of the maximum total score possible.

This was done for both the treatment group and the control group. We used the Student's t-test to check if the mean values of the score of sustainable purchases in the treatment and control groups were significantly different from each other in Stata.

4. RESULTS AND DISCUSSION

4.1 FINDINGS

Table 1, Table 2, and Figure 1 summarise the results of the survey that required participants to make product purchase choices and rank their values, beliefs, and norms given certain statements pertaining to sustainable consumption and environmental issues. The purchases made by the participants are indicative of their behaviour. Table 1 shows the scores for the treatment group, the one that received nudges, and Table 2 shows the scores for the control group, the one that did not receive nudges. The Google Form survey is available in the Appendix. As shown in the table, 38.93% of the purchases were sustainable products in the treatment group, whereas only 28.28% of the purchases were sustainable products in the control group.

We observe that both groups score similarly in the values, beliefs, and norms section of the survey. A Student's t-test for two samples was run on STATA to check if the mean value of the sustainable purchases score was significantly different for the treatment and control groups. We found that the averages are different at the level of significance of 5%. We conclude with 95% confidence that our interventions have encouraged participants in the treatment group to choose more sustainable products than members of the control group. The maximum score of 100% in the second section, i.e., the VBN questionnaire, suggests the maximum pro-sustainable consumption attitude that can be exhibited by a participant. The treatment and control groups have scored very similarly, 80.16% and 81.16%, respectively, in the attitude section, which is the summation of scores of values, beliefs, and norms. Since the framework is also used to predict pro-environmental behaviour, the scores indicated that participants in both groups are quite strongly and almost equally likely to exhibit sustainable consumption behaviour. When compared with their actual purchases, the attitude-behaviour gaps become apparent.

Table 1: Treatment group scores in sustainable consumption, value, belief, norm and total attitude.

Scores	Sustainable Purchases	Value Score	Belief Score	Norm Score	Total Attitude Score (VBN)
Actual Score	95	2046	1289	1799	5134
Maximum Score	244	2440	1525	2440	6405
Percentage (Actual out of maximum)	38.93%	83.85%	84.52%	73.73%	80.16%

Source: Authors' calculation

Table 2: Unemployment Rate (in percentage)

Scores	Sustainable Purchases	Value Score	Belief Score	Norm Score	Total Attitude Score (VBN)
Actual Score	69	2065	1317	1816	5198
Maximum Score	244	2440	1525	2440	6405
Percentage (Actual out of maximum)	28.28%	84.63%	86.36%	74.43%	81.16%

Source: Authors' calculation

Based on the results shown in Figure 1, it appears that the sample was homogeneous in terms of pro-environmentalist attitudes since the two groups scored differently in purchasing sustainable products but similarly in the values, beliefs, and norms sections. The differences in purchase patterns could be largely explained by the behavioural interventions implemented in the treatment group. The attitude-behaviour gap, as measured by the difference between the Total Attitude Score and the percentage of sustainable purchases, is observed to be about 41.23% in the treatment group, whereas the gap is 52.88% in the control group. Figure 2 shows the gap between the two groups' behaviours in purchasing

sustainable products. The blue bars represent the percentage of sustainable purchases made by the treatment group, and the red bars show the same for the control group. There are significant gaps between the sustainable consumption decisions of the two groups, except in the cases of information provision and herd mentality. Hence, the nudges that are observed to be the most effective are product labelling (as sustainable) and positive positioning of products (in the centre of the screen). It appears that the provision of information only has a negligible impact on motivating patients to purchase sustainable products.

Figure 1: Sustainable consumption and total attitude scores of the control and treatment groups

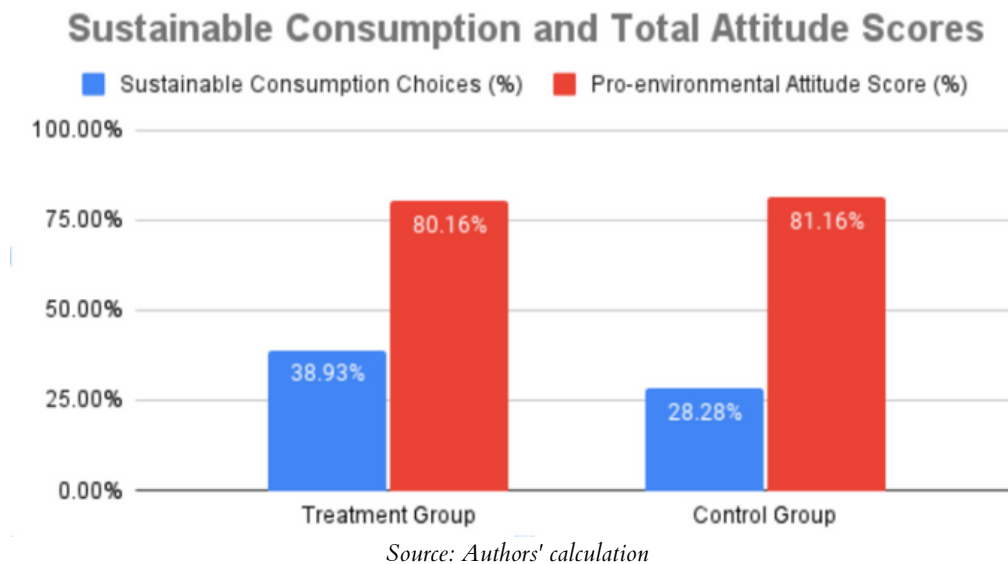
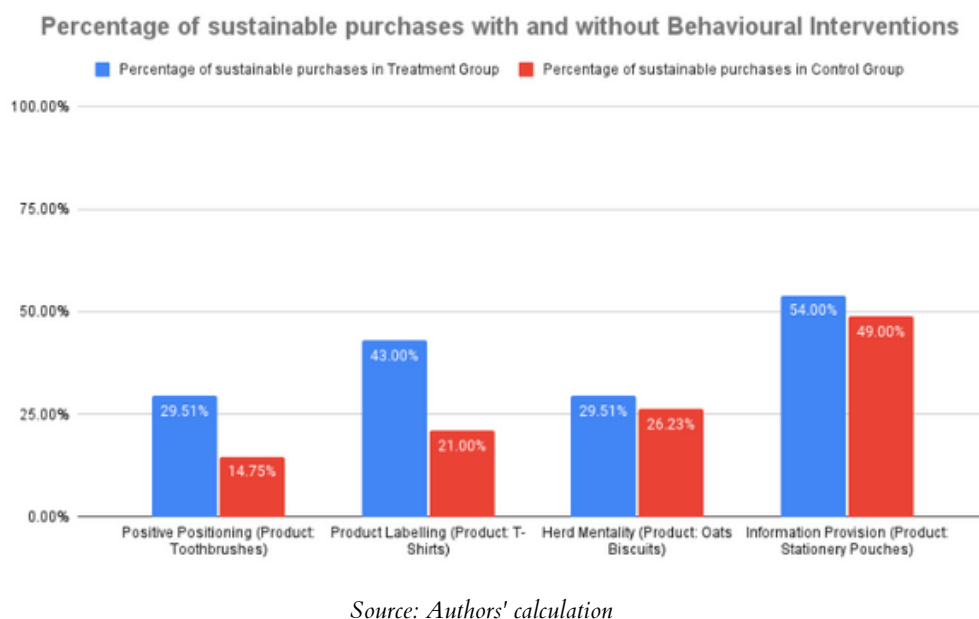


Figure 2: Percentage of sustainable purchases with and without behavioural interventions



4.2 LIMITATIONS

We observed a significant difference in the average sustainable purchase score values between the treatment and control groups, with a confidence level of 95%. We might have to see how we can modify our nudges in an effective way for the results to be more statistically significant. It is possible that participants might have been more conscious of the choices they made in the survey if they knew that they were being observed in a certain context—pro-environmental choices—as propounded by the Hawthorne effect. To overcome this limitation, we first collected the responses for the market simulation experiments studying their behaviour, followed by collecting data on their attitudes through the VBN framework, so that they would not be conscious of their choices and could respond genuinely. Another limitation could be that the participants might not have been completely honest in responding to the questions in the survey. We tried to reduce the possibility of such an occurrence by encouraging them to answer truthfully.

5. CONCLUSION

The Value Belief and Norms (VBN) framework helps to explain the relationship between an

individual's values, beliefs, and norms and their stance on environmental issues, in our case, the consumption of sustainable products. We conclude with 95% confidence that there exists a gap between sustainable consumption attitudes and behaviours in the control group and the treatment group. This, combined with the fact that both groups scored similarly in the attitude section, implies that people with similar attitudes are most likely to have differing purchasing decisions depending only on which group (control or treatment) they get assigned to, i.e., whether or not they are exposed to the behavioural interventions. The treatment group in our study made more environmentally friendly choices than the control group, suggesting the high effectiveness of behavioural interventions in the context of sustainable consumption. We also observed that product labelling and positive positioning are the more effective behavioural interventions, while the bandwagon effect or herd mentality and information provision were less effective. Further studies can look into how these behavioural interventions can be enhanced to yield better results on the basis of the identified limitations and explore whether certain demographic factors encourage or inhibit the effectiveness of such interventions.

APPENDIX

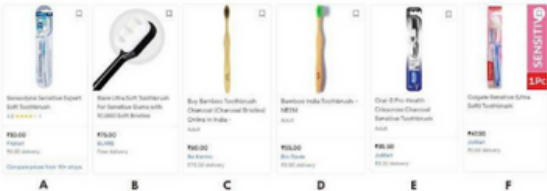
Market Simulation Forms sent to the treatment group:

Market Simulation
Thank you for participating in our survey. In this experiment, which one of the following products will you purchase given your actual income? Be honest with your choices.

* Required

1. Name *

Set 1 - Buying a Toothbrush

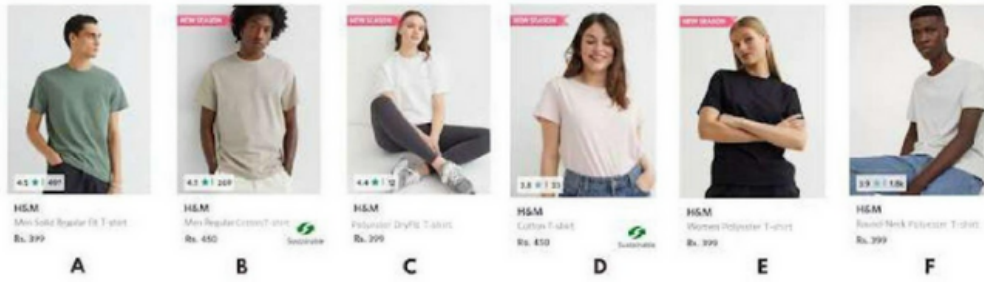


2. Purchase one item from Set 1 (Toothbrushes) *

Mark only one oval per row.

	A	B	C	D	E	F
Purchase:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Set 2 - Buying a T-shirt

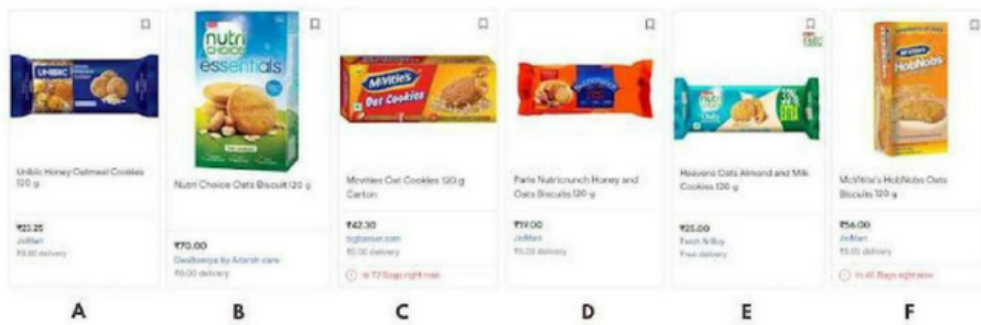


3. Purchase one item from Set 2 (T-shirts) *

Mark only one oval per row.

	A	B	C	D	E	F
Purchase:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Set 3 - Buying Biscuits

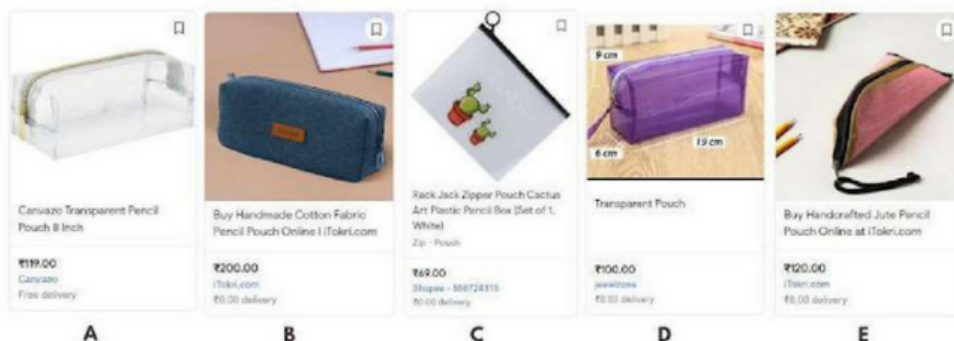


4. Purchase one item from Set 3 (Biscuits) *

Mark only one oval per row.

	A	B	C	D	E	F
Purchase:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Set 4 - Buying a Stationery Pouch



Every year, about 8 million tons of plastic waste escapes into the oceans from coastal nations. Nearly 700 species, including endangered ones, are known to have been affected by plastics.

5. Purchase one item from Set 4 (Pouches) *

Mark only one oval per row.

	A	B	C	D	E
Purchase:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Market Simulation Forms sent to the control group:

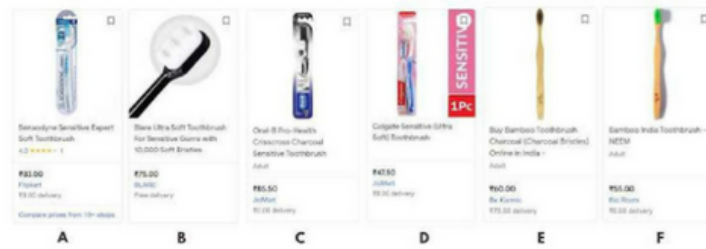
Market Simulation

Thank you for participating in our survey. In this experiment, which one of the following products will you purchase given your actual income? Be honest with your choices.

* Required

1. Name *

Set 1 - Buying a Toothbrush



2. Purchase one item from Set 1 (Toothbrushes) *

Mark only one oval per row.

	A	B	C	D	E	F
Purchase:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Set 2 - Buying a T-shirt



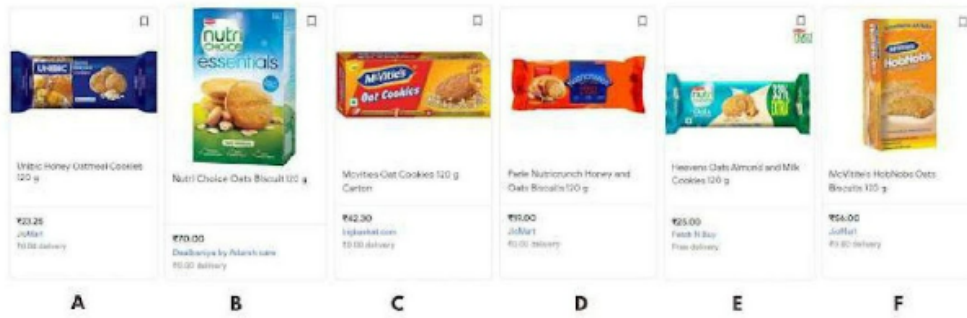
3. Purchase one item from Set 2 (T-shirts) *

Mark only one oval per row.

	A	B	C	D	E	F
Purchase:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Market Simulation Forms sent to the control group:

Set 3 - Buying Biscuits



4. Purchase one item from Set 3 (Biscuits) *

Mark only one oval per row.

	A	B	C	D	E	F
Purchase:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

VBN Questionnaire sent to both treatment and control group:

6. Values *

How important are the following values for you?

Mark only one oval per row.

	Not important	Slightly important	Moderately important	Important	Very important
Equality [Humans, animals, and plants are all equal]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Liberty [To do or be as you please without being oppressed]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Social Justice [Justice needs to be served to the right]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unity with Nature [The issues of nature are our issues]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Respecting the Earth	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Curiosity [To learn new things about the environment]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Openness to Change	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Influence [Having an impact on people and events]	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Beliefs

To what extent do you agree with the following beliefs?

7. I believe- *

Mark only one oval per row.

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
Climate change is real	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have a role to play to save the environment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Consumption of sustainable products will save the planet	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Not only the government and industries, I too am responsible for environmental deterioration.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel jointly responsible for learning about climate change.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Norms

Do you agree with the following:

8. *

Mark only one oval per row.

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
I feel guilty when I buy products with multiple layers of plastic packaging	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel obliged to learn about the environmental issues	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel I must do something to help future generations.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that it is my responsibility to protect the environment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My friends want me to act environmentally conscious.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My family wants me to act environmentally conscious.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Most people in my social circle think it is important to buy green products.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel obliged to pay attention to the environmental impact of the products I purchase	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

This content is neither created nor endorsed by Google.

REFERENCES

1. Antonetti, Paolo, and Stan Maklan. "Feelings That Make a Difference: How Guilt and Pride Convince Consumers of the Effectiveness of Sustainable Consumption Choices." *Journal of Business Ethics* 124, no. 1 (September 2014): 117–34. <https://doi.org/10.1007/s10551-013-1841-9>.
2. Berger, Michelle, Niclas Nüske, and Chiara Müller. "Digital Nudging in Online Grocery Stores – Towards Ecologically Sustainable Nutrition." *Forty-First International Conference on Information Systems.*, n.d. <https://www.fim-rc.de/Paperbibliothek/Veroeffentlicht/952/wi-952.pdf>.
3. Bolos, L. A., Lagerkvist, C. J., & Nayga, R. M. (2019). Consumer Choice and Food Waste: Can Nudging Help? *34*(1), 1–7. <https://www.jstor.org/stable/26758662>
4. Choi, Sungchul, and Alex Ng. "Environmental and Economic Dimensions of Sustainability and Price Effects on Consumer Responses." *Journal of Business Ethics* 104, no. 2 (May 26, 2011): 269–82. <https://doi.org/10.1007/s10551-011-0908-8>.
5. Fornara, Ferdinando, Erica Molinario, Massimiliano Scopelliti, Mirilia Bonnes, Flavia Bonaiuto, Lavinia Cicero, Jeroen Admiraal, et al. "The Extended Value-Belief-Norm Theory Predicts Committed Action for Nature and Biodiversity in Europe." *Environmental Impact Assessment Review* 81 (March 2020): 106338. <https://doi.org/10.1016/j.eiar.2019.106338>.
6. Francis, Allen, and Gopal K. Sarangi. "Sustainable Consumer Behaviour of Indian Millennials: Some Evidence." *Current Research in Environmental Sustainability* 4 (2022): 100109. <https://doi.org/10.1016/j.crsust.2021.100109>.
7. Grebitus, Carola, Rod D. Roscoe, Ellen J. Van Loo, and Irfan Kula. "Sustainable Bottled Water: How Nudging and Internet Search Affect Consumers' Choices." *Journal of Cleaner Production* 267 (September 2020): 121930. <https://doi.org/10.1016/j.jclepro.2020.121930>.
8. Kala, Mayanka, and Aruna Sharma. "Traditional Indian Beliefs: A Key toward Sustainable Living." *The Environmentalist* 30, no. 1 (November 10, 2009): 85–89. <https://doi.org/10.1007/s10669-009-9247-z>.
9. Ölander, Folke, and John Thøgersen. "Informing Versus Nudging in Environmental Policy." *Journal of Consumer Policy* 37, no. 3 (March 8, 2014): 341–56. <https://doi.org/10.1007/s10603-014-9256-2>.
10. Perry, George L.W., Sarah J. Richardson, Niki Harré, Dave Hodges, Phil O'B. Lyver, Fleur J.F. Maseyk, Riki Taylor, et al. "Evaluating the Role of Social Norms in Fostering Pro-Environmental Behaviors." *Frontiers in Environmental Science* 9 (June 4, 2021). <https://doi.org/10.3389/fenvs.2021.620125>.
11. Rokka, Joonas, and Liisa Uusitalo. "Preference for Green Packaging in Consumer Product Choices – Do Consumers Care?" *International Journal of Consumer Studies* 32, no. 5 (September 2008): 516–25. <https://doi.org/10.1111/j.1470-6431.2008.00710.x>.
12. Stern, P.C.; Dietz, T.; Abel, T.; Guagnano, G.A.; Kalof, L. A value-belief-norm theory of support for social movements: The case of environmentalism. *Hum. Ecol. Rev.* 1999, 6, 81–97. <https://humanecologyreview.org/pastissues/her62/62sternetal.pdf>
13. Stern, Paul C. "New Environmental Theories: Toward a Coherent Theory of Environmentally Significant Behavior." *Journal of Social Issues* 56, no. 3 (January 2000): 407–24. <https://doi.org/10.1111/0022-4537.00175>.
14. Theotokis, Aristeidis, and Emmanouela Manganari. "The Impact of Choice Architecture on Sustainable Consumer Behavior: The Role of Guilt." *Journal of Business Ethics* 131, no. 2 (July 19, 2014): 423–37. <https://doi.org/10.1007/s10551-014-2287-4>.

15. Vigors, Belinda. "Reducing the Consumer Attitude–Behaviour Gap in Animal Welfare: The Potential Role of ‘Nudges.’" MDPI, n.d. <https://www.mdpi.com/2076-2615/8/12/232>.
16. Wang, Jianhua, Minmin Shen, and May Chu. "Why Is Green Consumption Easier Said than Done? Exploring the Green Consumption Attitude-Intention Gap in China with Behavioral Reasoning Theory." *Cleaner and Responsible Consumption 2* (June 2021): 100015. <https://doi.org/10.1016/j.clrc.2021.100015>.
17. Yadav, Rambalak, and Govind S. Pathak. "Determinants of Consumers' Green Purchase Behavior in a Developing Nation: Applying and Extending the Theory of Planned Behavior." *Ecological Economics 134* (April 2017): 114–22. <https://doi.org/10.1016/j.ecolecon.2016.12.019>

THE DYNAMIC STABILITY OF EMPLOYEMENT IN A NON CLEARING MARKET

SRINJOY MAJUMDER*

Jadavpur University

Abstract

Undoubtedly, the theory of employment is a key issue in economic theory. The level of employment in an economy determines the output level, which in turn, decides the consumer's choice of allocating the output through consumption, investment and savings. But how does an economy's employment structure behave in situations of excess demand and supply in particular time periods? To investigate this effect, the paper discusses a dynamic model of employment through the product and money markets and determines the time path of employment. In a situation of excess supply, the time path is unstable in nature and diverges from the intertemporal equilibrium explained by the model. To explain how a stable time path for employment can be obtained, a consumer characteristic of the savings feedback is brought in, which is a result of excess supply and the particular condition under which the time path for employment will be stable, defined as the Employment's Dynamic Equilibrium Condition is derived.

JEL Classification: C3, E1, E2, J0

Keywords: Dynamic Model, Intertemporal Equilibrium, Savings Feedback, Employment's Dynamic Equilibrium Condition

1. INTRODUCTION

The term employment has been defined and described by the English Dictionary as 'the state of having paid work'. The newspapers, the TV channels, the political institutions and necessarily, the economists of every country speak about the issue of employment and unemployment. Unemployment is, of course, one of the most damaging economic circumstances. To understand the behavior of unemployment and its relation with the production of the economy and the demand by the domestic country, there is a need to realize the relation between employment and production in itself.

'Ultimately, it comes down to supply and demand', is a famous quotation by American attorney Bradford Smith on the internet. It goes without saying, the market forces of demand and supply are the most important determinants of price levels and employment. In this paper, the very necessary question in economics: "How are employment and the market forces of demand and supply related?" is examined. Empirically speaking, there has always existed a strong positive correlation between

employment and output. Supply and demand are impacted at the macroeconomic level by both domestic and global market dynamics, as well as elements like immigration, population aging, and educational attainment. Unemployment, productivity, participation rates, total income, and gross domestic product are important metrics (GDP).

At the microeconomic level, individual businesses deal with workers in terms of hiring, terminating, and changing hours and salaries. The link between supply and demand affects how many hours workers put in and how much they are paid in terms of wages, salaries, and benefits.

An economy faces a situation of excess supply when the planned or ex-ante demand of the economy is lower than the production of the economy. Observations across the world have shown that when such a situation of excess supply prevails in an economy, to equilibrate the markets, workers are often laid off, such that demand and supply equate to equilibrate the market. But what does this tell us about the trend of employment?

*Author's email address: joysmaj@gmail.com

In this paper, the relationships between employment and output, while taking into consideration both the money market and product market are derived and a dynamic model for employment and check whether the time paths for employment are stable or not is developed.

2. LITERATURE REVIEW

John Maynard Keynes argued in his seminal work "The General Theory of Employment, Interest, and Money" (1936) that excess demand, especially as aggregate demand, can stimulate employment growth. Keynes emphasized the role of government and respective interventions by way of implementing financial and monetary policies; emphasizing all seek and obtain full employment. His ideas formed the basis of Keynesian economics, which argued that excess demand could stimulate production and job creation. Milton Friedman, a leading figure in neoclassical economics, offered a different perspective. In "A Monetary History of the United States, 1867–1960" (1963), Friedman focused on the role of monetary policy in shaping economic outcomes. He argued that excess demand is a temporary phenomenon and markets will naturally adjust through the price process. According to Friedman, performance is largely determined by factors such as labor market conditions and productivity.

Several empirical studies have examined the relationship between excessive demand and performance, offering a nuanced perspective. Romer and Romer (2019) analyzed the impact of monetary policy shocks on employment in the United States and found that monetary policy expansion reduces excess demand and increases employment. Blanchard and Summers (1986) examined the effect of demand shocks on performance in the US. and Europe. They found that unemployment fell sharply due to the expansion of demand, supporting the Keynesian view. In contrast, Barro and King (1984) conducted a study on the relationship between government spending and employment in the United States and found limited evidence of a positive impact on employment. Their findings align with neoclassical theories, suggesting that excess demand plays a minor role in employment determination.

Debate and questions regarding wages, labor market conditions, and product market conditions and their

importance in employment dynamics raise necessary questions and have been studied in the research paper entitled Supply, Demand and Employment Dynamics by Mikael Carlsson, Stefan Eriksson and Nils Gottfries of Uppsala University and Ilan Cooper. The paper investigates market conditions and reveals real wage costs and product market demand shocks have significant effects on employment. No evidence was found that unemployed workers contributed to the creation of jobs in existing firms.

The paper titled Labor Demand in the Time of Covid-19: Evidence from vacancy posting and UI claims by Lisa B. Kahn, Fabian Lange and David Wiczer studied the collapse of job vacancies by the second half of March 2020 and the underlying causality of this impact. UI, or unemployment insurance was found to be matching the patterns of this collapse. This paper was studied to understand the impact of a demand and supply shock in an economy and their effects on employment and unemployment patterns.

The research paper entitled Labor Demand Research: Towards a better match between Better Theory and Better Data by John T. Addison, Pedro Portugal and Jose Verajao models the labor market in order to understand labor market frictions and imperfections and utilizes a dynamic analysis of labor demand, wage formation and estimation.

In 1996, Professor Jean Marc-Bottazzi and Professor Thorsten Hens published their paper titled Excess Demand Functions and Incomplete Markets in the Journal of Economic Theory (Volume 68, Issue 1) that characterized noncritical spot price systems in two-period exchange economies with incomplete markets and real assets. This paper focused on the changing dynamics of price with an existing force of excess demand in the economy and how price and consumer behavior adapts to it.

The work of Professor Malcolm C. Sawyer in the book Business Pricing and Inflation looks into the effect of excess demand on businesses and their employment structure closely in the chapter entitled Excess Demand, Expectations and Price Changes. Empirical evidence pertaining to theories of price change in a competitive market environment shows it to be one of the central causes of excess demand. The chapter discusses the problems arising in testing

such theories, particularly the measurement of crucial variables. The divergence between the boundaries of an industry and the corresponding market created considerable difficulties in testing the excess demand hypothesis. The effect of defining a range of goods and their belonging to a particular industry, in terms of product homogeneity has also been discussed in the chapter.

3. THEORETICAL BACKGROUND

Here, a model economy has been considered, which satisfies all conditions of a basic IS-LM structure. Therefore, the economy is assumed to have infinite firms in perfect competition, and infinite consumers. Production is assumed to be given and hence, only the demand side of the economy concerns the study.

The following is hypothesised:

- In the economy, the representative consumer has the income of Y , of which he consumes only a part and saves the rest. It is assumed that there have been periods in the economy that have not been accounted for. As a result, the individual has had some savings. His consumption, therefore, will depend on two sources: his current income, and his accumulated savings.
- Further, employment in the economy depends on aggregate demand in the economy. Following a period of excess demand, employment decreases in the economy, and following a period of excess supply, employment increases in the economy.
- If the economy faces excess supply in a certain period, and the consumer follows his usual consumption pattern, the time path for employment to reach its equilibrium is unstable. The system deviates from its intertemporal equilibrium.
- When the consumer faces a situation of excess supply, she reacts to that through her consumption pattern. The consumer, since already facing an excess of supply than what she requires to consume, does not need to consume from her savings in such periods. Therefore in periods of excess supply, the consumer reacts to the excess supply by only consuming from one source, her income.

4. OBJECTIVES

The objectives of this study are as follows:

- To obtain the time path for employment in an economy under an excess supply situation
- To obtain the condition under which time path for employment will be stable in an economy under an excess supply situation

5. MODEL SPECIFICATIONS

In this paper, a model for employment, in discrete time, which is dependent on levels of excess supply in the economy in the previous time period is developed. It is expressed as follows:

$$Q_{t-1}^S - Q_{t-1}^d = E_0 - k.E_t$$

where, Q_{t-1}^S = quantity supplied in the $(t-1)^{th}$ time period
 Q_{t-1}^d = quantity demanded in the $(t-1)^{th}$ time period

$Q_{t-1}^S - Q_{t-1}^d$ = excess supply in the $(t-1)^{th}$ time period
 E_0 = Autonomous employment
 E_t = level of employment in the t^{th} time period

In the model, k is a constant and is positive. It measures the degree of responsiveness of change in employment levels to the effect of excess supply in the previous time period.

E_0 , which is defined as the level of autonomous employment, can be understood as the level of employment that is generated irrespective of the demand-supply environment persisting in the economy. This employment may be a result of the employer's personal preference of government schemes.

Now, quantity demanded has been defined as follows:

$$Q_t^d = C_t + I_t + G_0$$

where, Q_t^d = quantity demanded in the t^{th} time period
 C_t = consumption demand in the t^{th} time period
 I_t = Investment demand in the t^{th} time period
 G_0 = government expenditure

Government expenditure is assumed to be exogenous and constant across all time periods in the model. Consumption demand is defined as follows:

$$C_t = a + bY_t + c[(1-b)Y_{t-1}]$$

where, C_t = consumption demand in the t^{th} time period

a = autonomous consumption

b = marginal propensity to consume of a consumer

Y_t = Income/output in the t^{th} time period

c = marginal propensity to consume savings

Y_{t-1} = Income/output of $(t-1)^{\text{th}}$ period

The consumption demand function of the consumer obeys certain restrictions. They are listed as follows:

● $0 < b < 1$ [Under the Keynesian model considered, the consumer neither consumes his entire income, nor saves his entire income]

● $0 \leq c \leq 1$ [This restriction signifies that a consumer might choose to consume her savings entirely in a time period or might not consume any of her savings in a time period, depending on the forces of excess demand or supply in the economy]

Now, the investment demand function is defined as follows:

$$I_t = d - g.r_t + m.Y_t$$

where, I_t = investment demand in the t^{th} time period

r_t = rate of interest in the economy in the t^{th} time period

d = autonomous investment demand

g = responsiveness of change of investment to change in interest rate

m = responsiveness of change of investment to change in income

Here, g is a positive constant given exogenously. m is also a constant, which is given and $0 < m < 1$.

Now, it is necessary to understand, the rate of interest in the economy will alone not depend on the goods market. There has to exist a money market and the interaction between the goods and money market will determine the interest rate for the economy.

In the simplified model that has been considered for the economy, only speculative demand for money and transactions demand for money constitute the consumers money demand, which has been defined as follows:

$$M_t^d = K.Y_t - L.r_t$$

where, M_t^d = Money demand in the t^{th} time period

Y_t = Income/output in the t^{th} time period

r_t = rate of interest in the economy in the t^{th} time period

K and L are positive constants denoting the degree of responsiveness of change in money demand to changes in income and interest rate respectively and are given in the model.

Money supply in the economy is exogenously given, and is written as:

$$M_t^s = M$$

where, M_t^s = Money supply in the t^{th} time period

M , which is equal to the nominal money supply by the price level, is exogenously given, and is a positive constant.

Having defined the money market equations, the output of the economy is to be defined.

The output of the economy in the t^{th} time period is defined, and the result previously used, as Y_t .

Now, there exists a crucial relationship between output and employment. Output is directly proportional to the level of employment in the economy, which can be written as follows:

$$Y_t \propto E_t$$

which implies that: $Y_t = j.E_t$

Here, j can be defined as an efficiency parameter that relates employment to the level of output and is positive.

The mentioned equations are used in the model to develop the time path for employment.

6. THE MODEL

In the product market, quantity demanded in the t^{th} time period is explained by the following equation:

$$Q_t^d = C_t + I_t + G_0$$

i.e. $Q_t^d = a + bY_t + c[(1-b)Y_{t-1}] + d - g.r_t + m.Y_t + G_0$ (i)

where the terms have their usual meanings.

The quantity supplied in the t^{th} time period is given as:

$$Q_t^s = Y_t$$

It is understood that the product market does not equilibrate as there will exist an excess supply or deficient supply (excess demand) in the market.

In the money market, money demand in the t^{th} time period is given by:

$$M_t^d = K.Y_t - L.r_t$$

where the terms have their usual meanings.

The money supply in the t^{th} time period is given by:

$$M_t^s = M$$

The money market equilibrium is given by:

$$M_t^s = M_t^d$$

i.e $M = K.Y_t - L.r_t$ (ii)

From (ii), it can be written that:

$$r_t = \frac{K}{L} Y_t - \frac{M}{L}$$
 (iii)

Using (iii) in (i), it can be written that:

$$Q_t^d = a + bY_t + c[(1-b)Y_{t-1}] + d - g \cdot \left[\frac{K}{L} Y_t - \frac{M}{L} \right] + m.Y_t + G_0$$
 (iv)

Now, the excess (or deficient) supply in the market can be expressed as:

$$Q_t^s - Q_t^d = Y_t - a - bY_t - c[(1-b)Y_{t-1}] - d + g \cdot \left[\frac{K}{L} Y_t - \frac{M}{L} \right] - m.Y_t - G_0$$

i.e

$$Q_t^s - Q_t^d = (1-b + g \cdot \frac{K}{L} - m). Y_t - c(1-b)Y_{t-1} - (a + d + g \cdot \frac{M}{L} + G_0)$$

i.e

$$Q_t^s - Q_t^d = j(1-b + g \cdot \frac{K}{L} - m). E_t - cj(1-b)E_{t-1} - (a + d + g \cdot \frac{M}{L} + G_0)$$
 (v)

Now, it is known that:

$$Q_{t-1}^s - Q_{t-1}^d = E_0 - k.E_t$$

i.e $Q_t^s - Q_t^d = E_0 - k.E_{t+1}$ (vi)

Using (vi) in (v) gives:

$$E_0 - k.E_{t+1} = j(1-b + g \cdot \frac{K}{L} - m). E_t - cj(1-b)E_{t-1} - (a + d + g \cdot \frac{M}{L} + G_0)$$

Moving one time period forward gives:

$$E_0 - k.E_{t+2} = j(1-b + g \cdot \frac{K}{L} - m). E_{t+1} - cj(1-b)E_t - (a + d + g \cdot \frac{M}{L} + G_0)$$

i.e

$$k.E_{t+2} + j(1-b + g \cdot \frac{K}{L} - m). E_{t+1} - cj(1-b)E_t = a + d + g \cdot \frac{M}{L} + G_0 + E_0$$

This is a difference equation for employment.

Normalizing the equation gives:

$$E_{t+2} + \frac{j}{k}(1-b + g \cdot \frac{K}{L} - m). E_{t+1} - c \frac{j}{k}(1-b)E_t = \frac{1}{k}(a + d + g \cdot \frac{M}{L} + G_0 + E_0)$$
 (vii)

To find the time path for employment, there is a need to find the particular solution and the complementary function.

The particular solution of the difference equation in (vii) is given by:

$$E_t^P = \frac{a + d + g \cdot \frac{M}{L} + G_0 + E_0}{k + j(1-b + gk - m) - cj(1-b)}$$
 (viii)

This is the intertemporal and stationary equilibrium of the dynamic model explained.

The complementary function of the difference equation in (vii) is given by:

$$E_t^C = A_1 b_1^t + A_2 b_2^t$$

where A_1 and A_2 are arbitrary constants and;

$$b_1 = \frac{-\frac{j}{k}(1-b + \frac{gk}{L} - m) + \sqrt{(\frac{j}{k}(1-b + \frac{gk}{L} - m))^2 + 4c \frac{j}{k}(1-b)}}{2}$$

$$b_2 = \frac{-\frac{j}{k}(1-b + \frac{gk}{L} - m) - \sqrt{(\frac{j}{k}(1-b + \frac{gk}{L} - m))^2 + 4c \frac{j}{k}(1-b)}}{2}$$

Thus, the time path of employment can be written as follows:

$$E_t = E_t^C + E_t^P$$

$$\text{i.e } E_t = A_1 b_1^t + A_2 b_2^t + \frac{a + d + g \cdot \frac{M}{L} + G_0 + E_0}{k + j(1-b + gk - m) - cj(1-b)}$$

$$Q_t^d = C_t + I_t + G_0$$

where,

$$b_1 = \frac{-\frac{j}{k}(1-b + \frac{gk}{L} - m) + \sqrt{(\frac{j}{k}(1-b + \frac{gk}{L} - m))^2 + 4c\frac{j}{k}(1-b)}}{2}$$

$$b_2 = \frac{-\frac{j}{k}(1-b + \frac{gk}{L} - m) - \sqrt{(\frac{j}{k}(1-b + \frac{gk}{L} - m))^2 + 4c\frac{j}{k}(1-b)}}{2}$$

7. OBSERVATION FROM THE MODEL

This system will be unstable in nature because the roots of the complementary function, b_1 and b_2 are of opposite signs. This means that as time increases, the system will deviate from the intertemporal equilibrium.

8. THE CONSUMER'S SAVINGS FEEDBACK: AN EXTENSION OF THE MODEL

Suppose that in the model economy considered, there exists excess supply in the t^{th} time period. The question is, how does the consumer react to the effect of excess supply.

In this section, we hypothesize that the effect of excess supply will affect the consumer's and in turn, the economy's consumption pattern. Assuming that the economy's consumption behavior does not change, it can be said that the economy will not consume its savings of the previous period as an effect of the excess supply. A consumer in an economy will only consume from her savings when there exists a shortage in production, i.e. a situation of deficient demand. In a situation of excess supply prevailing over a period in the economy, the consumer will have no motivation to use up her savings to meet up her consumption expectations.

Therefore, in the developed model, the consumption function is modified as follows:

$$C_t = a + bY_t$$

Now, the demand function in the product market is reduced to:

$$\text{i.e } Q_t^d = a + bY_t + d - g \cdot r_t + m \cdot Y_t + G_0$$

Keeping all other factors in the model defined unchanged, the excess supply function can be written as:

$$Q_t^S - Q_t^d = Y_t - a - bY_t - d + g \cdot [\frac{K}{L} Y_t - \frac{M}{L}] - m \cdot Y_t - G_0$$

i.e,

$$Q_t^S - Q_t^d = j(1-b + g \cdot \frac{K}{L} - m) \cdot E_t - (a + d + g \cdot \frac{M}{L} + G_0) \tag{A}$$

Now, it is also known that:

$$Q_{t-1}^S - Q_{t-1}^d = E_0 - k \cdot E_t$$

$$\text{i.e } Q_t^S - Q_t^d = E_0 - k \cdot E_{t+1} \tag{B}$$

Using (A) in (B),

$$E_0 - k \cdot E_{t+1} = j(1-b + g \cdot \frac{K}{L} - m) \cdot E_t - (a + d + g \cdot \frac{M}{L} + G_0)$$

i.e,

$$k \cdot E_{t+1} + j(1-b + g \cdot \frac{K}{L} - m) \cdot E_t = a + d + g \cdot \frac{M}{L} + G_0 + E_0 \tag{C}$$

This is a difference equation for employment with the savings feedback. Normalizing the equation in (C),

$$E_{t+1} + j \cdot \frac{j}{k}(1-b + g \cdot \frac{K}{L} - m) \cdot E_t = \frac{1}{k}(a + d + g \cdot \frac{M}{L} + G_0 + E_0) \tag{D}$$

To find the time path for employment, the particular solution and complementary function of the difference equation in (D) is required.

The particular solution of the difference equation in (D) is given by:

$$E_t^P = \frac{a + d + g \cdot \frac{M}{L} + G_0 + E_0}{k + j(1-b + gk - m)}$$

This is the intertemporal and stationary equilibrium of the dynamic model explained.

The complementary function of the difference equation in (D) is given by:

$$E_t^C = A_3 b_3^t$$

where A_3 is an arbitrary constant and;

$$b_3 = -\frac{j}{k}(1 - b + \frac{gk}{L} - m)$$

Thus, the time path of employment can be written as follows:

$$E_t = E_t^C + E_t^P$$

$$E_t = A_3 b_3^t + \frac{a + d + g \cdot \frac{M}{L} + G_0 + E_0}{k + j(1 - b + gk - m)}$$

9. OBSERVATION FROM THE MODEL

This system will be stable in nature under the following condition:

$$-1 < -\frac{j}{k}(1 - b + \frac{gk}{L} - m) < 1$$

i.e
$$-\frac{k}{j} < (1 - b + \frac{gk}{L} - m) < \frac{k}{j}$$

The economy, in case of an excess supply situation, will move towards and converge to an intertemporal equilibrium if and only if this condition holds. Otherwise, the system will be unstable and will diverge from the equilibrium. In this paper, this condition is named as the Employment's Dynamic Equilibrium Condition.

It is necessary to highlight the limitations of the paper here. This paper fails to interpret the restrictive conditions of the time path of the difference equation for employment to have a stable time path.

10. STATISTICAL RESULTS

Annual data from the World Bank, published between the years 1990 and 2021, is considered to check whether the rate of unemployment in a year following excess demand or excess supply is affected by the consumer's feedback or not. Data, particularly in

regard to India, considering annual consumer spending, annual investment spending, annual government spending, imports and exports, as well as the net annual savings and unemployment rate is used. From the data provided, it was possible to calculate net aggregate demand in the Indian Economy over the years, excess demand in the economy and aggregate demand resulting from non-consumption of savings. The detailed tables of data used have been provided in the Appendix.

The descriptive statistics is as follows:

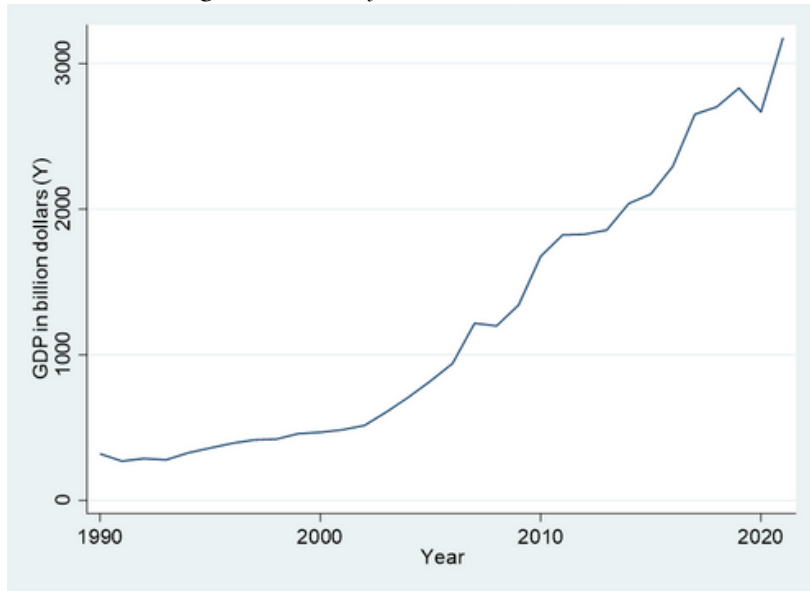
Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. dev.	Min	Max
gdpinbilli~y	32	1234.043	928.9803	270.11	3176.3
consumersp~r	32	731.475	541.9577	199.3684	1891.902
investment~a	32	368.5803	275.8339	66.10404	907.3083
government~a	32	133.9902	101.9642	29.92475	353.5213
importsinb~s	32	279.1341	240.356	22.94	758.87
exportsinb~s	32	242.3916	207.8953	22.64	679.68
netexportsnx	32	-36.7425	38.149	-122.91	.05
aggregates~s	32	370.3225	286.3837	59.16273	930.8742
cwithoutsa~s	32	361.1525	265.3713	129.9103	1001.909
aggregated~d	32	1197.303	887.1355	298.1457	3073.541
excessdemand	32	36.74018	57.54161	-79.66358	163.7757
unemployme~e	32	7.833031	.7467165	6.51	10.195
ED_without~s	32	407.0627	333.1833	31.12703	1033.633

Source: Author's Calculation

Here, gdpinbilliondollars stands for Aggregate Output (Y), consumerspendinginbilliondollars stands for consumption spending (C), investmentinbilliondollars stands for investment spending (I), governmentexpenditureinbilliondollars stands for government spending (G), importsinbilliondollars stands for imports, exportsinbilliondollars stands for exports, netexportsnx stands for net exports of the economy (NX), aggregatesavingsinbilliondollars stands for savings of the economy, cwithoutsavings represents consumption without savings, aggregatedemand is the summation of consumption spending, investment spending, government spending and net exports, excessdemand stands for excess of aggregate demand over Y, unemploymentrate stands for the rate of unemployment in the economy, and ED_without_savings stands for excess demand in the economy, calculated where consumption does not include the savings component

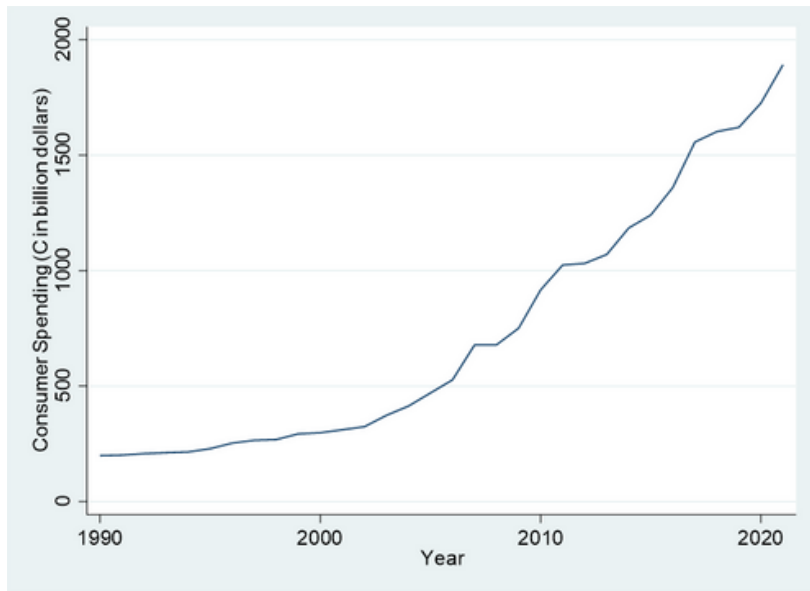
Figure 1: *Growth of India's GDP (1990-2021)*



1

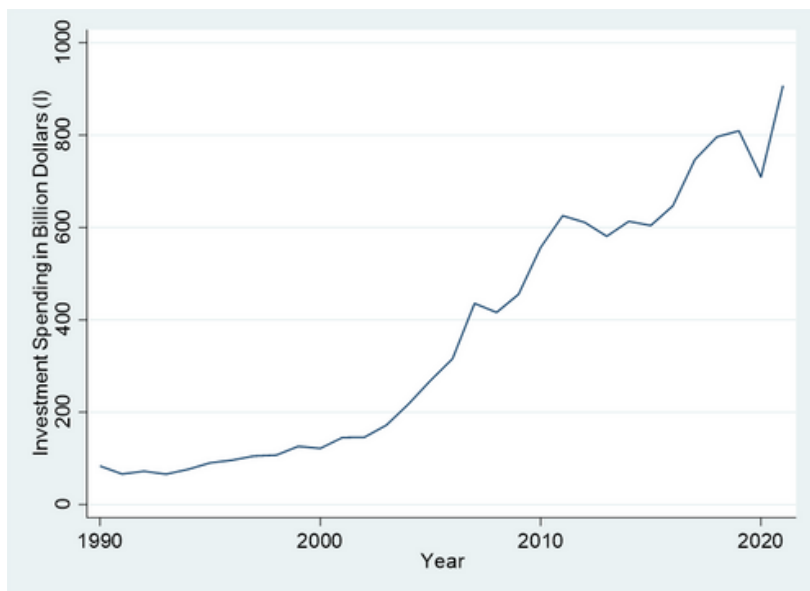
Source: Author's Calculation

Figure 2: *Consumption Spending in the Indian Economy (1990-2021)*



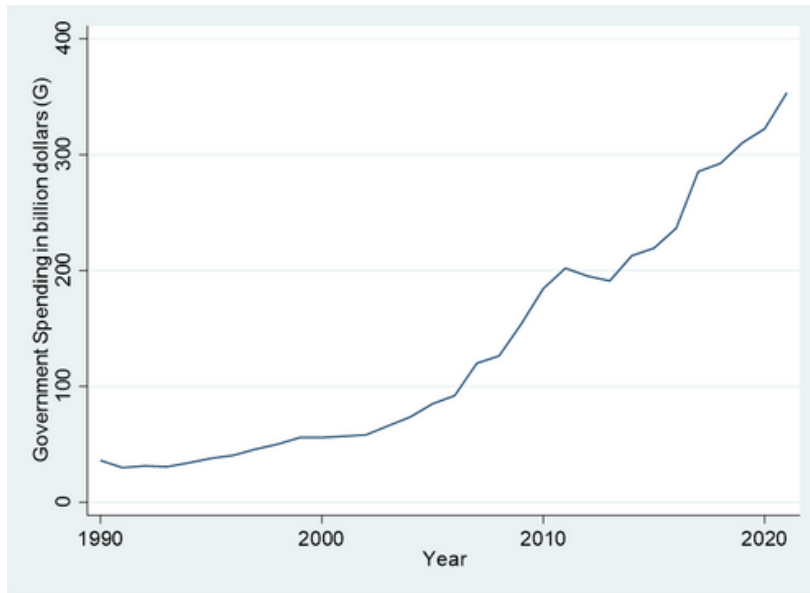
Source: Author's Calculation

Figure 3: *Investment Spending in the Economy (1990-2021)*



Source: Author's Calculation

Figure 4: Government Spending in the Economy (1990-2021)



1

Source: Author's Calculations

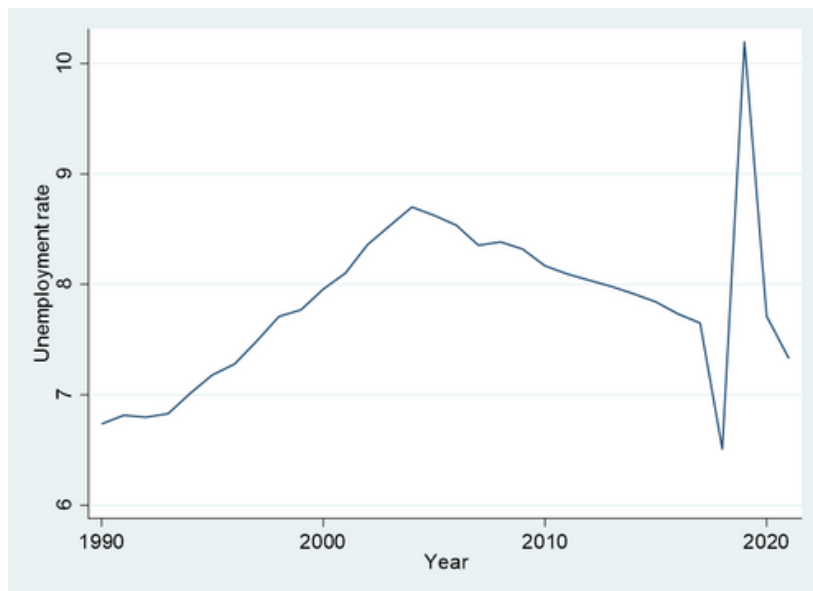
Figure 5: Net Exports of India (1990-2021)



2

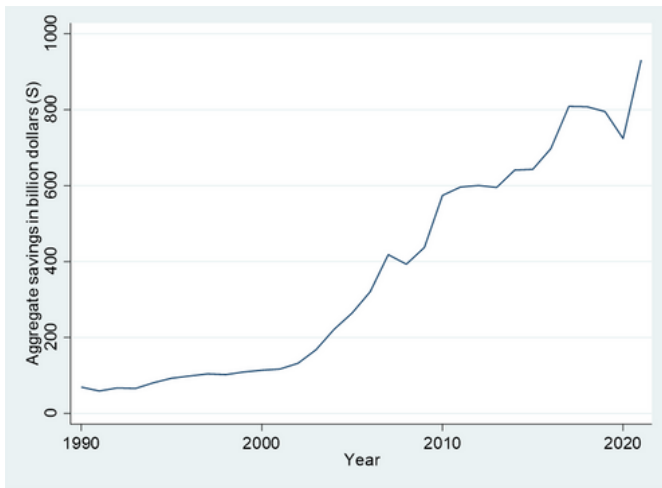
Source: Author's Calculations

Figure 6: Unemployment Rate in India (1990-2021)



Source: Author's Calculations

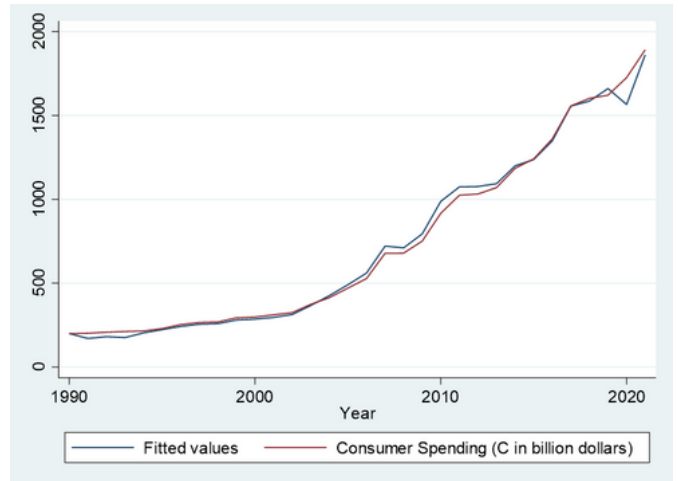
Figure 7: Savings in the Economy (1990–2021)



Source: Author's Calculations

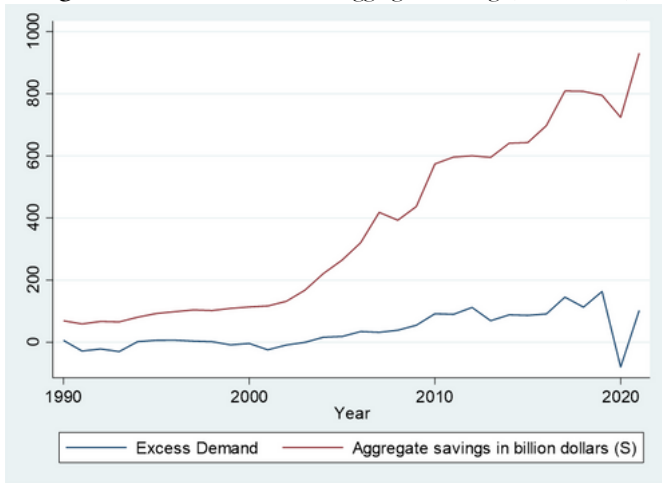
Consumption dependent on income, which includes the savings is regressed, as stated before.

Figure 9: Actual Consumption v/s Predicted Consumption



Source: Author's Calculations

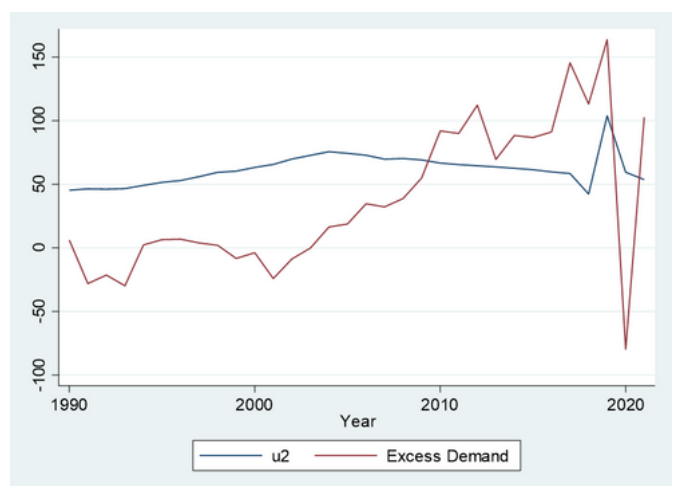
Figure 8: Excess Demand and Aggregate Savings(1990–2021)



Source: Author's Calculations

The impact of excess demand on the unemployment rate in the economy is visualized. However, relative to the excess demand values, unemployment rate values are obviously very small. As a result, the line diagram does not capture the effect. A quadratic transformation of the unemployment rate is taken, squaring the values, and plotted against excess demand, to show the changes in unemployment, without loss of generality.

Figure 10: Excess Demand v/s Unemployment



Source: Author's Calculations

The above depicted figure shows that as excess demand increased over time, savings decreased, implying, in periods of excess demand, people consume from their savings. Notice the counter-movement near 2020. It shows as excess demand dropped, savings in the economy increased, implying, in periods of excess supply, economic agents consume only from their income.

Table 2: Regression results of consumption function

```

. reg consumerspendinginbilliondollar gdpinbilliondollarsy
    
```

Source	SS	df	MS	Number of obs =	32
Model	9055628.53	1	9055628.53	F(1, 30) =	5473.41
Residual	49634.2949	30	1654.4765	Prob > F =	0.0000
Total	9105262.83	31	293718.156	R-squared =	0.9945
				Adj R-squared =	0.9944
				Root MSE =	40.675

consumerspendingci~r	Coefficient	Std. err.	t	P> t	[95% conf. interval]
gdpinbilliondollarsy	.5817977	.007864	73.98	0.000	-.5657372 .5978581
_cons	13.51157	12.07807	1.12	0.272	-11.15514 38.17828

Source: Author's Calculations

Notice in the above figure that post 2000, as excess demand begins to rise, unemployment falls, which satisfies the hypothesis in the modeling.

Now, equation (vi) is looked into and the regression equation is formed as follows:

$$U_{t+1} = \text{_cons} + (Q_t^d - Q_t^s)$$

where U refers to employment rate

The regression results are shown below:

Table 3: Regression results of Unemployment rate

. reg lagU excessdemand						
Source	SS	df	MS	Number of obs	=	31
Model	.190807015	1	.190807015	F(1, 29)	=	0.33
Residual	16.8331395	29	.580453086	Prob > F	=	0.5708
				R-squared	=	0.0112
				Adj R-squared	=	-0.0229
Total	17.0239465	30	.567464884	Root MSE	=	.76187
lagU						
	Coefficient	Std. err.	t	P> t	[95% conf. interval]	
excessdemand	-.0013699	.0023893	-0.57	0.571	-.0062566	.0035168
_cons	7.90094	.1638586	48.22	0.000	7.565811	8.236068

Source: Author's Calculations

The regression results show that the variable of excess demand is insignificant when the impact of excess demand on unemployment in the following period is looked into. Therefore, the 'Feedback' model for the time periods is looked into, where excess supply exists, and the possibility of better results is checked.

The regression results are as follows:

Table 4: Regression results of Feedback Model

. reg lagU ED_without_savings if excessdemand<0						
Source	SS	df	MS	Number of obs	=	9
Model	8.00836186	1	8.00836186	F(1, 7)	=	44.35
Residual	1.26393258	7	.180561797	Prob > F	=	0.0003
				R-squared	=	0.8637
				Adj R-squared	=	0.8442
Total	9.27229444	8	1.1590368	Root MSE	=	.42493
lagU						
	Coefficient	Std. err.	t	P> t	[95% conf. interval]	
ED_without_savings	.0052482	.000788	6.66	0.000	.0033848	.0071116
_cons	7.038301	.184628	38.12	0.000	6.601725	7.474877

Source: Author's Calculations

Now the regression model yields a significant result, as well as a better fit model. It can be seen that if there exists excess supply in a period, and the consumer is consuming from his income only, which if increases by 1 unit, raises unemployment in the following period by only 0.0052482 units, which is very small. This increase can be accounted for by systemic processes, not due to market mechanisms.

11. CONCLUSION

The paper began with a condition modeling an economy's behavior in the situation of excess supply. It was assumed that in this situation the money market equilibrium holds. The net real output of the industry was expressed in terms of the level of employment in the economy, which in turn was used to express the consumption and investment functions in terms of level of employment. It was assumed in the development of the model that, if there exists excess supply in the economy in a particular time period, the following period will show a fall in employment and vice versa, i.e. an inverse relation between excess supply and employment, in successive time periods was considered. However, the scope of an autonomous employment was kept while developing the model. Using the derived functions in terms of employment, a difference equation of second order was developed to derive the time path for employment. It was derived from the difference equation that the time path for employment was unstable i.e. with time, levels of employment diverged from the intertemporal equilibrium level of employment.

The model is now extended with a further scope that modifies the behavior of the consumer. It is hypothesized that the effect of excess supply will affect the consumer's and in turn, the economy's consumption pattern. Assuming that the economy's consumption behavior does not change, the economy will not consume its savings from the previous period as an effect of the excess supply. A consumer in an economy will only consume from her savings when there exists a shortage in production, i.e. a situation of deficient demand. In a situation of excess supply prevailing over a period in the economy, the consumer will have no motivation to use up her savings to meet up her consumption expectations. All other factors developed in the model were kept fixed. Using these derived functions, in terms of employment levels, a difference equation was developed to develop the time path for employment. It was derived from the difference equation that the time path for employment was stable under a particular condition, which has been labeled as Employment's Dynamic Equilibrium Condition in the paper.

APPENDIX

A.1 Detailed data used for calculations

Year	Imports (in billion dollars)	Exports (in billion dollars)	Consumer Spending (C in billion dollars)	GDP in billion dollars (Y)
1990	27.13	22.64	199.3683874	320.98
1991	22.94	22.94	201.8161899	270.11
1992	27.64	25.49	207.9667994	288.21
1993	27.42	27.47	212.2082372	279.3
1994	33.35	32.36	215.2971107	327.28
1995	43.32	39.07	229.5012643	360.28
1996	45.36	40.8	253.6355506	392.9
1997	49.61	44.46	265.7887015	415.87
1998	53.43	46.43	268.8590432	421.35
1999	61.31	52.54	293.6885933	458.82
2000	65.12	60.88	298.5501607	468.39
2001	65.22	60.96	311.3951555	485.44
2002	78.5	73.45	324.5635702	514.94
2003	95.07	90.84	373.7578955	607.7
2004	139.31	126.65	413.7991356	709.15
2005	183.74	160.84	470.7245401	820.38
2006	229.96	199.97	527.5793103	940.26
2007	302.8	253.08	678.4579006	1,216.74
2008	350.93	288.9	679.4958429	1,198.90
2009	347.18	273.75	750.9182463	1,341.89
2010	449.97	375.35	916.978109	1,675.62
2011	566.67	447.38	1024.685658	1,823.05
2012	571.31	448.4	1031.901767	1,827.64
2013	527.56	472.18	1070.321691	1,856.72
2014	529.24	468.35	1185.298233	2,039.13
2015	465.1	416.79	1241.269974	2,103.59
2016	480.17	439.64	1360.706916	2,294.80
2017	582.02	498.26	1557.081456	2,651.47
2018	640.3	538.64	1602.521697	2,702.93
2019	602.31	529.24	1621.119894	2,831.55
2020	509.43	499.1	1726.040715	2,667.69
2021	758.87	679.68	1891.901572	3,176.30

net Exports (NX)	Investment Spending in Billion Dollars (I)	Government Spending in billion dollars (G)	Aggregate savings in billion dollars (S)
-4.49	83.71854981	36.22417191	69.45806431
0	66.404744	29.92474746	59.16273312
-2.15	72.31044763	31.45825546	67.26998609
0.05	66.10404332	30.73044344	65.7633579
-0.99	76.44896933	34.15433033	80.91456882
-4.25	90.56330438	37.97447582	92.80550373
-4.56	96.35788859	40.59006554	98.67248227
-5.15	105.4232619	45.86516366	104.2146993
-7	107.270518	50.18232073	102.3095788
-8.77	126.336511	55.86358141	109.2680924
-4.24	121.883438	55.96246655	113.8805197
-4.26	145.3034039	57.09478234	116.950713
-5.05	145.8955033	58.26080115	132.1143358
-4.23	172.1907358	66.09472764	167.8469374
-12.66	217.7667849	73.7849467	221.5650511
-22.9	268.718234	85.04174095	264.6146344
-29.99	315.7853016	92.16870882	320.5119185
-49.72	435.7496132	119.9963069	418.2832506
-62.03	416.2336146	126.3458506	393.0558026
-73.43	455.5934866	153.7761311	437.1937215
-74.62	556.8087716	184.4456789	574.1936594
-119.29	625.5507346	202.0752769	596.2890247
-122.91	611.1067864	195.26243	600.4745944
-55.38	581.0754712	191.1522974	595.2472345
-60.89	613.3751378	212.9026434	640.9276388
-48.31	604.4275466	219.3684805	642.9502554
-40.53	646.8682977	236.5605612	697.5313251
-83.76	747.1263522	285.4890501	808.9012238
-101.66	796.3661077	292.5440205	807.8641157
-73.07	809.2924319	310.4319965	795.0786438
-10.33	709.2054447	322.4374239	724.1314371
-79.19	907.3082937	353.5212708	930.8742177

Source: World Bank

REFERENCES

1. Chiang, Alpha C. , *Fundamental Methods in Mathematical Economics*, Mcgraw Hill Education, 1967
2. Keynes, John M. , *The General Theory of Employment, Interest and Money*, Palgrave MacMillan, 1936
3. Robinson, Joan, *Essays in the Theory of Employment*, MacMillan and Co. ltd., 1947
4. Means, Gardiner, *A monetary theory of employment*, Routledge, 1955
5. Brenner, Y.S., *A Theory of Full Employment*, Springer, 1996
6. Harcourt, Geoffrey, *Income and Employment in Theory and Practice*, Springer, 1995
7. Knight, K.G., *Unemployment: An Economic Analysis*, 1986
8. "Gross Savings (% of GDP) | Data." 1990-2021. Worldbank.org.
<https://data.worldbank.org/indicator/NY.GNS.ICTR.ZS>.
9. Ortiz-Ospina, Esteban, Diana Beltekian, and Max Roser. 2018. "Trade and Globalization." *Our World in Data*. October 2018. <https://ourworldindata.org/trade-and-globalization>.
10. Mukherjee, D., & Majumder, R. (2011). Occupational pattern, wage rates and earning disparities in India: A decomposition analysis. *Indian Economic Review*, 131-152.
11. Schwanke, D. A. (2013). Barriers for women to positions of power: How societal and corporate structures, perceptions of leadership and discrimination restrict women's advancement to authority. *Earth Common Journal*, 3(2).
12. Portney, K. E. (2013). 'Local Sustainability Policies and Programs as Economic Development: Is the New Economic Development Sustainable Development,' Vol. 15, No. 1, *Climate Change and City Hall*, pp 45-62, US Department of Housing and Urban Development.
13. Abbas, Q. and E. M. Mukhtar (2000). 'The Role of Human Capital in Economic Growth: A Comparative Study of Pakistan and India,' *The Pakistan Development Review*, Pakistan Institute of Development Economics
14. Ploeg, F. (2011). 'Natural Resources: Curse or Blessing?' *Journal of Economic Literature*, Vol. 49, No. 2, pp. 366-420, American Economic Association.
15. Kanbur, R. (2020). 'Sustainable Development Goals and the Study of Economic Inequality,' *The Journal of Economic Inequality*, Cornell University.
16. Chaudhuri, S. (2004). 'International Migration of Skilled and Unskilled Labour, Welfare and Skilled-unskilled Wage Inequality: a Simple Model,' *Journal of Economic Integration*, University of Calcutta.
17. Beladi, H., A. Chakrabarti and S. Marjit (2009). 'Skilled-Unskilled Wage Inequality and Urban Unemployment,' *Economic Inquiry*, Vol. 48, No. 4, pp. 997-1007, Online Early Publication.
18. Sicular, T., X. Yue, B. Gustafsson and S. Li (2006). 'The Urban-Rural Income Gap and Inequality in China,' *World Institute for Development Economics Research*, United Nations University.

GENDER-POVERTY GAP AND THE INDIAN MPI

NEHAL KAUL*

Shri Ram College of Commerce, University of Delhi

Abstract

Given the vast literature existing on the “feminisation of poverty” (Chant, 2003) (Argiropoulos & Rajagopal, 2003) (Chant, 2008), this essay aims to reflect on the National Multidimensional Poverty Index of India¹ and to understand if the current structure of the Indian MPI sufficiently captures the incidence of disproportionality of female poverty or not. It is widely agreed upon that measures such as the MPI were created to get a bird's eye view of the development challenges plaguing the world. Therefore, in such a situation when the outcomes of such indices are used to allocate funds and develop policy solutions, it becomes of utmost importance that they truly represent the on-ground situation.

JEL Classification: I3, O1, O2

Keywords: Poverty Measure, Gender, Health, Education

1. INTRODUCTION

The United Nations' Sustainable Development Goals of 2030 identifies eradication of poverty as the first of its 17 agendas. It recognises that poverty eradication in all its forms is the most pressing global challenge and a necessary condition for sustainable and equitable development (Poverty Eradication | Department of Economic and Social Affairs). Although until the 1970s, poverty was traditionally measured using a uni-dimensional framework of either income or consumption, it is now widely accepted that poverty is much more nuanced than just the lack of income. It also includes lack of ability to access education, healthcare, sound and safe housing, employment opportunities and much more. In light of this, it is evident that no one indicator, such as income, is capable within itself to capture the multiple dimensions of poverty². Measures of income poverty are capable of providing information at the very basic level; however, a more holistic picture of poverty requires consideration of other parameters for numerous reasons. To begin with, the presence of income doesn't guarantee that individuals are able to access what they find valuable and necessary in life. Although income might act as a good proxy for being able to access basic necessities, some important

needs might not be satisfied if there is a failure in the functioning of markets or an inability to access markets. Secondly, the ability to convert income into the satisfaction of needs also varies among individuals. Individuals having the same level of income might not be able to enjoy the same standard of living as a virtue of their specific living conditions. Furthermore, when we look at income poverty, we are able to only gauge if an individual has enough income to access, let's say, education or healthcare. Having enough income doesn't in itself translate into well-educated or well-nourished individuals (Santos & Alkire, 2011). The recognition of the above drawbacks led to the formation of poverty measures which are more representative than the unidimensional income measure. The Multidimensional Poverty Index which was the successor of the Human Poverty Index has been commonly used since 2010 post its introduction in the flagship Human Development Report by the United Nations Development Program.

2. GENDER AND POVERTY

The link between gender and poverty has been widely studied over the last few decades. Even the first of the 17 SDGs recognises the gender-based

*Author's email address: nehalkaul2002@gmail.com

¹India uses Alkire-Foster (AF) methodology which is an extension of FGT and uses household level data collected via NFHS.

²According to the 2022 Global Multidimensional Poverty Index Report by UNDP, the data shows that 1.2 billion people live in acute poverty across 111 developing countries. This number is double of what we get when we use a unidimensional poverty measure of defining poor as those who live on less than \$1.90 per day.

disparities existing in poverty. Target 1.b)³ highlights the need for a gender-sensitive way forward for the eradication of poverty (Goal 1 | Department of Economic and Social Affairs). Studies have highlighted that women, girls, and female-headed households bear a disproportionate burden of poverty. A study conducted by the World Bank based on household surveys from 89 countries shows that overall girls and women of reproductive age are more likely to live in poor households than boys and men of the same age. According to the same study, 122 women between the ages of 25 and 34 live in poor households for every 100 men of the same age group (Boudet et al., 2018).

Women have less equitable access to resources which amplifies poverty by hindering access to important social systems. The incidence of poverty amongst women can be viewed by their ability (or lack thereof) to access and participate within the following social systems:

2.1. EMPLOYMENT AND ASSET OWNERSHIP

Owing to factors such as literacy rates, wage rates, social attitudes, etc. have created an uneven playing field for women in the job market, reducing their participation in the workforce. Those who find themselves in the workforce face the brunt of discrimination, gender-based wage gaps as well as occupational segregation with certain fields deemed more “man-like”. (The Gender Gap in Employment: What's Holding Women Back? 2017). This has led to lower levels of wealth accumulation with women only accumulating 74% of the wealth that their male counterparts do. (2022 Global Gender Wealth Equity Report, 2022)

2.2. HEALTH AND EDUCATION

Similarly on account of socio-economic factors women often find themselves unable to access proper healthcare which has the ability to have an adverse impact on their quality of life. It also acts as a negative externality for all other individuals in the households. The inability to access education reduces potential earning members of the family and makes the female members dependent on their male relatives.

2.3. GENDER BASED VIOLENCE

Around one-third of women worldwide have experienced physical and/or sexual violence by an intimate partner (The World's Women 2020: Trends and Statistics | United Nations, 2020). Public harassment is another concern that can restrict women's mobility and curb employment and education opportunities.

2.4. SOCIAL NORMS

Women continue to bear a disproportionate burden of care work and unpaid domestic work globally. On average, globally women spend 3 times the number of hours men spend on care work and unpaid domestic work (The World's Women 2020: Trends and Statistics | United Nations, 2020). This prevents women from participating in the labour force in many cases, as well as leaving them with little time for leisure activities, upskilling, and education.

3. ABOUT GMPI

GMPI refers to the Global Multidimensional Poverty Index. It is an international measure used to measure acute poverty⁴ in more than 100 countries across the globe. It is considered a complement to the existing poverty measures by accounting for the deprivation of individuals in 3 dimensions - Health, Education and Standard of Living using 10 indicators. The GMPI employs the Alkire-Foster (AF) methodology of dual cut-off for measuring the multidimensional nature of poverty.

Table 3.1: Structure of the GMPI

Dimension	Indicator	Weightage
Health	Nutrition	1/6
	Child Mortality	1/6
Education	Years of Schooling	1/6
	School Attendance	1/6
Standard of Living	Cooking Fuel	1/18
	Sanitation	1/18
	Drinking Water	1/18
	Electricity	1/18
	Housing	1/18
	Assets	1/18

Source: Oxford Poverty and Human Development Initiative

³ Target 1.b) states that – “Create sound policy frameworks at the national, regional and international levels, based on pro-poor and gender-sensitive development strategies, to support accelerated investment in poverty eradication actions”

⁴There are 2 major characteristics of acute poverty - It includes people who do not meet the minimum agreed standard of indicators of basic functioning and it includes the people who experience such deprivation in multiple indicators simultaneously.

Although the GMPI is cognizant of intra-household gender inequalities, it has not been able to integrate gender consideration into its analysis. It has been observed that MPI tends to be higher for households having a higher number of women or children (Alkire & Santos, 2013). Although ideally electing individuals as the unit of analysis and incorporating more gender-pertinent indicators might have helped to make the GMPI more gender-sensitive, it has not been possible due to technical considerations. The need to compare GMPI across countries necessitates a uniform design that incorporates indicators for which data is available for all the countries. It is found that due to the unavailability of data, the development of a women-specific GMPI is not possible for even 50 countries (Alkire & Kanagaratnam, 2021).

4. NATIONAL MULTIDIMENSIONAL POVERTY INDICES: ANALYSIS OF THE INDIAN NMPI

Countries around the world have developed their own national MPIs by harnessing the flexibility that the GMPI provides. Since NMPIs are not bound by the same restriction as the GMPI (with respect to comparability), they tend to be more flexible and can incorporate a gender lens in their poverty assessment methodology through the inclusion of gender-specific indicators and cut-offs. Generally, the NMPIs are tailored to reflect country-specific policy priorities.

The Indian MPI is based on the AF methodology which is based on the Foster-Greer-Thorbecke (FGT) class of poverty measures. This method classifies individuals as poor or non-poor on the basis

of a dual cut-off mechanism. The first cut-off is applied at the level of the individual indicator to be taken into consideration to understand if an individual is deprived in terms of a particular indicator. Thus a deprivation score is calculated for all the individuals by considering the deprivation at the level of individual indicators. The second-order cut-off then helps to identify if an individual is multidimensionally poor on the basis of this aggregated score.

Table 4.1: An example of calculation of deprivation score

Dimension	Deprived	Status	Weight	Score
Nutrition	Yes	1	1/6	0.16
Child and Adolescent Mortality	No	0	1/12	0
Maternal Health	Yes	1	1/12	0.08
Years of Schooling	No	0	1/6	0
School Attendance	No	0	1/6	0
Cooking Fuel	Yes	1	1/21	0.04
Sanitation	Yes	1	1/21	0.04
Electricity	No	0	1/21	0
Drinking Water	No	0	1/21	0
Housing	Yes	1	1/21	0.04
Assets	No	0	1/21	0
Banking Account	Yes	1	1/21	0.04
Deprivation Score				0.36

Source: Author's own calculation (based on the national MPI)

Considering the nutrition indicator, the individual is considered poor in that indicator since he/she doesn't fulfil the criteria for deprivation cut-off. This is the first cut-off. Second Order Cutoff = 0.33, thus the above individual is considered multidimensionally poor since his/her deprivation score ($0.36 > 0.33$) is greater than the second cutoff.

The indicators taken into consideration of the Indian MPI (National Multidimensional Poverty Index, 2021) are as follows:

Table 4.2: Indicators in the Indian National MPIs⁵

Dimension	Dimension Weight	Indicator	Indicator Weight	Deprivation Cut-off
Health ⁶	1/3	Nutrition	1/6	A household is considered deprived if any child (0-59 months), women (15-49 years) or man (15-54 years) - for whom nutritional information is

⁵In addition to the indicators which are considered in the global MPI measure, the Indian MPI also accounts for Antenatal Care in the Health dimension and Bank Accounts in the Standard of Living dimension.

⁶Unlike the global MPI measure, the indicators in the health dimension are not equally weighted. The indicators which take into account recent birth such as Antenatal Care and Child and Adolescent mortality share half of the weight of the health dimension equally to prevent the MPI measure to favour households that have no children or have had no birth in the preceding 5 years.

				available- is found to be undernourished. ⁷
		Child and Adolescent mortality	1/12	A household is considered deprived if a child or adolescent under 18 years has died in the 5 years preceding the survey.
		Antenatal Care	1/12	The household is deprived if any women in the household who has given birth in the 5 years preceding the survey has not received at least 4 antenatal care visits or has not received assistance from trained skilled medical personnel during the most recent childbirth.
Education	1/3	Years of Schooling	1/6	Not even one member of the household aged 10 years or older has completed 6 years of schooling.
		School Attendance	1/6	Any school-aged child is not attending school up to the age at which he/she would complete class 8.
Standard of Living	1/3	Cooking Fuel	1/21	The household cooks with dung, agricultural crops, shrubs, wood, charcoal or coal.
		Sanitation	1/21	The household has unimproved or no sanitation facility or it is improved but shared with other households.
		Drinking Water	1/21	The household does not have access to improved drinking water or safe drinking water is at least a 30-minute walk from home (as a round trip).
		Electricity	1/21	The household has no electricity
		Housing	1/21	The household has inadequate housing: the floor is made of natural materials, or the roof or the walls are of rudimentary materials.
		Assets	1/21	The household does not own more than one of these assets: radio, TV, telephone, computer, animal cart, bicycle, motorbike or refrigerator and does not own a car or truck.

⁷The deprivation construct of nutrition in the Indian MPI also ignores the age group of children from 6-14 years which comprise 18% of the Indian population, this severely underestimates the poor.

		Bank Account	1/21	No member of the household has a bank account or a post office account.
--	--	--------------	------	---

Source: National Multidimensional Poverty Index (Baseline Report)

The unit of identification and analysis in the case of the Indian MPI is the household. Although the NFHS⁸ collects data at an individual as well as household level, the MPI considers the information of all members in the household together. Thus, all members of a household are assigned a similar score even if some are more deprived or poorer than others. Although this structure is capable of accounting for any positive or negative intra-household externalities associated with nutrition, maternal health, and education, it is not able to capture the intra-household disparities which might exist between the male and female members of the household. For example: in the Year of Schooling Indicator, a brother and a sister in the specified age group, will both be considered non-deprived if only the brother attends or has completed 6 years of schooling. Now although the above situation would be identified in the School Attendance indicator, a situation wherein there are no children in the household and even one male educated member, the entire household would be considered as non-deprived in terms of education, even if every other member has not had at least 6 years of schooling. In this regard, the NMPI of Pakistan has a much more restrictive cut-off for Years of Schooling; it declares a household as deprived if a man or a woman aged 10 or above has not completed 5 years of schooling. So, even if a man has completed the requisite years of schooling, the household will be considered deprived if the woman has not completed 5 years of schooling herself. Similarly, Afghanistan's NMPI, disaggregates schooling into female and male schooling, thus capturing the gender disparities which are present within households.

Another point of consideration is the bank account indicator. According to this indicator, a household is considered non-deprived if even one member of the household has a bank account. As per NITI Aayog, this indicator is incorporated as bank accounts enable

financial inclusion and improve the capabilities of households by allowing them to avail benefits of government social security programs, allow access to institutionalised credit and allow for savings. The report (National Multidimensional Poverty Index, 2021) further highlights the supporting role of bank accounts to escape poverty in a female headed-household, yet there is no component to make this indicator gender-sensitive⁹.

Hence poverty measures based on household-level data (which ignore the household-level disparities by assuming equitable distribution) present an unfair picture of poverty incidence. The results from such studies which try to interpret individual-level results from household data tend to obstruct the differences between poverty. A study showed that ignoring intra household inequality can result in poverty measurement errors to the extent of 30% (Kanbur & Haddad, 1990).

5. RECOMMENDATIONS

Undoubtedly, as compared to the global MPI, certain incorporations in the Indian MPI make it more sensitive to gender issues in our country such as incorporation of Antenatal Care and Cooking Fuel. Yet, there is much more that can be done. The above section highlights the weaknesses of the current national MPI of India in terms of it being sensitive to gender-based disparities. This section, aims to explore what are certain changes that can be brought about in the construction of the NMPI. As mentioned previously, gender disparities have the ability to manifest themselves in Employment and Asset Ownership, Health and Education, Gender Based Violence, and Social Norms; incorporating indicators that take into account these dimensions can make the MPI more sensitive to gender-based disparities. This has been done by several nations around the world as is represented in the table below (Dirksen, 2020),

⁸National Family and Health Survey is the national household survey which is used for the calculation of the MPI in India

⁹A similar indicator in the case of the NMPI of Palestine has a gender component associated with it.

to avail healthcare services is pertinent in the case of India where access to healthcare is skewed against women vis a vis men (Dasgupta, 2020).

In the case of the NMPI of Palestine, specific indicators of personal freedom and safety have a gender-sensitive component to them. Indicator of personal freedom concerned with females: Control of women's income or women's participation in the labour market with deprivation limit as - Any women in the household does not have a separate bank account or does not control her use of income or earnings OR Any women in the household does not work (or look for work) because of husband/father/brother's restrictions.

Whereas, indicator of the safety dimension concerned with women considers the interpersonal and state violence faced by females with deprivation limit set as - Any household member was attacked or forcibly assaulted with or without a weapon last year OR, any child or women hit or attacked by another family member during the past year OR Injuries, deaths or torture in the household from state/settler violence during the past year. Such an addition is extremely important in case of the Indian MPI

because of the high number cases of domestic and sexual violence. According to NFHS-4 data, 30% of all women in India have experienced domestic violence at least once from when they are aged 15. Literature and studies point toward significant linkage between domestic violence and poor health and well-being of not only the survivors of such violence but also the children they give birth to. (Suri et al., 2022)

6. CONCLUSION

To conclude, although some steps have been taken, there is definitely much more that can be done. Although ensuring robust data collection about more factors is a long term approach, in the short run the existing data can also be used to paint a fairer picture of the disparities faced by the females in our country. Therefore, it is necessary that the NMPI is changed and updated while keeping in mind the specific realities of Indian society and how it impacts the poor (women). This is especially true when one realises that MPI is not just a statistic but rather a tool which can be used to allocate limited budgetary resources to alleviate poverty by capturing and working on inter-related deprivations.

REFERENCES

1. Alkire, S., & Kanagaratnam, U. (2021, May 14). Revisions of the Global Multidimensional Poverty Index: Indicator Options and Their Empirical Assessment. Oxford Development Studies. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3844922
2. Alkire, S., & Robles, G. (2016, March). Measuring Multidimensional Poverty: Dashboards, Union Identification, and the Multidimensional Poverty Index (MPI). Oxford Poverty and Human Development Initiative. <https://www.ophi.org.uk/wp-content/uploads/OPHIRP046a.pdf>
3. Alkire, S., & Santos, M. E. (2013, March 14). Measuring Acute Poverty in the Developing World: Robustness and Scope of the Multidimensional Poverty Index. Oxford Poverty and Human Development Initiative. <https://ophi.org.uk/wp-content/uploads/ophi-wp-59.pdf>
4. Argiropoulos, C., & Rajagopal, I. (2003, February). Women in Poverty: Canada and India. *Economic and Political Weekly*, 38(7), 612-614.
5. Boudet, M., Maria, A., Buitrago, P., Leroy De La Briere, B., Newhouse, D. L., Rubiano, M., Carolina, E., Scott, K., & Suarez Becerra, P. (2018). GENDER DIFFERENCES IN POVERTY AND HOUSEHOLD COMPOSITION THROUGH THE LIFE CYCLE. UN Women. <https://www.unwomen.org/sites/default/files/Headquarters/Attachments/Sections/Library/Publications/2018/SDG-report-Spotlight-01-Gender-differences-in-poverty-and-household-composition-en.pdf>
6. Chant, S. (2003, May). Female Household Headship and the Feminisation of Poverty: Facts, Fictions and Forward Strategies. LSE Research Online. <http://eprints.lse.ac.uk/574/1/femaleHouseholdHeadship.pdf>

7. Chant, S. (2008, June). The 'Feminisation of Poverty' and the 'Feminisation' of Anti-Poverty Programmes: Room for Revision? Taylor & Francis Online. <https://www.tandfonline.com/doi/abs/10.1080/00220380701789810>
8. Dasgupta, A. (2020, February). India's women may be missing tertiary healthcare. Nature India. <https://www.nature.com/articles/nindia.2020.23>
9. Dirksen, J. (2020, December 4). Which are the dimensions and indicators most commonly used to measure multidimensional poverty around the world? MPPN. <https://mppn.org/national-mpi-dimensions-and-indicators/>
10. Global Multidimensional Poverty Index | OPHI. (n.d.). Oxford Poverty and Human Development Initiative. <https://ophi.org.uk/multidimensional-poverty-index/> Goal 1 | Department of Economic and Social Affairs. (n.d.). Sustainable Development Goals. <https://sdgs.un.org/goals/goal1>
11. Kanbur, R., & Haddad, L. (1990, September). How Serious is the Neglect of Intra-Household Inequality? The Economic Journal Vol. 100, No. 402. https://pdf.usaid.gov/pdf_docs/PNABH829.pdf
12. National Multidimensional Poverty Index. (2021, November 24). | NITI Aayog. https://www.niti.gov.in/sites/default/files/2021-11/National_MPI_India-11242021.pdf
13. Poverty eradication | Department of Economic and Social Affairs. (n.d.). Sustainable Development Goals. Retrieved January 20, 2023, from <https://sdgs.un.org/topics/poverty-eradication>
14. Santos, M. E., & Alkire, S. (2011, November 23). TRAINING MATERIAL FOR PRODUCING NATIONAL HUMAN DEVELOPMENT REPORTS The Multidimensional Poverty Index (MPI) Sabina Alkire and Ma. Oxford Poverty and Human Development Initiative. https://www.ophi.org.uk/wp-content/uploads/MPI_TrainingMaterial_23Nov2011.pdf
15. Suri, S., Sarkar, D., & Mona. (2022, January). Domestic Violence and Women's Health in India: Insights from NFHS-4. ORF. https://www.orfonline.org/research/domestic-violence-and-womens-health-in-india-insights-from-nfhs-4/#_edn11
16. The gender gap in employment: What's holding women back? (2017). ILO. <https://www.ilo.org/infostories/en-GB/Stories/Employment/barriers-women#footer>
17. The World's Women 2020: Trends and Statistics | United Nations. (2020, October 20). the United Nations. <https://www.un.org/en/desa/world%E2%80%99s-women-2020>
18. 2022 Global Gender Wealth Equity Report. (2022, November 2). WTW. <https://www.wtwco.com/en-nl/Insights/2022/11/2022-global-gender-wealth-equity-report>

THE SOCIAL ROULETTE: A GAMBLE OF CHANCE AND INEQUALITY IN TIMES OF ECONOMIC CRISES

UTSA KAR* and SARTHAK SARKAR
St. Xavier's College, Kolkata

Abstract

This paper seeks to scrutinize the relationship between gambling and economic crises stemming from a plethora of factors which are but not limited to war, political turmoil, social upheaval and general unrest but at a micro-economic level with respect to individual behavior which has been the foundation for preceding literature on this topic in establishing a rather macroeconomic background to gambling as an economic behavior by employing a general qualitatively defined utility function. We specify this analysis to even greater degree by zeroing in on the subsection of the population which has been empirically identified as the recipient of a stratification induced social sedimentation of multifaceted risk factors which significantly metastasizes the propensity to gamble. Finally, we suggest certain targeted policy prescription to effectively mitigate certain risk factors and satisfy our mathematical analysis of the same.

JEL Classifications: D81, D71, J15, D64

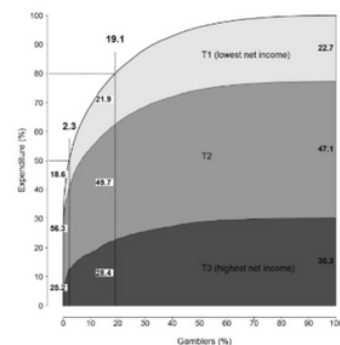
Keywords: Probabilities, Rationality, Uncertainty, Choice and Demographic.

1. INTRODUCTION

The idea of gambling has been omnipresent across much of the entire temporal spectrum of human existence on this planet. What hasn't been constant is its societal perception and subsequently its status and associations, case in point, the American card game of poker used for gambling purposes, is believed to have its ancestor in the card game named "As-Nas" which was a royal game played in the courts of Ancient Persia which gained popularity in the USA during its various wars as its pastime for the gentry and other migrants from across the Atlantic. The prevalence of gambling is not a mere coincidence however as the core principle of risk-taking that such a game involves and indulges is something intrinsic to the fundamental nature of humans as well who are naturally inclined towards the practice of gambling on a day-to-day basis in their lives albeit without the particular designation of it being gambling. However intrinsic might it be, it isn't something that has had a positive public perception of it on its side for the longest time. On a geographical, cultural and temporal scale, it has had varied responses to it. In

eastern Asian countries such as Japan and China where such practices are believed to have originated, it is something that is woven into the indigenous culture without any barriers to entry or accessibility. This is extremely relevant when compared to their neighboring state of Hong Kong which had been under British rule with greater colonial influence persisting beyond the years of occupation, has a blooming business culture centered around the practice of gambling in highly organized and regulated enterprises known as casinos which earn the government a significant portion of its revenue in

Figure 1: Gambling and Income



Source: Grönroos et al., (2022)

and of itself as well as attracting tourists from various countries.

These occurrences aren't just random results of an unrelated sequence of events rather they are a direct product of the economic behavior as molded by various factors such as culture, history so on and so forth. Hong Kong being a British colony was an attractive economic destination during the era of British Hegemony over the world order which meant that indigenous communities were routinely oppressed and marginalized by a colonial overlords which fostered certain habits among the gentry of the city one of them being gambling in many forms which proliferated rapidly to the extent that even legislative mandates couldn't eradicate it from the public sphere especially that of the people belonging to the lower strata of society which in turn brought about a negative connotation of the practice. This isn't too dissimilar to how gambling became a resort for the African American community in the United States especially during the inter war period landmarked by the economic collapse of the great depression alongside the onset of the second world war which accrued massive economic, social and moral costs to the American populace especially the marginalized groups. Hence, these factors are largely a determinant of people's choices of consumption and gambling amidst a period of turmoil, economic or otherwise.

Gambling in the current status quo is somewhat treated as a taboo because of its nature as a game of chance as well as its most concentrated prevalence in groups which are already associated with a negatively skewed perception. The organic reasons or rather the variables which lead to the parametric establishment of gambling is something that had piqued our interests leading us to evaluate the various determinants of rational choice under uncertainty and people's approach towards the idea of risk accommodating changes in expectation as well as psychological factors which affect the aforementioned aspect of consumer choice.

Large scale economic crises are often most accurately analyzed on the basis of micro-level changes in behavior of the people as that is the level where it is reflected to the greatest degree. This is exactly what our paper seeks to find namely the changes in consumer choices with respect to increase in macro-level risk surrounding income and other means of livelihood in the form of parameterized adjustments brought on by the occurrence of economic crises

akin to that of the great depression or the world wars which as stated before has had far reaching consequences on the psyche of the consumers naturally changing their patterns of consumption and inclination towards risk taking behavior. This is especially true of the marginalized communities because of a trickle-down amplification of adverse economic shocks which affect these group the quickest and hit them the hardest as they bear the brunt due to their presence at the very grassroots level of economic activities such as daily labor and employment opportunities in the similar bracket. This is why our paper has selectively chosen to magnify the plight of marginalized groups and why specifically the change in their consumption patterns on the pillars of historical precedence ergo empirical evidence has been scrutinized under the scope of this paper. This adds a new dimension to the already present literature studying choice under risk. The dimension of social inequality which has perpetually been a part of human history. Here, we add this into our analysis of consumer behavior and prove the counter intuitive notion of an increase in such choices despite a rise in the degree of risk associated with it in terms of various crucial factors directly tied to the very livelihood of such marginalized groups in society. This also percolates into the moral dimension of consumption choices which are made relevant too in our analysis of this shift in consumption pattern.

It doesn't however, end here as even crises as recent as the COVID-19 pandemic showed a greater deal of general interest and participation in activities involving a game of chance offered at a certain investment level due to various factors which were amplified due to the crisis such as a buoyant stock market even in the face of a catastrophic humanitarian and economic crisis which set back society by a considerable amount of time. This reflects that the question which this endeavor seeks to answer remains relevant in the present scenario as well alongside the various determinants which are duly explored in the literature review section of this paper. In fact, the prevailing technological environment not only facilitated the proliferation of information pertaining to gambling but also provided the platforms to do so, which naturally encouraged people to invest more even though they were facing an acute economic crisis. This further strengthens the need to understand and process the microeconomic relations governing the increased

demand for such gambling activities.

Another aspect worth looking into is that of societal structures enabling the activity. The very first question that can come into one's mind reading this is the possibility of gambling and its subsequent consumption patterns in privileged portions of society as, beyond its negative connotation as a hobby, there is also a prevalent narrative which lionizes the practice of gambling in casinos and makes it a symbol of higher status and thereby associating that activity with that of glee, glamour and gallantry, even paradoxically so, in the instance of Hong Kong, which as aforementioned emerged as a direct consequence of colonial oppression has become in this status quo, one of the most highly sought after destinations for conspicuously consuming gambling as an activity. A similar perception runs true for the city of Las Vegas in California which has its fair share of history regarding gambling which is deeply engendered by the entrenched social hierarchy. Examples of the same alongside these two runs abound across time and space. This kind of a contradiction however is not in the purview of our paper because of various reasons starting with the relative insularity of the privileged against adverse economic shocks as well as the absence of incentive in the form of upward social mobility make it trivial to our motivation and research question which specifically attempts to develop a micro-theoretic model based on consumer choice theory.

Hence, the introduction can be concluded at this point with the summarization and reiteration of our approach towards gambling and its proven correlation with macro-level adverse economic shocks in the form of a micro-economic approach which takes into the account the various factors involved in the decision-making process of the consumers. We take the analysis one step further by focusing on a particular stratum of society for the reasons we have mentioned above which will be substantiated academically in the literature review section. Now, we move onto the crux of the paper which encompasses the complex variables which shape the theoretical framework of our analysis against the backdrop of the research question to be stated in the following section.

2. RESEARCH QUESTION

What is the micro-economic background to the established yet counter-intuitive notion of increased participation in activities involving a payoff/utility mired in uncertainty in the face of a macroeconomic crisis affecting society at large especially with regards to the disadvantaged communities of those societies who face a greater existential risk in the circumstances endangering their lives and livelihood?

3. LITERATURE REVIEW

The brunt of any adverse situational or macro social and economic changes like the Economic crisis of 2008 or the Great Depression of 1929 is borne disproportionately by the weaker and marginalized sections of society. Layoffs are more severe in the informal sector leading to widening income inequality in society and higher levels of uncertainty. If economic rationale were to prevail, the fall in income for any individual or household should translate into increased thriftiness in response to uncertainty. However, studies conducted in Iceland show how the enduring economic recession that followed the collapse of the Icelandic banking system in 2008 led to a rise in gambling amongst the poorer sections of the society. A similar survey in New Zealand revealed that more individuals from ethnic minority groups like the Māori were engaged in gambling after the economic crisis than before. The Italian economy was severely affected by the Great Recession, which started around 2008. The gambling industry in Italy still grew during this period despite the economic decline. Researchers also found that as the male unemployment rate rose, which is an indicator of worsening economic conditions, people spent more on luck-based gambling. This leads us to the pressing question that our paper seeks to resolve: What are the factors causing such paradoxical change in behavioral pattern and what are the policies that could deter the same? The decision to gamble is incumbent upon a spectrum of cognitive, contextual, cultural, socio-structural and economic factors. The classical deprivation or strain theory of Devereux (1980) establishes a direct correlation between factors such as low levels of education and disadvantaged socio-economic positions with higher states of anxiety, leading to compensatory patterns of

behavior like gambling. The frustration from job loss or lowered income is heightened during any economic crisis when job creation is also on the decline. In such a situation gambling provides the means to release tension without having a disruptive impact on social order (Beckert and Lutter 2009). It constitutes a recreational activity with no adverse repercussions. Given the dismal actuality of existing social inequity, it would not be a gross misconception to identify the vulnerable sections of the population with lower educational levels and hence higher cognitive biases leading to systemic overestimation of the probability of winning and poor risk assessment capabilities. Additionally, the knowledge of their lack of means excludes them from the imaginative consumption of conspicuous commodities such as luxury cars and fine clothing. But the “fantasy world of the big win” can be bought at a cheap rate of a lottery ticket (Horva'th & Paap, 2012) intensifying the lure of the lottery as a vehicle to solve their financial woes. Friedman and Savage (1948) show that unskilled workers might prefer an actuarially fair gamble that offers a small chance of lifting them out of the class of unskilled workers into the “middle” or “upper” class to the certainty of income, notwithstanding the fact that the former choice is far more likely to make him one of the least prosperous unskilled workers. As the notion of meritocracy and ascriptive inequality gets reinforced during any period of economic austerity, further constricting the gamut of opportunities for upward mobility, members from lower strata find the apparent egalitarian distribution of chance of success in gambling which is independent of skill, class, education, or family background more attractive. However, memories of hardships faced in childhood due to excessive gambling by a family member act as deterrents and negatively impact the substitution rate of gambling with activities that ensure a sure source of income (Casey, 2021). In the event of an economic downturn, austerity policies abound. In cultures where individual autonomy and consumerism are celebrated, people experiencing financial hardships are more likely to opt into gambling during these times than in cultures valuing prudence and productivity.

4. METHODOLOGY

Since we are primarily concerned with the optimized decision making by consumers, we go ahead and

develop corresponding utility functions to be associated with the consumption bundle of the consumers. Naturally, the characteristics binding standard utility functions apply here. For the sake of simplicity, we introduce the functional form of the utility relation and then present them in a linear form for direct derivations.

Table 1: *Relevant notations*

Variables	Denotation
I	A fixed amount of income
ω	chance of upliftment
α	degree of economic crisis
$P(\cdot)$	Subjective probability of winning the gamble
U_L^G	Utility function of a gambler from the lower strata of society
U_L^N	Utility function of a non gambler from the lower strata of society
$I(\cdot)$	Income of an individual as determined by the crisis level affecting the economy

Source: Authors elaboration

ireater deal of general interest and participation in activities involving a game of chance offered at a certain investment level due to various factors which were amplified due to the crisis such as a buoyant stock market even in the face of a catastrophic humanitarian and economic crisis which set back society by a considerable amount of time. This reflects that the question which this endeavor seeks to answer remains relevant in the present scenario as well alongside the various determinants which are duly explored in the literature review section of this paper. In fact, the prevailing technological environment not only facilitated the proliferation of information pertaining to gambling but also provided the platforms to do so, which naturally encouraged people to invest more even though they were facing an acute economic crisis. This further strengthens the need to understand and process the microeconomic relations governing the increased demand for such gambling activities.

Another aspect worth looking into is that of societal structures enabling the activity. The very first question that can come into one's mind reading this

4.1 MATHEMATICAL MODEL: FORMATION AND FUNCTIONING

As aforementioned, social hierarchy plays a key part

in our analysis of gambling behavior, in order for the model to reflect this particular attribute, we devise two separate utility functions corresponding to one's social status or position in social hierarchy. This is reasonable assumption from an intuitive standpoint especially in the context of our analysis where the primary source of utility is income earned from wages. Ample empirical evidence and economic analysis exists on the incidence of discrimination on wage, which solidify the reasons on the basis of which we include this a negative function of exploitation stemming from lower social status, starting from Becker's (1957) pioneering paper in establishing a correlation between taste-based discrimination and wages. Discrimination in terms of employment and returns from the same are well documented across many social disciplines, some instances of which is Hirata, Soares (2016) which are although tangentially related to this particular aspect of discrimination as there is a greater emphasis on the economic significance of the same. Nevertheless, they ultimately attest to the fact that there exists a negative effect on utility from lower social status. This effect is multi-fold as lower social status accruing to discrimination and prevalent stratification also trickles down in creating harsher living conditions, adverse social and psychological environment which result in disutility for the individual consumers. Even physical health is worse off for the people belonging to marginalized communities with a higher likelihood of being positioned in disadvantageous position in society. These facts need accurate representation in any formulation of a utility function for a general consumer. This proves to be an additional burden on the income of the consumer making it convenient for us to explain this factor We accommodate this by creating assigning the utility function U_H and U_L to denote the utility function for someone belonging to a higher and lower social stratum. Since our analysis is mostly focused on the latter, we first define U_H to be the income of the consumer belonging to the higher stratum as follows:

$$U_H = \bar{I} + I(0) \quad (1)$$

Here, $I(\alpha)$ takes the maximum value as it is a decreasing function of $\alpha \in (0, 1)$

U_L , however, requires even more specialization to accommodate the two primary types of consumers belonging to the lower stratum pertinent to this

paper namely, the gambler and the non-gambler. The utility function for the non-gambler is a straightforward linear equation which is the sum of the income and the negative of income as function of alpha. This reflects the factors we have stated above barring alpha which will be explained in a separate paragraph. Let us denote this utility function by U_L^N

$$U_L^N = \bar{I} + I(\alpha) \quad (2)$$

Now, for the gambler's utility function, we incorporate the basic premise of calculating the prospective winnings of a gamble into the function where, there remains two possibilities i.e., one being of accruing losses from gambling and the other being that of winning from the gamble. We assign a probability distribution to the chance of winning the lottery which can be categorized as something good/bad depending on the skewness of the distribution, thereby being interpreted as the mean chance of winning which is directly proportional to its quality. There is also a subjective probability assigned to the actual rate of the gambler to signify the chance of realization of an aspirational value that stems from the desire to attain a higher social status which is also tied into the probability of winning from that gamble as income remains a key determinant of social status. This probability is subjective for a multitude of reasons namely: the social status of the person which determines to an extent, the ability to gather and subsequently process information regarding the possibility of winning said gamble which may be skewed due to perceptive and cognitive biases stemming from hearsay and so on. On top of which, lottery sellers do not reveal the statistically accurate measures of winning as in selling their product, they market their product which appeals to everyone and doesn't deter them in anyway as a statistical number on a lottery ticket may plausibly do. Thus, the utility for a gambler is composed of the three factors in the following way:

$$U_L^G = P(\alpha)\{\bar{I} + I(\alpha) + G.1\} + \{1 - P(\alpha)\}\{\bar{I} + I(\alpha)\} \quad (3)$$

The final and most important variable in our analysis is that of α which represents the degree of economic crisis in the country. α is a representative variable indexed upon various macroeconomic indicators such as unemployment, core inflation, wage growth or lack thereof, all of which are psychologically

factored into economic decision making by consumers due to their direct impact on the livelihood of the target demographic of this research endeavor. However, to avoid the computational complexities and umbrella assumptions pertaining to the degree of effect of these factors, we use α to indicate proportionate changes in the level of crisis affecting the stakeholders in our analysis, which precludes the idea of a threshold and converts the variable into one wherein the central idea is condensed into a factor affecting the perception and subsequently decision making of these people. We take a continuous domain for α because of the fact that economic crises in general are mostly identified and dealt with in posterity of the actual crisis occurring. Secondly, an economic crisis is not just a function of tangible machinations which form the foundation for any economic system to thrive. It is also contingent on the psyche of individuals which admittedly are mostly reactionary for a vast majority of the people. For example, recent housing crises (China, 2021 and USA 2008) which has had global consequences have not been existent on just a discrete point in time, instead existing in varying intensities over a temporal spectrum which means that the impacts of the said crises will also affect the endogenous variables so identified in ways which are to be made clear in the upcoming paragraphs alongside the mathematical implications of the same. This makes it easy to correlate and conclude on a relation as the second part of our analysis with respect to gambling, it is a key component in determining the various components of utility so identified, especially for the lower strata. Then, we must qualitatively ascertain the relationship between each variable in order to better understand the dynamics of this model. Similar to gambling, we omit the presence of an economic in the utility function associated with the higher stratum of society because of an empirically proven insularity of the higher classes relative to the lower stratum against economic shocks as well as its general unimportance in terms of our analysis. Hence, α is null for U_H . Income(I) is a negative function of α because higher degree of economic crisis affects the income through inflation, unemployment and others in a negative way. Mathematically, it can be expressed as follows:

$$I = I(\alpha) \tag{4}$$

$$\frac{dI}{d\alpha} < 0 \tag{5}$$

P is a negative function of the crisis factor as one values their chances of winning to be lesser in the face of increased widespread uncertainty.

$$P = P(\alpha) \tag{6}$$

$$\frac{dP}{d\alpha} < 0 \tag{7}$$

On the other hand, ω representing one's chance in upliftment is the strongest when there is no crisis occurring and gradually decreases with the increased intensity of the crisis. ω is a decreasing function of α where, $\omega, \alpha \in (0, 1)$.

$$\omega(0) = 1 \tag{8}$$

$$\omega = \omega(\alpha) \tag{9}$$

$$\frac{d\omega}{d\alpha} < 0 \tag{10}$$

At this point, we develop the relationship between two utility functions of gambling and non-gambling respectively.

$$\omega(\alpha)U_L^G = \omega(0)U_L^N \tag{11}$$

Where U_L^G and U_L^N are defined by equations (2) and (3)

We primarily use an equality sign to denote the relationship between the utility functions, this is significant because gambling as a commodity involves choice under risk which by convention shouldn't be preferred to certain income. Hence, we use this equality sign to find a level of G which is consumed even when the utility from gambling during a crisis discounted by the factor $\omega(\alpha)$ is exactly equal to the utility from not gambling during periods of relative stability, which when derived with an inequality greater than 0, gives us the sufficient conditions for consumption of gambling given utility levels. This condition embodies the essential idea of a reduction in chances of upward mobility in times of crisis due to the exacerbation of existing discriminatory social norms that necessitate resorting to gambling to keep one's utility intact at pre-crisis levels.

4.2 COMPARATIVE STATICS AND FINDINGS

4.2.1 LEMMA 1:

Consumption of gambling as a good is contingent on a direct relation between the utility functions

which is only possible when the utility from gambling exceeds the utility from non-gambling. This is intuitively easy to understand from a utility maximizing perspective. We further derive the results mathematically in the appendix A.1 and arrive at the necessary conditions required for gambling goods to be consumed. It takes the following form:

$$\frac{\{I + I(\alpha)\}\{1 - \omega(\alpha)\}}{P(\alpha)\omega(\alpha)} = G \tag{12}$$

G is greater than 0 if and only if the product of the income and (1- ω) is greater than 0 which is only possible when omega or the aspirational factor is not equal to 1. The aspirational factor is equal to 1 only in the case when alpha takes the value 0 and as explained earlier, in the absence of an economic crisis, the aspirational rate can take the highest value solely because at that point of social stratification is the least stringent compared to a time period amidst an economic crisis. This reasoning for this is quite clear as it is a combination of deficient demand for goods, translating to that of labor leading to lower overall income coupled with austerity policies implemented by the government and general price inflation causing higher strain on lower strata due to a low base of income in the first place. Secondly, to add to that, there are the adverse medical and socio-cultural factors compounding the issue further to the detriment of the populace. Due to a large prevalence of poorer living standards and greater exposure to hazardous environment led to more harm for the people. This also eventually spills over to the chance of attaining a higher status as a vicious cycle tends to form imprisoning people in the same stratum and thus reducing ω . With reference to the equation above, it is clear that consumption of gambling as a good is directly proportional to the income I and inversely proportion to the perceived chance of winning owing to cost minimizing behavior and the chance of upward mobility owing to increasing despair arising out of a worsening crisis.

4.2.2 COMPARATIVE STATICS

Increase in Economic Crisis(α) Mathematically, it will be an increase in the value of alpha which when incorporated into the model corresponding to the degree and direction of response, will cause primarily income to fall because of the added mental, medical and societal costs of living accruing to a heightened

economic crisis faced by an individual from the lower stratum resulting in lower standards of living. This kind of general and widespread concern will pervade into the physical and mental space of the individual who will now be more likely to perceive that lotteries will be less likely to earn them any sort of winning whatsoever, causing the subjective probability of winning the gamble much lesser. On the other hand, the omnipresent notions of ascriptive inequality will get reinforced in the minds of the people as well as be a detrimental factor in reality against the possibility of upward social mobility for the person, implying that omega too would fall as established earlier providing greater incentive for indulging in gambling. To support this, mathematically, we employ differentiation to arrive at the following equation:

$$\frac{dG}{d\alpha} = \frac{P(\alpha)\omega(\alpha)\left[-\frac{d\omega}{d\alpha}(I + I(\alpha)) - (1 - \omega)\left(\frac{dI}{d\alpha}\right)\right] - (1 - \omega)(I + I(\alpha))\left(\frac{dP}{d\alpha}\omega + \frac{d\omega}{d\alpha}P\right)}{(P(\alpha)\omega(\alpha))^2} \tag{13}$$

Therefore, for $\frac{dG}{d\alpha} > 0$ (14)

$$0 < \frac{\frac{d\omega}{d\alpha}}{\omega(0) - \omega(\alpha)} < \frac{\frac{dI}{d\alpha}}{I + I(\alpha)}$$

Which when checked for positivity condition leads us to the intuitive condition (showed in equation 12 & 13) that a fall in chance of upward mobility with respect to the initial chance has to be greater than the fall in income with respect to the initial income for the person to engage in greater consumption of gambling goods. Given fulfilment of this condition, we arrive at the following conclusion:

4.2.3 LEMMA 2

An increase in the level of economic crisis plaguing a country has a positive effect of the consumption of gambling whose incidence is higher on the lower stratum of society who also bear a disproportionate amount of strain at many levels due to the aforementioned change.

5. POLICY PRESCRIPTION

5.1 GOVERNMENT MANDATED DISCLOSURE OF STATISTICALLY ACCURATE WINNING PROBABILITY BY THE LOTTERY ORGANIZER

We have intuitively shown people assign progressively lower values to their probability of winning the lottery as uncertainty increases. This value can be safely regarded as being less than the

actual probability of winning. If the government were to mandate disclosure of statistically accurate winning probability by the lottery organizer, the probability of winning would cease to become a function of uncertainty and the factor of asymmetric information would be eliminated. For \bar{p} greater than p of α , accurate perception of chances of success would induce individuals to buy lesser lottery tickets at any given level of crisis.

$$\text{Let, } \bar{P} > P(\alpha) \tag{15}$$

$$\text{Then } \frac{\{I + I(\alpha)\}\{1 - \omega(\alpha)\}}{P(\alpha)\omega(\alpha)} > \frac{\{I + I(\alpha)\}\{1 - \omega(\alpha)\}}{P\omega(\alpha)} \Rightarrow G < G \tag{16}$$

5.2 GOVERNMENT AIDED SUPPORT PROGRAMS TO DISINCENTIVIZE GAMBLING

The government could guarantee a social security scheme to reverse the causality between gambling (G) and crisis-born uncertainty assuring enough income to offset the conditions derived in Lemma 2 and ensure lesser participation in gambling on the virtue of a reduced vector of causative factors pertaining to the economic societal and psychological. An amount is lying within the interval defined below when given to individuals of the lower-income group, would effectively deter gambling during periods of economic austerities.

$$\left(\bar{I} + I(\alpha) - \frac{\omega(0) - \omega(\alpha)}{\frac{d\omega}{d\alpha}} \frac{dI}{d\alpha}\right) < S < (\bar{I} - I) - \frac{p\omega(1 - \omega) \frac{dI}{d\alpha}}{\frac{d\omega}{d\alpha} + (1 - \omega)\left(\frac{dP}{d\alpha}\omega + \frac{d\omega}{d\alpha}P\right)} \tag{17}$$

6. CONCLUSION

Our model has been a micro-theoretic analysis of the gambling preferences of individuals belonging to the lower-income stratum against the backdrop of an economic meltdown. There are a host of socio-economic and cultural factors that influence this addictive behavioral tendency, of which we have chosen to foreground the following few: i) Uncertain income as captured by the term $I(\alpha)$. Labor laws are slackened in the wake of any economy-wide financial crisis, making way for exploitation, unfair reductions in wages and disproportionate financial hardships for lower-income households. ii) Perceived probability of success (here, winning the lottery) as being dependent on macro-level uncertainty represented by P . As the prevailing instability palls

the future, individuals expect lower gains from all sources of income including the games of chance. iii) The imminent mechanism of upward mobility for individuals in the lower strata is portrayed by ω . The chances of navigating into the higher classes get increasingly hindered with the increase in the macro-risk factor owing to the exacerbation of institutional and societal discrimination. Having made a clear distinction between the utility derived from not gambling and gambling, we assumed that individuals refrain from gambling in the absence of instability. Equating the discounted utility from not gambling and gambling we derived the number of lottery tickets that the individual needs to consume in periods of uncertainty wherein factors i) and iii) positively influence gambling while factor ii) has a negative impact. The fact that the lure of a “big win” offsets the decreased expectation of succeeding at the game of chance explains the latter causality. Next, we find an increase in gambling tendencies with a rise in instability, provided his or her fall in chances of upward mobility outweighs the proportional fall in income due to the uncertainty. Despondence over the limited scope presented by a crisis-torn society to climb up the income ladder reflected by increased rejections of job applications based on ethnicity, religion, etc., acts as a far greater incentive for the individual to resort to gambling than a mere fall in income. Gambling becomes a vehicle of hope for upward mobility. However, increasing preference for gambling as opt-out mechanism breeds within the individual a resigned acceptance of one’s current situation and undermining of work ethics, both of which leads to impacts on a societal level: individuals refrain from making real efforts to improve their disadvantaged position, become less productive at work, and hence reduce their usefulness to the economy in recovering from the crisis. As a result, we have prescribed government intervention in the form of the following policies to restrict such behavioral tendencies: a) Government man-dated disclosure of accurate winning probability would lead to a relatively correct analysis of chances of winning, and hence reduce gambling. b) A social security scheme for poor people could act as compensation for the increased exploitation and reduction in income, thus decreasing gambling tendencies with a rise in uncertainty. This paper embodies a novel attempt to build a theoretical model on the rise in the seemingly irrational consumption of gambling commodities by the disadvantaged

section of the population during unstable periods controlling for a range of emotional, social, economic and cultural factors. The scope of this model could be furthered by including these factors and aiding households and the government in

moderating gambling tendencies. Hence, the idea of the titular social roulette is well and truly realized in the course of the paper through a multitude of forms ranging from one of birth and one of dearth and probabilistically one of both in the gamble of human life.

APPENDIX

Mathematical Derivation of Non-Gambling condition (NGC)

$$U_L^G = U_L^N$$

$$\Rightarrow \bar{I} + I(\alpha) = P(\alpha)\{\bar{I} + I(\alpha) + G.1\} + \{1 - P(\alpha)\}\{\bar{I} + I(\alpha)\}$$

Taking $\bar{I} + I(\alpha)$ to the *L.H.S* and taking $\bar{I} + I(\alpha)$ common

$$\Rightarrow (\omega(0) - \omega(\alpha))(\bar{I} + I(\alpha)) = GP(\alpha)\omega(\alpha)$$

$$\Rightarrow \frac{\{I+I(\alpha)\}\{\omega(0)-\omega(\alpha)\}}{P(\alpha)\omega(\alpha)} = G$$

Which is nothing but equation (12)

REFERENCES

1. Agrawal, T. (2014). Gender and caste-based wage discrimination in India: some recent evidence. *Journal for Labour Market Research*, 47(4), 329-340.
2. Beckert, J., Lutter, M. (2009). The inequality of fair play: lottery gambling and social stratification in Germany. *European sociological review*, 25(4), 475-488.
3. Berson, C. (2016). Local labor markets and taste-based discrimination, *IZA Journal of Labor Economics*, 5(1), 1-21.
4. Capacci, S., Randon, E., Scorcu, A. E. (2014). Luck vs skill in gambling over the recession. Evidence from Italy.
5. Casey, E. (2021). Gambling, deprivation and class: Reflections from a UK case study. *Critical Gambling Studies*.
6. Devereux, E. C. (1980). *Gambling and the social structure: A sociological study of lotteries and horse racing in contemporary America* (Vol. 1). Ayer Company Pub.
7. Friedman, M., Savage, L. J. (1948). The utility analysis of choices involving risk. *Journal of political Economy*, 56(4), 279-304.
8. Grönroos, T., Kouvonon, A., Kontto, J., Salonen, A. H. (2021). Socio- demographic factors, gambling behaviour, and the level of gambling expenditure: A population-based study. *Journal of gambling studies*, 1-17.
9. Hirata, G., Soares, R. R. (2016). Competition and the racial wage gap: Testing Becker's model of employer discrimination.
10. Horváth, C., Paap, R. (2012). The effect of recessions on gambling expenditures. *Journal of Gambling Studies*, 28, 703-717.
11. Olason, D. T., Hayer, T., Brosowski, T., Meyer, G. (2015). Gambling in the mist of economic crisis: Results from three national prevalence studies from Iceland. *Journal of Gambling Studies*, 31, 759-774.

12. Wheeler, B. W., Rigby, J. E., Huriwai, T. (2006). Pokies and poverty: problem gambling risk factor geography in New Zealand. *Health place*, 12(1), 86-96.

ON THE ECONOMICS OF CLIMATE CHANGE AND CHILD PREFERENCE : MALTHUS MEETING BECKER

SOUMIT KARKOON* and SOUMENDRA DAS
St. Xavier's College (Autonomous), Kolkata.

Abstract

One of the biggest challenges of our time is climate change, and its implications on economics have been among the most widely contested scientific topics. Despite that, economists have largely overlooked the impacts of climate change on people's individual preferences until now. This paper intends to intervene in this domain to establish a connection between climate change and children's preferences for wealthy and poor families. In this paper, we employ a family optimization model based on Becker (1993). We also test the "Malthusian population trap" in reverse concerning population in the context of global climate change. In brief, we have extended Becker's theory to examine the impacts of pollution on the population, which is the reversal of the Malthus hypothesis. Interestingly, we find that the impact of global climate change on population growth is diverse which depends on family heterogeneity. Specifically, our result suggests that for poor households, the "income effect" owing to changes in adult and child wage rates was significantly more important, outweighing the effects of "pollution", whereas, for wealthy households, concern for "environmental quality" outweighs the income effect, since they had high initial income.

JEL Classification: D13, D50, Q50

Keywords: Climate change, demand for children, family heterogeneity, Malthus.

1. INTRODUCTION

Climate change is the most important threat to humanity, causing drought and wetter areas, resulting in more severe winters and hotter summers. Due to the severe effect of climate change, such as increasing temperatures, sea level rise, draughts, and famine, in the next 10 to 20 years, the most fundamental concern will be what those families will look like. (Royal Society 2020).

The current industrial society intrinsically destroys the world (the Atlantic 2014). In essence, everything that must be done by people to make life simpler, safer, and more comfortable worsens conditions for the biosphere. To sum it up, increasing sea levels and permafrost methane release will primarily result in food and water shortages, which we are already experiencing and will continue to do. There is a shortage of everything humans require to exist, including food, water, and that window, which causes a great deal of instability in the human system and increases the likelihood of bloodshed.

Numerous ecosystems will perish as the ocean rises and engulfs the shoreline and the towns we construct (IPCC 2018).

A growing number of individuals are preferring not to have children considering the grim realities of the climate issue. Some ladies feel utterly unprepared to become parents. There is also a term for it called "Birthstrike: mothering the world" (the Years Project 2019). A common assumption says the fertility rate will decline as the relative cost of having a kid rises, either because the absolute cost of having a child rises or because the cost of another activity drops (Pritchett 1994). But this is not true for financially unstable poor people who are mainly employed in the labor-intensive workforce where the number of the total workforce largely determines the income of the family. So, the fertility rate will increase as the relative benefits of having more children rise (Riphahn & Wiyneck 2017).

*Corresponding author's email address: soumitkarkoon.ind@gmail.com

In a world affected by climate change, newborn babies' health deteriorates along with that of the natural world (the World Bank 2015). Poor people choose to have more kids because having more kids increases the likelihood that they can be replaced in the workforce, keeping it stable.

A study of 18,000 couples in China in 2016 revealed that climate change, particularly pollution, was associated with a 20% increased likelihood of infertility (the Guardian 2021). The following year UCLA researchers found that the number of births in the United States decreased in the nine months following an extreme heat event (UCLA 2018). Many impoverished countries that are located near the equator are suffering greatly as a result of climate change's negative effects (pnas 2021). Climate change will cause massive population movement in these places because it will make it very difficult to live in some of these locations of the world, make food and water sources less reliable, and increase the frequency and severity of storms and floods. We are aware that when infant mortality increases, individuals tend to have more children. Therefore, people in these areas could want to have more children to increase the possibility that the clan would survive (Casey et al 2019). Change can promote reproduction in addition to structural reorganization, eliminating the gender pay gap, and lowering infant mortality. As a result, climate warming may make inequality worse by raising schooling and lowering fertility in affluent Northern nations while doing the opposite in poorer tropical ones (UN 2020).

Malthusian population trap (Malthus 1798), states that the human population expands faster than the food supply until hunger, war, or sickness decreases the population. This idea is put to the test in this essay by revising the theory of fertility (Becker 1963), which employs the utility function to explain family economics. In this part, by considering climate change as a factor of Becker's fertility theory, we develop a reverse Malthusian hypothesis that is the effect of pollution on population growth which is proxied by the number of newborn children. This study has demonstrated that increasing pollution leads to an increase in the overall market wage rate, and that child preference decreases as pollution's effects become more severe in Skilled (Rich) and Unskilled (Poor) households. However, depending on the degree to which one group is able to control another, child preference may be greater or lower. In

the case of poor households, the changes in adult wage rates as well as child wage rates are much more significant than the level of pollution, while in the case of wealthy households, the effects of skilled wage rates are insignificant due to their high initial wages and pollution effect dominates in case of child preference.

This remainder of the paper is organized as follows: Section 2 reviews literature focusing on the relationship between household child preference and income, and climate change's effect on income, showing pollution as the main factor of climate change and a brief discussion on Malthus and Becker's theories and their modifications. Section 3 discusses household optimization behaviour. We consider both skilled and unskilled households in this part. In section 4 we develop a multi-sector multi-factor market equilibrium model. A couple of comparative statics is carried out in section 5. Section 6 provides results and discusses these findings with appropriate interpretations

2. LITERATURE REVIEW

Life expectancy and child mortality are highlighted by long-term variations in fertility. There may be a connection between climate and fertility since climatic change will have an impact on mortality. Parents may raise fertility in these areas near the equator, where many developing nations are found, in order to guarantee that they reach some minimal desired level of fertility despite the high and unpredictable death rates. In conclusion, climate change may worsen inequality by raising schooling and lowering fertility in affluent northern nations while doing the opposite in poorer tropical ones (Gregory Casey et al 2019). Later on, an 'environmental research letter' published (IOPScience), cited a study (Murtaugh and Schlax, 2009) named 'quantified future emissions of descendants based on historical rates, based on heredity,' and concluded that having one fewer child has much greater potential to reduce emissions than commonly promoted strategies like comprehensive reforestation (Wynes & Nicholas 2017). However, for poor uneducated countries, the option can be relatively limited.

A study on family planning gave particular emphasis on the extra burden that climate change throws on communities already dealing with migration issues brought on in part by rapid population increase (Bryant, Carver, Butler, Anage 2009). For example, the lack of fresh water is undoubtedly a major issue

or many nations, and reports frequently relate it to rapid population increase. Although some publications also include the consequences of growing pollution levels upon fresh water, the problem is often one of dwindling supply (due to climate change) in the face of increasing demand (due to population increase). The dual impacts of population increase and sea level rise in Bangladesh on the relative availability of fresh water have not gone unnoticed (Bryant et al 2009). To cite another example; the population of Tajikistan, the poorest nation in Emerging Europe, is predicted to more than quadruple by the end of the century. (IntelliNews 2022) The paper makes the premise that income is likewise affected by climate change. The poorer half will experience income effects from climate change more severely than many of us now anticipate. (OCED 2002) research with many big collaborations showed how existing poverty-related vulnerabilities will likely be impacted by climate change. Another analysis indicates how global warming has exacerbated economic inequality and is projected to do so in the future (Differbaugh & Burke 2019). UN acknowledging the gravity of this situation stated that 'The United Nations Development Program is committed to ending poverty and supporting countries' efforts to advance sustainable human development (UN 2007).

Next, the task is to identify how income influences population growth. According to a study (the Institute of Family Studies 2013), volunteers surveyed nearly ten thousand households to find out how income and population increase are correlated and concluded mixed results depending on many factors. The facts on fertility rates would lead one to believe that having children is a lesser good. Within nations, household income and fertility have a high negative link, and there is a large negative correlation between GDP and fertility globally. That is, wealthy nations have lower fertility rates than poor ones, and high-income families in a particular country have fewer kids than low-income couples do (Joseph Price, IFS 2013). Economist (T. Paul Schultz) raised a similar point; between nations, there is an inverse relationship between income per adult and fertility, and this negative relationship is typically observed between families as well (Yale University 2005). Numerous studies (NCBI 1993), (World Economic Forum 2015), (Kim, UniChicago 2010) show that fertility is lower in women with greater levels of education and frequently higher in women whose families own more

land and assets.

This paper also identifies pollution as a key contributor to climate change. It is simple to figure out that pollution is one of the primary and most important causes of climate change, with other elements depending on it either directly or indirectly. In order to have a clearer perspective in this regard, it is crucial to establish Malthus and Becker's idea. We know from the research hypothesis that the human population grows faster than the food supply until famine, conflict, or disease causes the population to decline (Malthus 1798). This is referred to as population theory. However, this model has a few significant flaws. The validity of the hypothesis is still a topic of discussion among economists today. On the one hand, it is accurate since having more children increases pollution and the carbon impact (BBC 2019). While many detractors claim that the theory fails to take into account future technological advancements, the "green revolution" in agriculture, or scientific advancements that did not exist when this concept was being constructed. Next, the theory of fertility (Becker 1963) says that individuals have children in order to think about and enjoy the pleasure of their offspring (utility). In simple language, it discusses family economics using the utility function. Moreover, it omitted some significant outside factors like child labour, gender, or pollution. Becker's model is largely expanded in this study. We are revising Becker's theory to test the reverse Malthus hypothesis i.e., the impact of pollution on the population.

3. HOUSEHOLD BEHAVIOUR.

We have considered a small developing economy where the total population has been divided into two categories – skilled and unskilled. The skilled population enjoys higher wages (W_s) and forms the high-income household. On the other hand, the unskilled population earns (W) and forms the low-income household. In the unskilled household we have assumed the utility function as a monotonically increasing function of composite commodity X_p and also the number of children l_{cp} , as the number increases, the more will be the income from child labour and hence more utility. Similarly, in the case of skilled households, we include the environmental quality which is the function of Pollution along with the no of children and the composite commodities. As Pollution increases, the environmental quality decreases, and as a result, the utility falls. As number of

children increases, families derive happiness from it. But as skilled households are more conscious about the pollution level so they trade off an extra child for the betterment of society¹. We get the budget equation for the unskilled and skilled households by equating the total expenditure and the total earnings.

3.1 UNSKILLED HOUSEHOLDS

The utility of the representative unskilled household is given by the following:

$$U = U(X_p, I_{cp}) \quad (1)$$

Where X_p denotes the composite commodity and I_{cp} denotes the number of children in the family. The subscript p implies unskilled households.

The budget constraint is given by the following:

$$PX_p = h(Z)W + W_c I_{cp}(1 - \phi(Z)) - \phi(Z)I_{cp} \quad (2)$$

Where p denotes the price index Z denotes the level of pollution and $h(Z)$ denotes the efficiency of adult labour such that $h(Z) \in (0,1)$; $dh/dZ < 0$. $\phi(Z)$ denotes the probability that the child will get diseased and the family has to incur expenditure on treatment, where, $d\phi/dZ > 0$ and $\phi \in [0,1]$

W_c implies the wage rate of child labour. The term $h(Z)W$ implies the total effective wage earned by the adults of the household, $W_c I_{cp}$ denotes the wage earned by the child labour and is the wage lost by the household if the child has diseases due to pollution, and $W_c I_{cp} \phi(Z)$ represents the money spent by the household on the healthcare of children born with a disease due to pollution. We have considered that the health expenditure borne by the household is in unity.

Let, the utility function in the form of a Cobb-Douglas utility function i.e., $U = X_p^\alpha I_{cp}^{1-\alpha}$ so by taking the log on both sides the equation can be written as

$$U = \alpha \log X_p + (1-\alpha) \log I_{cp} \quad (3)$$

Now substituting in equation (3) we get,

$$U = \alpha \log \left(\frac{h(Z)W + W_c I_{cp}(1 - \phi) - \phi(Z)I_{cp}}{p} \right) + (1-\alpha) \log I_{cp} \quad (4)$$

Now to find the first-order condition we differentiate the above equation to get,

$$I_{cp} = \left(\frac{1-\alpha}{\alpha} \right) \frac{PX_p}{\{\phi - W_c(1-\phi)\}} \quad (5)$$

This leads to the following lemma.

LEMMA 1: $I_{cp} > 0$ is implied by $\phi > W_c(1-\phi)$

Now taking the log on both sides of eq (5) we get,

$$\log I_{cp} = \log \left(\frac{1-\alpha}{\alpha} \right) + \log P + \log X_p - \log \{\phi - W_c(1-\phi)\} \quad (6)$$

Differentiating equation (4) with respect to Z we get,

$$\frac{1}{I_{cp}} \frac{\partial I_{cp}}{\partial Z} = \frac{1}{X_p} \frac{\partial X_p}{\partial Z} - \frac{1}{\{\phi - W_c(1-\phi)\}} \{\phi' + W_c \phi'\} \quad (7)$$

Using equation (2) we can find $\frac{\partial X_p}{\partial Z}$

$$p \frac{\partial X_p}{\partial Z} = Wh'(Z) - W_c I_{cp} \phi'(Z) + W_c(1-\phi) \frac{\partial I_{cp}}{\partial Z} - \phi \frac{\partial I_{cp}}{\partial Z} - \phi' I_{cp} \quad (8)$$

Substituting this equation in equation (7) we get,

$$\frac{\partial I_{cp}}{\partial Z} = \frac{\frac{I_{cp}}{P \times p} [Wh'(Z) - \phi' I_{cp}(1+W_c)] - \frac{I_{cp} \phi'(1+W_c)}{\{\phi - W_c(1-\phi)\}}}{1 + \frac{I_{cp}}{P \times p} \{\phi - W_c(1-\phi)\}} < 0 \quad (9)$$

Differentiating equation (6) with respect to W what we get,

$$\frac{\partial I_{cp}}{\partial W} = \frac{\frac{h(Z)}{P \times p}}{1 + \frac{I_{cp}}{P \times p} \{\phi - W_c(1-\phi)\}} > 0 \quad (10)$$

Differentiating equation (6) with respect to W_c what we get,

$$\frac{\partial I_{cp}}{\partial W_c} = \frac{(1-\phi) \left[\frac{I_{cp}}{P \times p} + \frac{1}{\phi - W_c(1-\phi)} \right]}{1 + \frac{I_{cp}}{P \times p} \{\phi - W_c(1-\phi)\}} > 0 \quad (11)$$

Thus, we get the following result

$$I_{cp} = I_{cp} \begin{pmatrix} Z & W & W_c \\ - & + & + \end{pmatrix} \quad (12)$$

Therefore, from the above equations, we obtain the following lemma 1.

LEMMA 2: The demand for children in unskilled households varies inversely with the level of pollution, however, increases with the adult & child wage rate provided $\phi > W_c(1-\phi)$

Proof: - We offer intuitive proof to support this lemma. Suppose that the level of pollution increases, then the health expenditure would also increase lowering the family income of the poor unskilled families. Thereby, unskilled people could afford to have fewer children.

¹ The details about the derivation of budget equations for unskilled and skilled households are briefly described in sections 3.1 and 3.2 respectively

On the other hand, if the wage of the child increases, then the net family income would also increase so the parents can afford to have more children.

3.2 SKILLED HOUSEHOLDS

In what follows, we analyse the demand for children in skilled households. The skilled household's utility function is represented by the following:

$$V = V \left(\begin{matrix} C_R & I_{CR} & E(Z) \\ + & + & + \end{matrix} \right) \quad (13)$$

Where C_R implies composite consumption which includes the consumption of all the other goods that the household needs to consume to sustain itself. \bar{Z} is the pollution as perceived by the skilled families in the future and E is the environmental quality which is negatively related with \bar{Z} . We must also note that, $E' < 0$ and $E'' = 0$. The notation R implies skilled households and $\bar{Z} = I_{CR} \bar{Z}$, skilled people perceive that pollution increases as the no. of children increases². Here \bar{Z} is the actual level of pollution. Now taking the logarithm of the utility function we write it as

$$\begin{aligned} V &= \ln C_R + \ln I_{CR} + \ln E(\bar{Z}) \\ \therefore V &= \ln C_R + \ln I_{CR} + \ln E(I_{CR} \bar{Z}) \end{aligned} \quad (14)$$

Here We have assumed a budget equation for the same which is as follows

$$PC_R = W_s - \phi(Z)I_{CR} \quad (15)$$

Here p denotes the price index, W_s implies the wage earned by the adults of the skilled household, I_{CR} represents the number of children. Unlike the unskilled household where there is no component of the wages earned by the children and the wage loss due to the diseased children as skilled people are rich and they won't let their children work and earn a wage. Similarly, the cost incurred by the household on the treatment of the diseased child and the health expenditure is in unity per child.

Now substituting equation (15) in equation (14) and differentiating with respect to we get,

$$\frac{1}{I_{CR}} = \frac{\phi(Z)}{PC_R} - \frac{E'Z}{E(\bar{Z})} \quad (16)$$

Equation (16) is also the first-order condition. Now we differentiate equation (16) with respect to I_{CR} we get,

$$\frac{\partial I_{CR}}{\partial Z} = \frac{\left[\frac{\phi'(Z)}{PC_R} + \frac{\phi\phi'I_{CR}}{P^2C_R^2} - \frac{E'}{E} + \frac{ZE'^2I_{CR}}{E^2} \right] I_{CR}^2}{\left[-\phi^2 I_{CR}^2 - 1 - \frac{E'^2 Z^2 I_{CR}}{E^2} \right]} < 0 \quad (17)$$

The above equation is less than 0 because of the term $\left[\frac{\phi'(Z)}{PC_R} + \frac{\phi\phi'I_{CR}}{P^2C_R^2} - \frac{E'}{E} + \frac{ZE'^2I_{CR}}{E^2} \right] > 0$ and $I_{CR}^2 > 0$ but $\left[-\phi^2 I_{CR}^2 - 1 - \frac{E'^2 Z^2 I_{CR}}{E^2} \right] < 0$ so $\frac{\partial I_{CR}}{\partial Z} < 0$. From this, we may say that $\therefore I_{CR} = I_{CR} \begin{pmatrix} Z & W_s \\ - & + \end{pmatrix}$ which gives rise to Lemma 3

LEMMA 3: Demand for children varies inversely with the level of pollution, however, it increases with the skilled wage rate.

Proof:- We offer intuitive proof to support this lemma, as the income of the skilled households increases, they will have more children, but if the pollution level increases then they may have less of children as they are concerned about the environment.

4. THE GENERAL EQUILIBRIUM ANALYSIS

The general equilibrium system consists of the following equations. The competitive industry equilibrium conditions for the two sectors are as follows.

$$W a_{l1} + W_s a_{l1} + R a_{k1} = 1 \quad (18)$$

$$W_s a_{s2} + R a_{k2} = P_2 \quad (19)$$

where, a_{ji} is the input-output ratios. w, w_s, w_c respectively represents Wages of unskilled labours, skilled labours, and child labours and represents the interest rate. In equation (18) we have assumed the price of the good 1 as unity and P_2 is the relative price of P_1 . All the nominal variables are real. Here K is the capital and R is the interest on capital as capital is the borrowing to pay back. a_{c1}, a_{k1}, a_{l1} respectively represents the child labour, capital required and labour required per unit of production of output X_1 in sector 1. a_{s2} represents the skilled labour required per unit production of X_2 in sector 2. Equation (18) and (19) implies the zero economic profit condition. The full-employment conditions for adult unskilled labour, child labour, capital, and skilled labour are given by the following four equations, respectively.

$$a_{l1} X_1 = \bar{L} h(Z) \quad (20)$$

$$a_{c1} X_1 = \bar{L} (1 - \phi(Z)) I_{CR} (Z, W, W_s) \quad (21)$$

$$a_{k1} X_1 + a_{k2} X_2 = K(R); K' > 0 \quad (22)$$

$$a_{s2} X_2 = \bar{S} \quad (23)$$

² See the Section literature review and Interventions for empirical evidence.

Here we assume that \bar{S} is the total number of skilled labours who are earning the skilled wage rate W_s . \bar{L} is the total labour in Sector 1 and Sector 2. The general equilibrium system is represented by equations (18) – (23). The same number of endogenous variables namely, X_1, X_2, R, W_s, W & W_c . Hence the system is consistent. Equation (20) solves for X_1 . X_2 is solved from equation (23). Substituting these values in equation (22), we obtain . Finally, equations (18), (19) and (21) solve for W, W_c and w_s .

This completes the determination of the equilibrium values in the system.

5. COMPARATIVE STATICS

In this section of this paper, we would now like to investigate how gradually increasing pollution (rise in Z) affect the demand for children in household, we solve the equations from (18) – (23) and obtain the following propositions,

Proposition 1: *An exogenous increase in the level of pollution leads to an increase in the market wage of both unskilled and skilled workers.*

Proof: As Pollution (Z) increases efficiency $[h(Z)]$ decreases as a result the supply of adult labour decreases i.e. $[\bar{L}h(Z)]$ decreases in eqn (20), Hence as the supply decreases the Unskilled adult labour wage i.e. W increases. Similarly, from eqn (21) we see that due to increase in (Z) the supply of child labour i.e. $\bar{L}(1-\phi(Z))l_{cp}(Z, W, W_c)$ decreases and hence the child labour wage W_c increases. Now as both W and W_c increases to keep the RHS constant of eqn (18) the interest rate R falls. Now as R falls to keep the RHS constant of eqn (19) the skilled wage rate W_s increases.

Proposition 2: *When market-based effects of pollution are into consideration, then pollution may lead to*

(a) *a higher preference for children if the wage effect dominates the direct negative effect of pollution and vice-versa.*

(b) *for the skilled households, no of children may increase if the wage effect dominates but it may fall if the pollution effect dominates.*

Proof: We offer an intuitive proof of the above propositions as follows. An increase in pollution leads to a fall in efficiency (Fall in h). It follows from

equation (20) that the output of sector 1 falls (X_1 falls), whereas there is no change in the output of sector 2 (X_2 no change) as X_2 is independent of components h or Z as in equation (23). So, from equation (22) as X_1 decreases without any change in X_2 so the demand for capital falls which results in the fall of R . Now coming to equation (19) as R falls but P_2 remains constant, hence wages of skilled labour (W_s) must rise. Now coming to equation (18) as R falls, but the RHS is constant so to maintain the wages of unskilled labour (W) and wages of child labour (W_c) both of them must rise. So, from LEMMA 2 W as and W_c increases the demand for children must rise. Similarly for skilled households as wages of skilled labour (W_s) increases the demand for children increases but on the other hand as pollution level increases (Z) the demand for children will decrease [LEMMA 3]. Hence, we may conclude that a change in the adult wage rate and child wage rate in the unskilled household will have a more significant effect on the demand for children than the pollution factor. Whereas in the case of skilled household the effect of pollution on the demand for children is much more dominating than the wage rate as skilled people already has a high initial wage.

6. CONCLUSION

This paper made a modest attempt to explain the economics of climate change and child preferences. The primary goal was to determine how children's preferences for wealthy and impoverished homes were affected by the effects of climate change. Here we revised Becker's theory of fertility in order to verify the validity of the reverse Malthusian theory. To establish the effects of climate change, we used pollution as the main factor. To develop the model, we considered the cases of Rich or Skilled and Poor or Unskilled Labour. For rich families, the total utility was considered a function of skilled labour wage rate and the effects of efficiency due to pollution. For Poor households, we also took the factor of non-disabled child labour wage rate. The study came to the conclusion that family preferences for children vary inversely with pollution level but rise with wage rate. We have demonstrated that how rising pollution causes the market wage rate to rise overall, and how child preference declines as pollution's impacts worsen. Depending on how well one group can dominate another, however, the

preference for children may be higher or lower. It could be inferred from this study that for poor households, changes in adult and child wage rates were much more significant, dominating the effects of pollution, whereas, for wealthy households, changes in skilled wage rates were trivial compared to the effects of pollution since they had high initial wages.

To fully grasp the impact of child preference due to climate change it is necessary to consider how adaptation to climate change may involve demographic change, change in technology, change in job roles, etc. These findings point to the necessity for further investigation and quantification of other significant channels in order to expand upon our findings.

REFERENCES

1. Barreca, Alan, et al. "Maybe Next Month? Temperature Shocks and Dynamic Adjustments in Birth Rates." *Demography*, vol. 55, no. 4, Aug. 2018, pp. 1269–93. DOI.org (Crossref), <https://doi.org/10.1007/s13524-018-0690-7>.
2. Becker, Gary S., and Robert J. Barro. "A Reformulation of the Economic Theory of Fertility." *The Quarterly Journal of Economics*, vol. 103, no. 1, Feb. 1988, p. 1. DOI.org (Crossref), <https://doi.org/10.2307/1882640>.
3. Browning, Martin, et al. *Economics of the Family*. Cambridge University Press, 2014.
4. Bryant, Leo, et al. "Climate Change and Family Planning: Least Developed Countries Define the Agenda." *Bulletin of the World Health Organization*, vol. 87, no. 11, Nov. 2009, pp. 852–57. DOI.org (Crossref), <https://doi.org/10.2471/BLT.08.062562>.
5. ---. "Climate Change and Family Planning: Least Developed Countries Define the Agenda." *Bulletin of the World Health Organization*, vol. 87, no. 11, Nov. 2009, pp. 852–57. DOI.org (Crossref), <https://doi.org/10.2471/BLT.08.062562>.
6. Casey, Gregory, et al. "The Impact of Climate Change on Fertility*." *Environmental Research Letters*, vol. 14, no. 5, May 2019, p. 054007. DOI.org (Crossref), <https://doi.org/10.1088/1748-9326/ab0843>.
7. Dodson, Jenna C., et al. "Population Growth and Climate Change: Addressing the Overlooked Threat Multiplier." *Science of The Total Environment*, vol. 748, Dec. 2020, p. 141346. DOI.org (Crossref), <https://doi.org/10.1016/j.scitotenv.2020.141346>.
8. Guillebaud, John. "Voluntary Family Planning to Minimise and Mitigate Climate Change." *BMJ*, May 2016, p. i2102. DOI.org (Crossref), <https://doi.org/10.1136/bmj.i2102>.
9. Patterson, Kristen P., et al. "Building Resilience through Family Planning and Climate Adaptation Finance: Systematic Review and Opportunity Analysis." *The Lancet Planetary Health*, vol. 3, Sept. 2019, p. S12. DOI.org (Crossref), [https://doi.org/10.1016/S2542-5196\(19\)30155-X](https://doi.org/10.1016/S2542-5196(19)30155-X).
10. Pinkert, Felix, and Martin Sticker. "Procreation, Footprint and Responsibility for Climate Change." *The Journal of Ethics*, vol. 25, no. 3, Sept. 2021, pp. 293–321. DOI.org (Crossref), <https://doi.org/10.1007/s10892-020-09345-z>.
11. Schneider-Mayerson, Matthew. "The Environmental Politics of Reproductive Choices in the Age of Climate Change." *Environmental Politics*, vol. 31, no. 1, Jan. 2022, pp. 152–72. DOI.org (Crossref), <https://doi.org/10.1080/09644016.2021.1902700>.

12. Schneider-Mayerson, Matthew, and Kit Ling Leong. "Eco-Reproductive Concerns in the Age of Climate Change." *Climatic Change*, vol. 163, no. 2, Nov. 2020, pp. 1007–23. Springer Link, <https://doi.org/10.1007/s10584-020-02923-y>.
13. Stephenson, Judith, et al. "Population, Development, and Climate Change: Links and Effects on Human Health." *The Lancet*, vol. 382, no. 9905, Nov. 2013, pp. 1665–73. DOI.org (Crossref), [https://doi.org/10.1016/S0140-6736\(13\)61460-9](https://doi.org/10.1016/S0140-6736(13)61460-9).
14. Torpman, Olle. "Reproductive Timing and Climate Change." *Philosophies*, vol. 6, no. 2, June 2021, p. 47. DOI.org (Crossref), <https://doi.org/10.3390/philosophies6020047>.
15. Wynes, Seth, and Kimberly A. Nicholas. "The Climate Mitigation Gap: Education and Government Recommendations Miss the Most Effective Individual Actions." *Environmental Research Letters*, vol. 12, no. 7, July 2017, p. 074024. DOI.org (Crossref), <https://doi.org/10.1088/1748-9326/aa7541>.
16. Barreca, A., Deschenes, O., & Guldi, M. (2018). Maybe Next Month? Temperature Shocks and Dynamic Adjustments in Birth Rates. *Demography*, 55(4), 1269–1293. <http://www.jstor.org/stable/45048810>

Ramjas Economic Review
Team of the Year 2022-23



First (Top) Row (Left to Right)

Priyanshu Gupta, Amal Varghese, Vibhor Vanvani, Arjun Rastogi

Second (Bottom) Row (Left to Right)

Namit Mahajan (Deputy Editor-in-Chief), Kajal Singhal, Mehakdeep Kaur (Deputy Editor-in-Chief), G Soundharya (Editor-in-Chief), Meghna Sharma, Aadya Bakshi

