(Indexed: Proquest, EBSCO, i-scholar database)

Volume 10 Issue 1

ISSN: 2321-1857

International Journal of

Business Analytics & Intelligence

April 2022

A Publication of Publishing India Group

International Journal of Business Analytics & Intelligence

Editorial Message

Greetings from IJBAI team!!!

Let me take the pleasure of making available to you the first issue of Volume 10 in this year 2022.

We are continuously trying our effort in developing a union between academia and industry practitioners to bring various perspective of data science to enhance readership. The journal is a platform for exchanging research insights, analytical techniques and knowledge in various areas which include with constant exploration. In this issue of IJBAI, we are pleased to publish the most coveted column, "Analytically Yours" by Professor Arnab Kumar Laha along with five insightful and informative papers which are focused on four different themes.

In the column "Analytically Yours", Professor Laha has enlightened us on Information Theory with his thoughtful paper, "Information and Dependence". Present trends in business are very vibrant, volatile, and evolving day by day. Various innovations can be seen in each domain of the business. The development of this has led to change in the marketing sector. In this regard, detection of customer retention and taking targeted approach is an essential part of keeping top and bottom line intact is essential. A paper on "Customer Attrition Analytics: The Case of a Recruitment Service Provider" focuses on this aspect whereas "A Comparative Analysis of Artificial Intelligence in Marketing and Traditional Marketing" depicts the shift. AI is an inevitable part of the future marketing and sales environment with speed. This research focused on the comparative study of AI with traditional marketing, its risks, benefits, and its impact on digital marketing and its future.

As we progress with technology and data management, it is essential part of faster processing and quick turn around time to increase process efficiency. Increasing work efficiency and productivity, decreasing workload and production costs, improving accuracy, refining service and customer relations, and resolving security issues on a vast scale are a few of the top uses drones offer industries globally. Drones are proving to be extremely beneficial in places where man cannot reach or is unable to perform in a timely and efficient manner. "A Report on the Application of Drones in Infrastructure Safety" provides an insight on the methodology of drone application in infrastructure is that they provide construction teams with an overhead view of job sites, materials, machinery, and people. Contractors are using the autonomous flying machines to record images and videos that help optimise everything, from grading plans and operations to identifying differences between as designed and as-built site plans.

In the era of data Tsunami, data security organisations face more and more serious challenges than ever. Organisations are increasing spending and turning to automation, DevSecOps and more. Despite huge investments made by companies to keep their information systems safe, there are many information securities breaches that infiltrate companies' systems; consequently, these cost them their reputation, affect customers' confidence, and bring huge financial losses. The literature of the paper "Investigating the Influence of Ethiopian National Culture on Information Security Policy (ISP) Violation: The Case of the Ethiopian Financial" suggests that almost all investments in information security related issues are for technological solutions. The findings showed strong evidence on the influence of contextual factors and national culture, on employees' information security behaviour, and consequently, it highlighted the importance of taking some level of precaution when organisations introduce new policies or standards that are copied from abroad.

The last paper on economics i.e., "Macroeconomic Stability in India: Vector Error Correction Estimation of the Causal Relationship between Inflation, GDP, Money Supply, Interest Rate, Exchange Rate, and Fiscal Deficit" represents the significance, nature, and direction of the effect of inflation on economic growth and macroeconomic stability are contentious both in theory and empirical analysis by examining the causal relationship between inflation and macroeconomic variables.

We wish to create this IJBAI, a leading repository of knowledge in emerging technologies. All the above constructive steps are taken to delight our esteemed readers. Do let us know your wish, suggestions, and views to enrich our journal

At the end, I would like to thank the researchers and renowned data science practitioners who have honored us by selecting our journal to publish some of their research cases.

Sincerely yours,

Madhumita Ghosh
Joint Editor-in-Chief
&
Dr. Tuhin Chattopadhyay

Editor-in-Chief

Dated: 4th May 2022

International Journal of Business Analytics & Intelligence

Volume 10 Issue 1 April 2022

ISSN: 2321-1857

Journal is also available online at www.publishingindia.com

International Journal of Business Analytics & Intelligence
10 (1) 2022, 01-03
http://publishingindia.com/ijbai/

Analytically Yours: Information and Dependence

Arnab Kumar Laha*

Introduction

The field of information theory has found interesting applications in many different areas. While information theory's primary focus was on data compression and transmission, its theories have now been applied to many other fields, including probability theory, statistical inference, complexity theory, ergodic theory and machine learning. The two key ideas of entropy and mutual information, which are functions of the underlying probability distribution generating the data, have proved to be immensely useful. Entropy is now routinely used as a criterion for deciding the optimal splitting of nodes while constructing a decision tree. In this article, we briefly introduce these important ideas with a specific focus on identifying dependence between two random variables. It is well known that Pearson's linear correlation coefficient (r) accounts only for linear relationships and that the value of this correlation coefficient can be misleading in the presence of non-linear dependence. In fact, it is easy to construct examples, where $r = 0$ even though Y is a function of X. In contrast, mutual information is capable of taking into account all types of dependence.

The *entropy* of a random variable X with a probability mass function (pmf) $p(x)$ is defined as

$$H(X) = -\sum_{x} p(x) \log_2 p(x) = E(-\log_2 p(x))$$

Here, we have used logarithms to base 2 and in this case, the unit of entropy is called *bits*. If instead the natural logarithm is used, the unit of entropy is then called *nats*. The entropy is a measure of the average uncertainty in the random variable.

Consider the toss of a coin, let the outcome "Head" be coded as 1 and "Tail" be coded as 0. Let the probability of the coin turning up "Head" be p. Then the pmf of X is given in Table 1.

Table 1

Outcome	*0(Tail)*	*1(Head)*
Probability	1-p	p

The entropy of the random variable, X, is then $H(X) = -(p \log_2 p + (1-p)\log_2(1-p))$. Using the convention $0.\infty = 0$, we obtain the graph given in Fig. 1, where the x-axis represents the values of p and the y-axis represents the values of H(X).

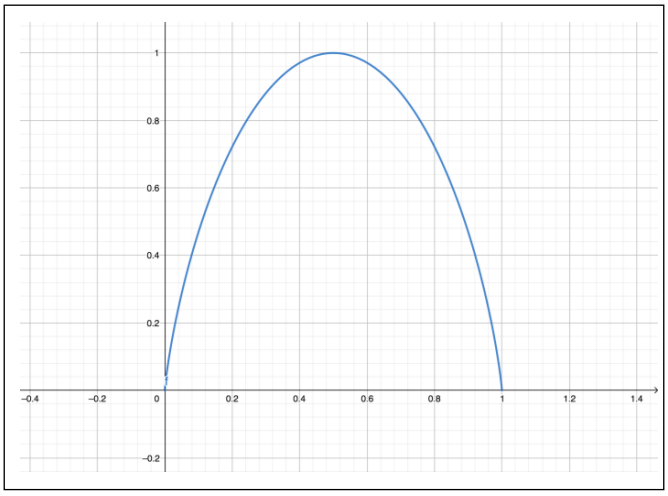


Fig. 1

From this graph, we see that the entropy is maximum when p = 0.5, i.e. when the coin is a fair coin with an equal chance of turning up Head or Tail. Intuitively, this is expected, since in this situation, the uncertainty is maximum. As the value of p deviates from 0.5 uncertainty decreases as one of the outcomes, Head or Tail, becomes

* Indian Institute of Management Ahmedabad, Gujarat, India. Email: arnab@iima.ac.in

more probable than the other. Of course, when p=0 or p=1, there is no uncertainty and the value of the entropy is then 0.

Entropy is the uncertainty of a single random variable. We can define *conditional entropy H(X/Y)*, which is the entropy of a random variable (X) conditional on the knowledge of another random variable (Y). The reduction in uncertainty of the random variable (X) due to another random variable (Y) is called the *mutual information*.

The mutual information $I(X; Y)$ is a measure of the dependence between the two random variables X and Y. For two random variables, X and Y with joint pmf $p_{X,Y}$ and marginal pmfs p_X and p_Y, the mutual information $I(X; Y)$ is defined as

$$I(X;Y) = H(X) - H(X \mid Y) = \sum_{x,y} p_{X,Y}(x,y) \log_2 \frac{p_{X,Y}(x,y)}{p_X(x)p_Y(y)}$$

We use the conventions $0 \log \frac{0}{0} = 0, \log \frac{0}{q} = 0$ and $p \log \frac{p}{0} = \infty$ if $p > 0$.

The mutual information $I(X; Y)$ is symmetric in X and Y and is always nonnegative. It is equal to zero if and only if X and Y are independent random variables. Also, note that $I(X; Y) = H(X)$.

The *joint entropy* of the random variables X and Y is defined as

$$H(X,Y) = -\sum_{x,y} p_{X,Y}(x,y) \ \log_2 p_{X,Y}(x,y)$$ The following can be shown using the simple algebra:

$$I(X; Y) = H(X) + H(Y) - H(X, Y).$$

Since $I(X; Y) \geq 0$, we have two interesting results follow immediately:

- *Conditioning reduces Entropy*: $H(X/Y) \leq H(X)$ and
- *Independence bound on Entropy*: $H(X/Y) \leq H(X) + H(Y)$.

Mutual information turns out to be a special case of a more general quantity called *relative entropy (also known as. Kullback–Leibler divergence)* $D(p||q)$, which is a measure of the "distance" between two probability mass functions p and q. It is defined as

$$D(p \,||\, q) = \sum_x p(x) \ \log \frac{p(x)}{q(x)}$$

$D(p||q)$ is always nonnegative and is zero if and only if p = q. It is easy to observe that $I(X; Y) = \log_2 e \ D(p_{X,Y} \,||\, p_X p_Y)$.

As an example, let us compute the mutual information of two random variables X and Y having the joint pmf given in Table 2. Here,

$$I(X;Y) = 0.15 \log_2 \frac{0.15}{0.55 \times 0.4} + 0.25 \log_2 \frac{0.25}{0.45 \times 0.4}$$

$$+ 0.4 \log_2 \frac{0.4}{0.55 \times 0.6} + 0.2 \log_2 \frac{0.2}{0.45 \times 0.6} = 0.06$$

Table 2

$Y \downarrow / X \rightarrow$	0	1	p_Y
0	0.15	0.25	0.4
1	0.4	0.2	0.6
p_X	0.55	0.45	

Up to this point, we have discussed entropy and mutual information in the context of discrete distributions. Can these ideas be extended to continuous distributions? The answer is Yes, if these continuous distributions have probability density function (pdf), which most commonly occurring continuous probability distributions do. For the continuous case, the entropy is defined as

$$H(X) = -\int_{-\infty}^{\infty} f(x) \ \log f(x) \ dx$$

where f is the pdf of X. For two random variables, X and Y with joint pdf $f_{X,Y}$ and marginal pdf's f_X and f_Y respectively the mutual information is defined as

$$I(X;Y) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} f_{X,Y}(x,y) \ \log \frac{f_{X,Y}(x,y)}{f_X(x) f_Y(y)} \ dx dy.$$

As before it is easy to observe that $I(X; Y) = 0$. if and only if X and Y are independent random variables.

As an example, let us consider the $(X,Y) \sim$ BVS $(0,0,1,1,p)$. Straight forward computations yield $I(X;Y) = -\frac{1}{2} \log(1 - \rho^2)$. Thus, when $p = 0$ (i.e. when X and Y are independent) we have $I(X; Y) = 0$ as expected and when $p^2 \rightarrow 1$ then $I(X; Y) \rightarrow \infty$. Thus, a large value of $I(X; Y)$ is indicative of strong dependence between the random variables X and Y. Figure 2 gives the plot of $I(X; Y)$ (y-axis) and p (x-axis).

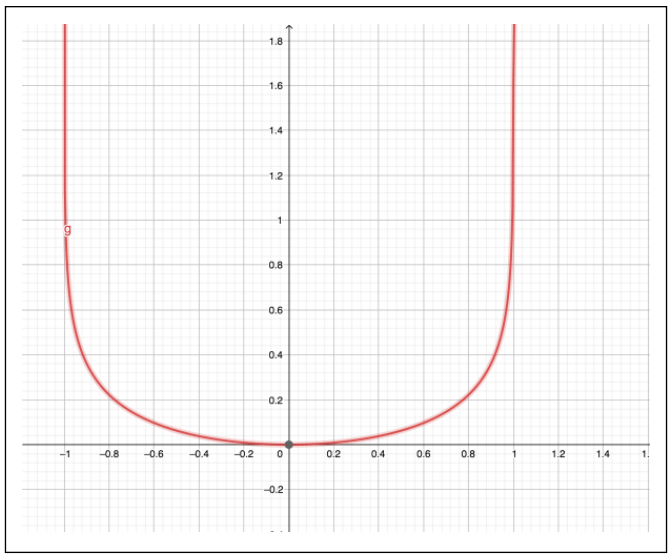


Fig. 2

Linfoot (1957) defined a correlation measure between two random variables X and Y, which is based on mutual information and called it *informational coefficient of correlation* (r_j). It is defined as

$$r_I = \sqrt{1 - e^{-2I(X;Y)}}$$

It is easy to observe that $0 \le r_1 \le 1$ with $r_1 = 0$ if and only if X and Y are independent random variables. Returning to our example, where $(X, Y) \sim \text{BVS}(0,0,1,1,p)$ we find that $r_1 = |p|$. Being based on mutual information, $r_I r_I$ is able to take into account both linear and non-linear dependence between the random variables X and Y.

If you find the topic of information theory interesting and would like to know more, you may find the book a good place to start (Cover & Thomas, 2006).

References

Linfoot, E. H. (1957). An informational measure of correlation. *Information and Control, 1,* 85-89.

Cover, T. M., & Thomas, J. A. (2006). *Elements of information theory* (2nd ed.). Wiley - Interscience.

International Journal of Business Analytics & Intelligence
10 (1) 2022, 04-15
http://publishingindia.com/ijbai/

Customer Attrition Analytics: The Case of a Recruitment Service Provider

Mihir Dash*, Vishnu Raghavan*

Abstract

Customer attrition is the phenomenon wherein a customer leaves a service provider. With the growing competition in the service sector, preventing customer attrition has become critical for sustainability, as it is well established that retaining existing customers is more profitable than acquiring new customers (Jacob, 1994). This gives customer attrition analytics the challenging task of predicting which customers are likely to leave, and of subsequently designing and implementing retention programmes for these customers. Customer analytics has made many strides in marketing, employer desirability, and branding, but has so far made limited strides in the recruitment industry space. The objective of the study is to identify the factors affecting a candidate's decision to accept a job opportunity in an organisation, using predictors such as the industry verticals, the candidate's skillsets, workplace location, gender, compensation offered, and the notice period of the candidate. The model developed is a logistic regression model, to determine whether a candidate selected will accept a job opportunity in an organisation or not. The analysis was performed based on a sample of 443 candidates who were provided job offers in the period 2013-2015 by a recruitment service provider.

Keywords: Customer Attrition Analytics, Factors Affecting Customer Attrition, Logistic Regression Models

Introduction

Customer attrition is the phenomenon wherein a customer leaves a service provider. With the growing competition in the service sector, preventing customer attrition has become critical for sustainability, as it is well established that retaining existing customers is more profitable than acquiring new customers (Jacob, 1994). This gives customer attrition analytics the challenging task of predicting which customers are likely to leave, and of subsequently designing and implementing retention programmes for these customers. Customer analytics has made many strides in marketing, employer desirability, and branding, but has so far made limited strides in the recruitment industry space.

The HR services industry in India has grown exponentially in the last decade, with the need for more specialised providers of services growing rapidly across the world. The services included under its ambit are recruitment and staffing, payroll processing, and several other services (Dash et al., 2009). Of these, a significant portion is occupied by organisations in the recruitment space. The total size of the industry in India is approximately USD 3.5 billion, with major players such as Adecco, Ranstaad, and ADP offering diversified services, and a few organisations specialising in niche skill hires.

Recruitment is generally considered the basis of all HR activity, and as a result, is very important. The nature of services provided in the recruitment space are quite varied. These are classified as follows:

- *Permanent Contingent Hires:* In this case, an organisation will hire a replacement for a position that will turn vacant. Certain large organisations, such as banks and IT product development organisations, are beset with a problem of constant attrition for certain in-demand skillsets, and as a result, hold periodic recruitment drives to fill actual and potential gaps in the organisation.
- *Contract Staffing:* Certain organisations require a huge proportion of employees on contract for proj-

* Alliance University, Bengaluru, Karnataka, India. Email: mihirda@rediffmail.com
** MBA Graduate, Alliance University, Bengaluru, Karnataka, India. Email: raghavan.vishnu@gmail.com

ects that arise from time to time. These employees work for the organisation, but are on the payroll of the recruitment firm. These services require a ready supply of available talent that can be drafted in to plug the gaps.

- *RPO:* Recruitment process involves certain employees working for a client, but on the payrolls of the parent recruitment firm. The role of these employees is to schedule, coordinate, and arrange the entire recruitment process for the client organisation.

There are specialised organisations that provide contract staffing and RPO services. The organisation in question is a contingent manpower placement organisation, with a decade's experience in hiring across verticals and levels. The organisation specialises in 'Niche Skill Hires', which is a rarer set of skills to work on and close. The organisation provides RPO-type services and permanent placements for IT product companies, in addition to manufacturing and banking verticals.

The industry is still largely fragmented in India. Although large players in the HR services, such as ADP, Ranstaad, and Manpower, specialise in contingent hires, the space is also occupied by many small players due to the size of India's workforce and the relatively low cost of operating in this space. In addition, there are established players that handle only CXO level hires (executive search firms), such as RGF Search, Korn Ferry, Spencer Stuart, and so on.

Organisation Overview

The organisation in question, XYZ Pvt. Ltd., is a decade-old player in the recruitment service industry. It has a team of 75 research recruiters and its focus is on niche hires. This is a unique value proposition that focuses predominantly on clients in the IT product development space, BFSI, pharmaceutical, and manufacturing verticals. The candidates placed with the clients are across varying levels of seniority, ranging from junior professionals with 1-2 years of experience, through to senior, CXO-level candidates. The organisation has a dedicated wing for placing CEO/CXO-level candidates, owing to the varied nature of recruiting these professionals. The candidates also differ in terms of their skillsets, ranging from purely technically-qualified candidates, through to techno-functional candidates, and to purely managerial candidates. It is spread across Chennai, Bengaluru, Hyderabad, Coimbatore, Salem, and Puducherry, and is planning to expand to Pune and the Middle East. It services clients not just in India, but also from across the globe, including Malaysia, Singapore, UAE, Qatar, and the USA. The organisation places around 400-500 candidates per annum successfully, and has a success rate of 85% in converting offers into joiners.

The organisation is structured into various levels, viz., the directors, followed by the operations manager, the assistant managers, and team leads, followed by the recruiters. The assistant managers lead specialised teams that focus on specific industry verticals.

The organisation uses a standard procedure during its recruitment process. The first step is obtaining a job description from the client. The same is entered in the organisation's ERP system and shared with the recruitment team. The next step is to explain the profile to the recruiters. The recruiters then source profiles and speak to the candidates. The profiles are sourced from job portals and social media sites such as LinkedIn, Zoominfo, Skillpages, and so on. The profiles are then screened by a validation team for their suitability and the details of the candidate are noted. The profiles deemed suitable are then subject to a process of validation by a specialised team. The profiles must avoid duplication within the recruitment firm, which is facilitated by means of an ERP system and a set of robust internal procedures. Additionally, the profile must not be processed by a competing recruitment firm. This is ensured by means of the speed with which the recruiters work. Also, the recruiters cross-check with the candidate if they have attended interviews with the client earlier.

Next, the profiles are sent to the client with the relevant details, and feedback is awaited. If the profile is shortlisted, the feedback is sent to the recruitment firm with a request for an interview. The candidates are then contacted and scheduled for an interview on a suitable date and time in agreement with the client. The interview usually consists of a few rounds and the candidate is followed by the recruiter to ensure attendance. The candidates are sent a call letter with detailed instructions and are followed up with, to ensure that a maximum number of candidates attend the interview. This will help increase the chances of offers. Following the selection of the candidate, the

client releases an offer letter which must be accepted by the candidate. Next, the candidate must resign from his/her organisation. The tentative date of relieving is obtained and the same is communicated to the client. Following this, the candidate must actually join the client organisation. The notice period ranges from a few days or weeks to a few months. The candidate may at times hold a series of other offers. Following the release of the offer, the intent of the candidate to resign or to take up the offer is gauged by periodic follow-ups by the recruiter, as well as the respective team leads. The follow-ups continue till the candidate finally joins the organisation. In addition, an independent team meant for process improvement has been assigned to monitor the candidates and their seriousness in taking the offers. The team makes a series of periodic random calls to assess the candidate and provides information in advance to the team leads, who in their turn pass this information to the clients.

Problem Statement

The requirements to be filled by the client organisation usually are mandates that the client is unable to accomplish owing to a host of factors. The factors include paucity of time, shortfall of candidates, and also, exhausting the resources available on job boards. As a consequence, the same is outsourced to a service provider with specialisation in recruitment. The requirements are usually shared on a non-exclusive basis, and as a result, there are certain issues that are addressed by the recruitment firm. These are the speed of generation of profiles, the quality of the profiles, and a certain critical mass of profiles. This will ensure a greater chance of closures for the client from the service provider's end.

After a candidate is given an offer, the recruitment firm must first gain the acceptance of the offer and then seek the candidate to resign from his/her current organisation. These two steps are mandatory and will determine if the candidate was serious about the offer or was merely testing his/her suitability for the job market.

Following the acceptance of the job offer, a candidate usually follows one of three courses of action:

- He/she will cease to seek any new offers. This happens in a small proportion of candidates. They are satisfied with the offer on hand and they confine their search to the client from which they get their first offer, and except in some contingencies, they join the organisation.
- The candidate will continue to seek job offers. This may be due to a host of factors that differentiate the candidates, and as a result, the candidate will be reluctant to take up the offer on hand in search of something better.
- The candidate may get retained by his parent organisation, and as a result, will decline the offer.

There are several possible factors at play for the candidates while selecting a new workplace. The requirements are broadly classed into IT- and non-IT-based requirements, depending on the nature of skillsets. In addition, the candidate's level of experience may influence the decision to shift. The location of the offer is also an important factor. There is generally no bar on candidates based on gender, marital status, or age, although clients sometimes specify gender requirements in advance, owing to the nature of the job and the attendant duties. In addition, the candidates will have notice periods that vary. Some may have negotiable notice periods, others may be serving notice, while still others may have fixed notice periods. Intuitively, in-station candidates are more likely to join an organisation; male candidates are more likely to accept relocation; and candidates with longer notice periods are more likely to attempt a switch. In addition, non-IT candidates have fewer job opportunities as of date vis-à-vis IT candidates; the latter are more likely to decline or avoid a new job offer.

Clients are dependent on the replacement candidate to ensure continuity of business. In case a candidate is assessed as a potential ditch, it helps the client and the recruitment firm schedule and prepare back-up candidates to ensure business continuity. However, it is not possible to determine which candidate will join, and the likelihood of joining of a candidate. Knowledge of these details will enable us to optimise the follow-up calls, and also to inform the client in advance regarding the intention of the candidate. This will enable the recruitment firm to take suitable steps and mitigate any losses with time.

The candidates, on receiving the offer, are often approached by more than one recruiting firm. The competing firms may approach the same candidate for a

position with a competing organisation. A combination of the above factors, along with an ever-fluctuating job market, makes determining the intention of the candidate extremely difficult. During follow-up by a recruiter post-offer and salary negotiations, candidates may disguise the fact that they are not satisfied with the current offer. A candidate may be unwilling to relocate from their current location. Sometimes the candidate may not be happy with the organisation that they will be joining, owing to negative reviews they have read about the organisation online. Also, a candidate may be lured by a better salary package to join a competing organisation. Additionally, there may be pressure from the family of the candidate to seek a better offer. Candidates also will disguise the fact that they hold extra offers till the last minute. This results in a loss of revenue for the client as well as the recruitment firm, and the value proposition of the recruiter is weakened. While customer analytics has made many strides in business and management, it has so far not addressed the issues discussed above. This paper is an attempt to address these issues.

Literature Review

Recruitment firms the world over are faced with a problem of whether a candidate will accept a job offer from a particular company or client. There are a few factors that need to be taken into account in this context, including:

- *The Notice Period of the Candidate:* Notice periods can range from two weeks to four months. Candidates who serve short notices tend to have other offers already or are currently unemployed, and accept the clients' offer. With longer notice periods, candidates tend to attempt interviews with many organisations. Thus, candidates with longer notice periods are usually more likely to not take up a job offer, compared to those with shorter notice periods.
- *The Location of the Job Opportunity:* Candidates tend to prefer a job opportunity that is located near their hometown, or in some cases, in a cosmopolitan city. Hence, cities such as Pune, Bengaluru, or Mumbai will attract candidates from across India, while areas like NCR or Chennai will attract people from areas that are closer. Additionally, candidates who are within a city will prefer to stay there and will not be willing to relocate.
- *Nature of the Skill Set:* Generally, employees from non-IT backgrounds tend to have fewer opportunities, and hence have fewer options for career advancement. Candidates from IT and related areas tend to have a greater number of opportunities and represent a threat to the organisation. Skillsets in heavy demand, such as Java developers, command better salaries and/or salary hikes, and candidates tend to shift readily.
- *Employer Brand Value Proposition:* Employers with a good reputation tend to attract a greater number of applicants. Usually, such clients are faced with fewer ditches by the candidate, while lesser known clients tend to have a problem in terms of joiners. The reputation of an employer is also important. Reviews posted by employees are available on the Internet and these are a source of feedback to candidates who may join the organisation.
- *Compensation Package on Offer:* Candidates are swayed, to a good extent, on the compensation package they receive. A better employer with a satisfactory compensation structure will pull potential employees to the organisation. Candidates may at times be swayed by better compensation from rival organisations and may not be willing to take up an offer with certain clients.
- *Gender:* Male candidates, as a rule, will usually be willing to relocate more readily, compared to female candidates.
- *Marital Status:* Married candidates tend to prefer a stable work location, owing to the attendant factor of relocation of their spouses and children.

Several statistical techniques are commonly applied for customer attrition analytics, including classification and regression trees (Gray & Fan, 2008), logistic regression (Au et al., 2003), artificial neural networks (Datta et al., 2001), survival analysis (Ma & Li, 1994), and several others (Hadden et al., 2006). There are mixed results concerning the most appropriate technique; however, several studies support the logistic regression model. For instance, Mozer et al. (2000) and Hwang et al. (2004) suggested that logistic regression predicted customer attrition better than decision trees and neural networks.

Methodology

The primary objective of the study is to identify the factors affecting a candidate's decision to accept a job

opportunity in an organisation. The data sources employed were primarily the internal databases of the organisation, XYZ Ltd. The period of the study was 2013-2015, based on data availability.

The independent variables (predictors) considered included the industry verticals (banking, telecom, pharma, IT, non-IT, and so on), the candidate's skill sets (IT, non-IT, and so on), workplace location, the level of the position offered, compensation offered, notice period of the candidate, and the gender of the candidate.

The dependent variable (outcome) was the binary variable of whether a candidate had accepted or had declined to accept a job opportunity in an organisation. The model developed is a logistic regression model, to determine whether a candidate selected will accept a job opportunity in an organisation or not.

The analysis was based on a sample of 443 candidates, who were provided job offers through XYZ Ltd. during the period 2013-2015. Around 81.3% of the candidates were men, while 18.7% were women; 54.9% of the candidates were IT-skilled, while 45.1% were non-IT-skilled. There were 31 clients represented in the data, of which the top five were Scope (28.4%), Barclays (12.2%), Aon Hewitt (9.0%), Hospira (9.0%), and UST (6.8%). The positions were offered across 17 locations, of which the top five were Chennai (66.4%), Bengaluru (12.9%), Mumbai (6.1%), Coimbatore (2.7%), and Thiruvananthapuram (2.3%). The clients belonged to nine verticals, of which the top five were BFSI (45.8%), IT (13.3%), Pharma (12.4%), IT Products (9.5%), and Telecom (7.7%). The positions offered were classified into seven hierarchical levels, and the basic salaries were in the range Rs. 6,000 p.m. to Rs. 5,50,000 p.m., with a mean of Rs. 73,352.59, a standard deviation of Rs. 57,683.66, and a median of Rs. 58,310.00. The month of joining varied roughly uniformly across the 12 months, except for lows in January and February. The notice period of the candidates varied between one and three months, with a mean of 1.7020 months, a standard deviation of 0.7455 months, and a median of 1.5 months. Finally, 78.1% of the candidates accepted the positions offered, while 21.9% did not. The frequency tables are available in the Appendix.

Analysis and Findings

Initial exploratory cross-tabulations indicated various significant differences in the percentage of non-joiners between groups. For ease of presentation, some prominent differences are listed point-wise as follows:

- IT skillset (25.8%) vs. non-IT skillset (17.9%); $\chi^2 = 3.986$, $p = 0.046$
- for women, Chemicals (66.7%), IT Products (50.0%), Telecom (42.9%), BFSI (16.7%), and others (0.0%); $\chi^2 = 18.782$, $p = 0.009$
- for women with IT skillset, Chemicals (100.0%), IT Products (50.0%), Telecom (42.9%), BFSI (17.4%), and others (0.0%); $\chi^2 = 15.901$, $p = 0.014$
- for IT vertical, men (34.8%) vs. women (0.0%); $\chi^2 = 6.204$, $p = 0.013$
- for IT vertical with IT skillset, men (31.6%) vs. women (0.0%); $\chi^2 = 5.034$, $p = 0.025$
- for IT skillset, Middle Level Managers (100.0%), Project Level Managers (50.0%), Senior Entry Level (26.3%), Junior Entry Level (25.0%), Project/Team Lead (23.1%), Junior Level Managers (6.7%), and Senior Level Managers (0.0%); $\chi^2 = 15.473$, $p = 0.030$
- for IT skillset in the IT vertical, Project Level Managers (100.0%), Senior Entry Level (29.6%), and others (0.0%); $\chi^2 = 18.232$, $p = 0.006$
- for men in the IT vertical, Project Level Managers (100.0%), Senior Entry Level (41.7%), Junior Level Managers (20.0%), and others (0.0%); $\chi^2 = 16.758$, $p = 0.010$
- for IT vertical, Project Level Managers (60.0%), Senior Entry Level (32.3%), Junior Level Managers (14.3%), and others (0.0%); $\chi^2 = 14.317$, $p = 0.026$
- for Junior Entry Level, IT skillset (25.0%) vs. non-IT skillset (3.3%); $\chi^2 = 5.975$, $p = 0.015$
- for women at Junior Entry Level, Telecom (100.0%), IT Products (75.0%), BFSI (8.3%), and others (0.0%); $\chi^2 = 11.111$, $p = 0.049$
- for women at Senior Entry Level, Chemicals (100.0%), IT Products (40.0%), BFSI (16.7%), and others (0.0%); $\chi^2 = 13.876$, $p = 0.031$
- for women Project Level Managers, IT skillset (20.0%) vs. non-IT skillset (0.0%); $\chi^2 = 7.000$, $p = 0.008$

In view of these observations, the logistic regression analysis was performed for each of the major verticals, as well as for men and women, separately. Table 1 presents the overall logistic regression results.

Table 1: Overall Logistic Regression Results

	Coeff.	*P-Value*	*Exp(B)*	*Coeff.*	*P-Value*	*Exp(B)*
Men	−0.2696	0.4231	0.7637			
IT Skillset	−0.2375	0.4796	0.7886	−0.5385	0.0277	0.5836
Level		0.4082				
Junior Entry Level	0.4724	0.4635	1.6038			
Senior Entry Level	−0.0897	0.8742	0.9142			
Project/Team Lead	−0.1165	0.8489	0.8900			
Junior Level Managers	0.8230	0.2692	2.2774			
Project Level Managers	−0.6602	0.3037	0.5167			
Middle Level Managers	−0.2553	0.7133	0.7746			
Notice Period		0.0146			0.0082	
1.00 Month	1.2266	0.0013	3.4095	1.1077	0.0012	3.0274
1.50 Months	0.4762	0.2390	1.6099	0.3717	0.3270	1.4502
2.00 Months	0.3484	0.3726	1.4168	0.2647	0.4754	1.3030
2.50 Months	0.2223	0.6471	1.2489	0.0878	0.8426	1.0917
Basic Salary	0.0000	0.9964	1.0000			
Vertical		0.4423				
BFSI	0.3073	0.5163	1.3597			
Chemicals	−0.9605	0.2077	0.3827			
Electronics	0.4158	0.6590	1.5156			
Infrastructure	0.5213	0.6620	1.6841			
IT	−0.3213	0.5352	0.7252			
IT Products	−0.1377	0.7958	0.8714			
Manufacturing	0.6379	0.4880	1.8924			
Pharma	0.7607	0.1890	2.1398			
[Constant]	0.8270	0.2984	2.2864	1.0218	0.0004	2.7782
Model Fit X^2	35.623	0.0330		18.952	0.0020	
Nagelkerke R^2	12.2%			6.6%		
% Correctly Classified	79.4%			77.3%		

The overall logistic regression results suggest that the only significant variables affecting the likelihood that a candidate joins are the candidate's skillsets and the notice period. In particular, candidates with IT skillsets are less likely to join than candidates with non-IT skillsets; and the lesser the notice period, the more likely the candidate is to join. The explanatory power of the overall logistic regression results is quite low, indicating scope for improvement.

Table 2 presents the logistic regression results for the BFSI vertical.

Table 2: Logistic Regression Results for BFSI Vertical

	Coeff.	*P-Value*	*Exp(B)*	*Coeff.*	*P-Value*	*Exp(B)*
Men	−0.3417	0.4761	0.7105			
IT Skillset	0.2547	0.5938	1.2900			
Level		0.4680				
Junior Entry Level	0.7349	0.4603	2.0854			
Senior Entry Level	0.0504	0.9435	1.0517			
Project/Team Lead	−0.8199	0.2853	0.4405			

	Coeff.	P-Value	Exp(B)	Coeff.	P-Value	Exp(B)
Junior Level Managers	0.6540	0.5049	1.9232			
Project Level Managers	0.8228	0.4181	2.2769			
Middle Level Managers	0.0124	0.9878	1.0124			
Notice Period		0.0225			0.0177	
1.00 Month	1.6171	0.0119	5.0383	1.6337	0.0063	5.1228
1.50 Months	0.2039	0.7463	1.2261	0.2744	0.6392	1.3158
2.00 Months	0.1646	0.7815	1.1789	0.1646	0.7687	1.1789
2.50 Months	−0.5640	0.4511	0.5689	−0.3542	0.5952	0.7018
Basic Salary	0.0000	0.8435	1.0000			
[Constant]	0.9918	0.2427	2.6961	0.8650	0.0401	2.3750
Model Fit X^2	22.645	0.066		14.674	0.005	
Nagelkerke R^2	17.6%			11.6%		
% Correctly Classified	79.8%			80.3%		

The logistic regression results for the BFSI vertical suggest that the only significant variable affecting the likelihood that a candidate joins is the notice period. In particular, the lesser the notice period, the more likely the candidate is to join. The explanatory power of the logistic regression results for the BFSI vertical is relatively low, indicating scope for improvement.

Table 3 presents the logistic regression results for the IT vertical.

Table 3: Logistic Regression Results for IT Vertical

	Coeff.	P-Value	Exp(B)	Coeff.	P-Value	Exp(B)
Men	−20.9601	0.9985	0.0000	−20.8344	0.9986	0.0000
IT Skillset	0.5452	0.6578	1.7250			
Level		0.8664			0.8774	
Junior Entry Level	1.6128	1.0000	5.0168	−0.2843	1.0000	0.7526
Senior Entry Level	−19.0146	0.9994	0.0000	−20.8664	0.9994	0.0000
Project/Team Lead	2.0703	0.9999	7.9273	−19.8166	0.9994	0.0000
Junior Level Managers	−18.1976	0.9994	0.0000	0.0000	1.0000	1.0000
Project Level Managers	−21.1692	0.9993	0.0000	−22.3015	0.9994	0.0000
Notice Period		0.9071				
1.00 Month	21.3840	0.9996	1.94E+09			
1.50 Months	21.8670	0.9996	3.14E+09			
2.00 Months	22.8788	0.9995	8.63E+09			
2.50 Months	41.4084	0.9992	9.63E+17			
Basic Salary	0.0000	0.5604	1.0000			
[Constant]	18.8920	0.9997	1.60E+08	42.0373	0.9989	1.81E+18
Model Fit X^2	30.432	0.004		25.568	0.001	
Nagelkerke R^2	59.5%			52.0%		
% Correctly Classified	80.7%			78.9%		

The logistic regression results for the IT vertical suggest that the only significant variable affecting the likelihood that a candidate joins is the level. In particular, candidates are less likely to join at lower hierarchical levels. The explanatory power of the logistic regression results for the IT vertical is moderate.

Table 4 presents the logistic regression results for the Pharma vertical.

Table 4: Logistic Regression Results for Pharma Vertical

	Coeff.	*P-Value*	*Exp(B)*	*Coeff.*	*P-Value*	*Exp(B)*
Men	−17.9120	0.9990	0.0000			
IT Skillset	2.5031	0.2257	12.2198			
Level		0.8000				
Junior Entry Level	10.3550	0.9994	3.14E+04			
Senior Entry Level	−9.7970	0.1218	0.0001			
Project/Team Lead	14.6203	0.9991	2.24E+06			
Junior Level Managers	−10.9619	0.1173	0.0000			
Project Level Managers	−13.0461	0.0874	0.0000			
Middle Level Managers	7.1471	0.9998	1270.4238			
Notice Period		0.9234				
1.00 Month	25.5640	0.9979	1.27E+11			
1.50 Months	2.3287	0.5291	10.2650			
2.00 Months	1.2656	0.4168	3.5452			
2.50 Months	25.9374	0.9983	1.84E+11			
Basic Salary	−0.0001	0.0267	0.9999	−0.0000	0.0146	1.0000
[Constant]	35.1282	0.9980	1.80E+15	3.3800	0.0002	29.3719
Model Fit X^2	31.304	0.003		6.630	0.010	
Nagelkerke R^2	75.1%			19.9%		
% Correctly Classified	90.4%			88.5%		

The logistic regression results for the Pharma vertical suggest that the only significant variable affecting the likelihood that a candidate joins is the salary. In particular, candidates are less likely to join at higher salary levels. The explanatory power of the logistic regression results for the Pharma vertical is low.

Table 5 presents the logistic regression results for the IT Products vertical.

Table 5: Logistic Regression Results for IT Products Vertical

	Coeff.	*P-Value*	*Exp(B)*	*Coeff.*	*P-Value*	*Exp(B)*
Men	0.9238	0.3313	2.5189			
Level		0.9827				
Junior Entry Level	−18.7421	0.9996	0.0000			
Senior Entry Level	−18.5389	0.9996	0.0000			
Project/Team Lead	−17.6939	0.9996	0.0000			
Junior Level Managers	1.6308	1.0000	5.1079			
Middle Level Managers	−19.9158	0.9996	0.0000			
Notice Period		0.6975				
1.00 Month	−0.2593	0.8250	0.7716			
1.50 Months	−0.2173	0.8876	0.8047			
2.00 Months	−0.4993	0.6771	0.6069			
2.50 Months	−1.7610	0.1940	0.1719			
Basic salary	0.0000	0.4013	1.0000			
[Constant]	17.7266	0.9996	5.00E+07	0.8023	0.0162	2.2308
Model Fit X^2	9.908	0.624		-	-	
Nagelkerke R^2	29.6%			-		
% Correctly Classified	73.8%			69.0%		

The logistic regression results for the IT Products vertical suggest that none of the variables considered affect the likelihood that a candidate joins.

Table 6 presents the logistic regression results for the Telecom vertical.

Table 6: Logistic Regression Results for Telecom Vertical

	Coeff.	*P-Value*	*Exp(B)*	*Coeff.*	*P-Value*	*Exp(B)*
Men	1.3428	0.4449	3.8297			
IT Skillset	−22.6703	0.9995	0.0000			
Level		0.9603				
Junior Entry Level	−1.0559	0.4329	0.3479			
Project/Team Lead	−0.3848	0.7862	0.6806			
Junior Level Managers	19.9889	0.9994	4.80E+08			
Project Level Managers	−40.4920	0.9987	0.0000			
Notice Period		0.9923				
1.00 Month	0.6774	0.6155	1.9688			
1.50 Months	0.2863	0.8385	1.3314			
2.00 Months	21.1121	0.9989	1.48E+09			
2.50 Months	62.5131	0.9990	1.41E+27			
Basic Salary	0.0000	0.4289	1.0000			
[Constant]	23.0563	0.9995	1.03E+10	0.8755	0.0200	2.4000
Model Fit X^2	15.020	0.182		-	-	
Nagelkerke R^2	50.8%			-		
% Correctly Classified	82.4%			70.6%		

The logistic regression results for the Telecom vertical suggest that none of the variables considered affect the likelihood that a candidate joins.

Table 7 presents the logistic regression results for men.

Table 7: Logistic Regression Results for Men

	Coeff.	*P-Value*	*Exp(B)*	*Coeff.*	*P-Value*	*Exp(B)*
IT Skillset	−0.0476	0.8987	0.9535			
Level		0.5114				
Junior Entry Level	0.7293	0.3064	2.0736			
Senior Entry Level	−0.0524	0.9326	0.9489			
Project/Team Lead	−0.1058	0.8739	0.8996			
Junior Level Managers	1.1189	0.1782	3.0615			
Project Level Managers	−0.4830	0.4927	0.6169			
Middle Level Managers	0.1784	0.8085	1.1953			
Notice Period		0.0095			0.0138	
1.00 Month	1.4324	0.0007	4.1885	1.1069	0.0024	3.0250
1.50 Months	0.4996	0.2568	1.6480	0.3124	0.4433	1.3667
2.00 Months	0.4875	0.2589	1.6282	0.3365	0.4082	1.4000
2.50 Months	0.2000	0.7044	1.2214	−0.0953	0.8375	0.9091
Basic Salary	0.0000	0.6796	1.0000			
Vertical		0.3110				
BFSI	0.3183	0.5486	1.3748			

	Coeff.	*P-Value*	*Exp(B)*	*Coeff.*	*P-Value*	*Exp(B)*
Chemicals	−0.8561	0.3021	0.4248			
Electronics	0.3623	0.7087	1.4366			
Infrastructure	0.4718	0.6994	1.6029			
IT	−0.6935	0.2209	0.4998			
IT Products	0.0113	0.9850	1.0114			
Manufacturing	0.5765	0.5468	1.7797			
Pharma	0.7125	0.2524	2.0391			
[Constant]	0.3852	0.6320	1.4699	0.6931	0.0114	2.0000
Model Fit X^2	34.037	0.049		13.411	0.009	
Nagelkerke R^2	14.2%			5.7%		
% Correctly Classified	77.4%			76.5%		

The logistic regression results for men candidates suggest that the only significant variable affecting the likelihood that a candidate joins is the notice period. In particular, the lesser the notice period, the more likely the men candidates are to join. The explanatory power of the logistic regression results for men is relatively low, indicating scope for improvement.

Table 8 presents the logistic regression results for women.

Table 8: Logistic Regression Results for Women

	Coeff.	*P-Value*	*Exp(B)*	*Coeff.*	*P-Value*	*Exp(B)*
IT Skillset	−0.7136	0.4677	0.4899			
Level		0.9840				
Junior Entry Level	−19.0334	0.9992	0.0000			
Senior Entry Level	−19.3713	0.9991	0.0000			
Project/Team Lead	−19.9730	0.9991	0.0000			
Junior Level Managers	−19.1141	0.9991	0.0000			
Project Level Managers	−19.8140	0.9991	0.0000			
Middle Level Managers	−20.4831	0.9991	0.0000			
Notice Period		0.9999				
1.00 Month	−0.0449	0.9706	0.9561			
1.50 Months	−0.1981	0.8938	0.8203			
2.00 Months	−0.0751	0.9512	0.9276			
2.50 Months	−0.0165	0.9917	0.9836			
Basic Salary	0.0000	0.6235	1.0000			
Vertical		0.9346			0.3733	
BFSI	0.6144	0.6177	1.8485	1.2993	0.1896	3.6667
Chemicals	−21.8651	0.9996	0.0000	−21.6084	0.9996	0.0000
IT	20.4491	0.9987	7.60E+08	20.7974	0.9987	1.08E+09
IT Products	−0.7502	0.5749	0.4723	−0.4055	0.7255	0.6667
Pharma	20.0157	0.9991	4.93E+08	20.7974	0.9991	1.08E+09
[Constant]	20.4821	0.9991	7.86E+08	0.4055	0.6569	1.5000
Model Fit X^2	18.341	0.368		15.155	0.010	
Nagelkerke R^2	32.9%			27.7%		
% Correctly Classified	82.7%			82.7%		

The logistic regression results for women suggest that the only significant variable affecting the likelihood that a candidate joins is the vertical. In particular, women candidates are more likely to join in the IT and Pharma verticals, and less likely to join the Chemicals vertical. The explanatory power of the logistic regression results for the women is moderate.

Discussion

The model provides a tool for recruitment firms to prioritise job offers to candidates. The model can be used to optimise candidate-job matching, benefiting all parties involved; in particular, the losses to the recruiters and clients can be minimised. Depending on the candidate's preference for a job opportunity, their likelihood of joining can be notified to the client in advance. Based on the client's assessment, a suitable backup can be generated to ensure business continuity. Further, follow-ups to the candidate can be made on the basis of the priority accorded to the candidate.

The results of the study indicate that there are different factors affecting the likelihood of joining; it may vary with different sub-groups. In particular, the factors should be analysed in detail, to clearly identify the factors affecting the decreasing popularity of our teams. More detailed analysis is required to minimise the differences between groups for the Indian respondents.

There are several limitations inherent in the study. The sample size is relatively small, and in particular, some verticals were under-represented. In the same vein, women were quite under-represented in almost all of the groups. A difficulty in some of the results is the low explanatory power, which suggests that other variables should be considered to improve the same. A more serious difficulty is that some of the results indicate multicollinearity between some of the independent variables, suggesting that some variables may have to be excluded from consideration in order to yield more robust results. Also, the data is collected during the period 2013-15, and so may not reflect more up-to-date recruitment trends.

There are several ways through which the results of the study can be updated and/or extended. More variables can be introduced into the model, for example, the candidate's level of experience could be another factor – more experienced candidates would be less likely to switch jobs unless it resulted in better pay or a better profile. Other similar hypotheses may be examined in detail for future studies.

References

Au, W., Chan, C. C., & Yao, X. (2003). A novel evolutionary data mining algorithm with applications to churn prediction. *IEEE Transactions on Evolutionary Computation, 7,* 532-545.

Dash, M., Singh, A., Mishra, N., & Gupta, G. (2009). A study of human resource outsourcing in Indian IT companies. SSRN Working Papers.

Datta, P., Masand, B., Mani, D. R., & Li, B. (2001). Automated cellular modelling and prediction on a large scale. *Issues on the Application of Data Mining,* 485-502.

Gray, J. B., & Fan, G. (2008). Classification tree analysis using TARGET. *Computational Statistics & Data Analysis, 52,* 1362-1372.

Hadden, J., Tiwari, A., Roy, R., & Ruta, D. (2006). Churn prediction using complaints data. *Transactions on Engineering, Computing and Technology, Enformatika, 13,* 158-163.

Hwang, H., Jung, T., & Suh, E. (2004). An LTV model and customer segmentation based on customer value: A case study on the wireless telecommunications industry. *Expert Systems with Applications, 26,* 181-188.

Jacob, R. (1994). Why some customers are more equal than others. *Fortune,* 149-154.

Ma, G., & Li, S. (1994). *Applications of the survival analysis techniques in modelling customer retention.* Workbook for the 5th Advanced Research Techniques Forum, American Marketing Association.

Mozer, M. C., Wolniewicz, R., Grimes, D. B., Johnson, E., & Kaushansky, H. (2000). Predicting subscriber dissatisfaction and improving retention in the wireless telecommunications industry. *IEEE Transactions on Neural Networks, 11,* 690-696.

Appendix

Table 9: Frequency Table of Verticals, Clients, and Glassdoor Ratings

Vertical	*Client*	*Glassdoor Rating*	*Frequency*
BFSI	ANZ	3.5	23
	Barclays	3.4	54
	Scope	3.4	126
Chemicals	VWR	3.3	10
Electronics	Flextronics	3.3	6
	Logitech	4.0	3
Infrastructure	Aparna Constructions	2.9	1
	Dar Engineering	3.0	1
	IWL India	2.3	2
	MYK Laticrete	3.7	4
	RGM	4.8	3
IT	Adaptive Mobiles	4.0	3
	Cross Domain	3.2	5
	Durr India	3.7	4
	IDOCZ	1.0	2
	New Age Management	4.0	5
	Software One	3.3	1
	Touchbase	3.5	3
	UST	3.0	30
	Valuelabs	3.0	3
	Williams Lea	3.3	3
IT Products	Aon Hewitt	3.7	40
	Lennox	3.5	2
Manufacturing	Hirotec	2.9	1
	Sharada Ceramics	2.3	1
	TVS Sundaram-Brake Linings Limited	2.3	5
	TVS Sundaram industries	3.5	13
Pharma	Astrazeneca	3.5	15
	Hospira	3.0	40
Telecom	Ericsson	3.6	19
	Prodapt	3.3	15
	Total		443

Table 10: Frequency Table for Locations

	Frequency
Chennai	294
Bengaluru	57
Mumbai	27
Coimbatore	12
Thiruvananthapuram	10
Delhi NCR	9
Hyderabad	8
Visakhapatnam	6
Cochin	5
Dubai	3
Kolkata	3
Pune	3
Ahmedabad	1
Jamshedpur	1
Mysuru	1
Raipur	1
Vijayawada	1
Total	442

Table 11: Frequency Table for Levels

	Frequency
Junior Entry Level	66
Senior Entry Level	180
Project/Team Lead	72
Project Level Manager	32
Junior Level Manager	38
Middle Level Manager	22
Senior Level Manager	28
Total	438

Table 12: Frequency Table for Month of Offer

	Frequency
Jan	6
Feb	14
Mar	40
Apr	52
May	47
Jun	54
Jul	41
Aug	48
Sep	35
Oct	35
Nov	38
Dec	32
Total	442

International Journal of Business Analytics & Intelligence
10 (1) 2022, 16-21
http://publishingindia.com/ijbai/

A Comparative Analysis of Artificial Intelligence in Marketing and Traditional Marketing

Sumitha K.*

Abstract

Present trends in business are very vibrant, evolving day by day. Such innovations can be seen in each and every domain of the business. The marketing sector has also not been left untouched. With the change in the approach of communication and integration, conventional marketing has been progressing into non-conventional marketing, through the inculcation of artificial intelligence in marketing. The development of this has led to change in the marketing sector. To study the evolution of AI in marketing, along with the adoption and the perspective of customers towards AI marketing through the medium of this research is a desire. Artificial intelligence (AI) is an essential portion of many sectors, including marketing. The way in which we use data to make important marketing decisions and improve customer experience has been revolutionised by AI. The objective of this study was to determine the future of artificial intelligence in marketing, and to compare artificial intelligence marketing and traditional marketing. This research focused on the comparative study of AI with traditional marketing, its risks, benefits, and its impact on digital marketing and its future. A qualitative research methodology was utilised to address these topics. The theoretical framework discusses the topic of artificial intelligence in marketing, comparing it with traditional marketing. With the incredible progress in AI, machine learning, and deep learning in its sub-segments, businesses are reaching new levels of data analytics productivity, which has an impact on the whole sector. For this thesis, the qualitative research method was applied by examining the marketing use of AI, to investigate how AI is changing the digital marketing sector. The objective of this approach was to do a broader and more detailed study of AI in marketing. Based on the findings of this thesis, it can be concluded that AI is going to fundamentally change how marketers do their work, making ads more personalised, predictive, and automated, than it has ever been. It is found that AI is an inevitable part of the future marketing and sales environment. The sooner we get acquainted with AI capabilities, the better.

Keywords: Artificial Intelligence, Marketing, Traditional Marketing, Machine Learning

Introduction

Artificial intelligence (AI) marketing is a system of using client data to anticipate the client's next move and ameliorate the client trip. AI offers a way to bridge the gap between data gathering and execution, by sifting through and assaying extensive data, which was formerly an invincible process.

As Sterne points out, data is the primary asset of AI-grounded marketing approaches. Data for marketing comes from a company's own systems, agencies, third-party syndicators, client online actions, and numerous other sources; and clearly comprises 'big data' in the total. About 25 per cent of moment's marketing budgets are devoted to digital channels, and nearly 80 per cent of marketing organisations make technology-acquainted capital expenditures – generally hardware and software – according to a recent Gartner check. Easily, some of that capital will be spent on AI.

The creation and construction of data is expanding at a tremendous rate; it is growing exponentially every day. By 2020, it is anticipated that the world will have created over 40 zettabytes of data (1 zettabyte = 1 trillion terabytes), with 80-90 of it being unshaped. The elaboration of big data and advanced logical results have made it possible for marketers to make a clear picture of their target group.

* Associate Professor, Hindustan Business School, Bengaluru, Karnataka, India. Email: sumipraba05@gmail.com

Artificial intelligence can reuse both structured and unshaped data with exponentially more speed and delicacy than any human could. It is a crucial point of interest for companies floundering to organise their consumer data in a simple way. Marketers are using the capability of machine literacy to make connections between data points to gain perspective on their client base. These systems can dissect speech to determine emotion from spoken language, produce visual definitions to show social media trends, and crunch data to make prognostications.

Still, AI is an important supporter, "If you're in marketing. However, marketing is a rich problem set, If you're in data wisdom." – Jim Sterne.

"Artificial Intelligence (AI) had an advance time in 2016, not only with machine literacy, but with public mindfulness as well. And it's only going to continue. This time, utmost marketers believe consumers are ready for the technology." Artificial Intelligence Roundup, eMarketer, February 2017.

World in the current script is going through a surge in digitalisation; the husbandry are evolving going from the point and mortar to the structure of click and bricks. This modernisation is affecting each aspect of the ultramodern life; and business, being dynamic, has not been left untouched by this metamorphosis. The invention, always being of utmost significance in the business world, is inculcating similar digital changes in its functioning. The impact of similar inventions can be seen in each scrap of business – manufacturing, client services, order placement, estimations, and marketing. Kother observes that marketing which has been doing for any of the business form, set up with the identification of the target client group, and selling the products for them using the right blend of the marketing tools and similar marketing tools could be either direct or indirectly create impact in the market. Marketing is a division of the business which plays a significant part in the success of the business, including the setting up of the target member of the customers and using suitable approaches for connecting with the target group.

According to Kother, each targeted member of the customers can be reached using different ways, to make marketing successful. Now these marketing approaches are being mixed with the modernised approach or non-conventional approach, which are providing fruitful results to the business organisations. One of these approaches is the inculcation of artificial intelligence or machine intelligence in the marketing tools. These marketing tools have opened up the supplementary ways of doing marketing and conducting business; along with this, they have been developed as a way to prize the plethora of databases related to the different aspects of business. In the marketing division, artificial intelligence can been used to value and collect data related to client management, client preservation, client creation, and client services. The data mining, done through the artificial intelligence, points the way to reach the implicit customers, retaining the loyal customers, and so on.

Favourable Side of Artificial Intelligence: Machine literacy, which can be applied to the colourful different fields, and which can inter-relate the colourful fields with each other, which can grow, indicate its mind and intelligence into colourful fields by relating each other. This literacy is used in the e-commerce spots.

Slighting Side of Artificial Intelligence: The machine literacy which is concentrated on just one field and ply this intelligence in just that area and don't relate the different areas. Like the machine literacy in GPS.

Comparing artificial marketing with traditional marketing, the latter is the selling of products using the conventional way of commerce with the stakeholders like social medias, journals, advertisement agencies etc. These marketing ways have different impact factors and different life spans; these styles may have a particular touch, which facilitates two-way communication or one-way communication only. Artificial intelligence is a way of marketing which develops over time, saves the data for an endless time period, and provides a wider base for one-to-one marketing which less operations of financial reserves of an organisation. In the period of globalisation, artificial intelligence evolved as a boon for the small-scale businesses, as it provided them the opportunity to go transnational and conduct business over the Internet. Artificial intelligence has grown in truly effective and productive ways in the globalised field of business, where the marketing is done over a website and the backing is handled by the software system.

Krishnamurthy (2016) discussed that e-marketing is the use of Internet technologies and the internet, web and related information technologies have supported for the transformational. E-marketing is using the synthetic

intelligence and automation to sell the products over the Web. This marketing focuses on the event of a system-led solution to a problem, and also allows human interaction to develop a precious solution to the issue faced in the business context, like segmentation of the business markets, management and development of customer relations, business channel relationship management, structuring the supply-chain management, personal selling, customised solutions, pricing strategies, production development consistent with customer specifications, and so on. The platform used by major websites like Google and Facebook is governed by artificial intelligence which collects and provides vast information. They use various ways of interacting with people to accumulate the info and build the info base system, which displays the products matching the buyer's preference. In the foreseen future, it is certain that businesses are going to suffer because of synthetic intelligence in a number of ways, where synthetic intelligence would be able to replace the human element in the business. This study basically covers the evolution of synthetic intelligence in the field of business, reviews the factors affecting the adoption and evolution of synthetic intelligence in the minds of the customers or consumers, and well-connected and accepting to either traditional or artificial marketing within the minds of the purchasers.

The most popular AI applications in marketing are content creation, voice search, predictiveness analysis, lead scoring, ad targeting, and dynamic pricing. With these AI applications, marketers can analyse customers based on their movement and behaviour over time, to achieve dynamic micro-segmentation and forecast their future movements, in general. With all these specific information, marketers can focus on the specific needs and create a long-term relationship with the brand. Micro-segmentation is helping brands to communicate in person with each customer, and to improve loyalty and life-time value.

Brands are using the power of the AI for personalisation of email/SMS marketing campaigns, which provides better connection, and transformation of these users into clients. Digital advertising is the area with the most successfully adopted AI. Facebook and Google are good examples of AI and machine learning usage. They analyse the user's information, their interests, and demographics, to learn and detect the best audience for their brand. Predictive analysis is the usage of data, statistical algorithms, and machine learning techniques with the goal of identifying all the future conclusions, based just on data history. Besides, AI can lower production costs and increase competitiveness.

Therefore, AI does not exist to replace the jobs of the marketers or advertisers, but to help them develop their creative and strategic potential. In addition, they should learn to use the advantages of AI.

In this paper, the comprehensive analysis of AI and ML application in marketing is given. AI really came into existence with the birth of computers, around the 1940s and 1950s. During the earlier period of its development, attention was clearly focused on getting computers to do things. In the 1960s and 1970s, there was a real philosophical discussion about how close human brain and computers could be. The next decade, from the1980s to the 1990s, brought a whole new approach. Artificial computer brains had opened up possibilities and created a completely new set of questions.

The next decade has brought advanced software intelligent agents. An intelligent agent is a software with a possibility of assisting people and acting on their behalf. Agents can automate repetitive tasks, remember things that users forgot, learn from the user, or can make recommendations. AI could be intelligent in its own way now: there is a potential to be bigger, faster, and better. People realised that the artificial brain could outplay the human brain. AI technologies are used in numerous Internet tools: search algorithms, recommendation systems, and systems for creating websites.

AI is unsurpassed by the human brain nowadays. AI applications in the nance, military, and manufacturing sectors are something that a human brain cannot compete with. Artificial brains now have their own bodies. They are supported by the ability of the AI to learn from experiences and adapt over time. First capability includes images, sounds, and speech. Facial recognition is the latest practical proof of improving productivity. Natural language and inference engines make better comprehension of collected information. AI systems can take different actions through technologies in the physical world. Auto-pilot in cars is the best example.

Research Methodology

The Objectives of the Study

- To determine the future of artificial intelligence in marketing.
- To compare artificial intelligence marketing and traditional marketing.

This is an exploratory research based on literature and the desire to find out the persuasive results in the E-Commerce Company and Regular customer use the online shopping. Both primary and secondary data have been used to fulfil the requirement of achieving the objectives. An extensive survey has been used to collect the primary data from the employees and customers, mainly through a questionnaire.

Research Design

An empirical and descriptive research structure has been followed to get the information related to our objectives, which deals with the factors governing the adoption and future of AI in marketing. Along with this, qualitative research design is used to have an in-depth insight into factors governing the adoption of AI, as it may be a new phenomenon, and for the researcher to possess an in-depth understanding of the behaviour of the customer, alongside the conceptual and theoretical framework of AI application. The primary study has been conducted on 200 people using convenient sampling.

Review of Literature

- According to T. Thiraviyam (2018), "Artificial intelligence (AI) marketing is a method of leveraging customer data to anticipate the customer's next move and improve the customer journey. AI offers the way to bridge the gap between data science and execution by sifting through and analysing huge dumps of data which was once an insurmountable process."
- Ramin Muhammadian (2020, July), "AI is becoming popular due to it being more accurate and precise than humans, which leads to more work efficiency. Visual search, video branding, and block chain technology will determine the marketing sector in the future. Analysis, adjustments, and predictions in digital marketing are easier now with the help of AI. Methods can be tested in smarter ways without losing too much money. On the other hand, users are becoming more aware of how their information is used. Therefore, marketers have to attract customers in meaningful ways, without copying too much of their personal information. In spite of marketing obstacles that will emerge in the future, such as regulations, digital marketing is ready for possibility and variety. In the author's opinion, AI is going to fundamentally change how marketers are doing their work and making ads more personalised, predictive, and automated than it has ever been. While the computer analyses and decides at much higher rates and precisions than before, people still have the skills to challenge the conclusions of the machine and take final decisions".

Evolution of Artificial Intelligence in Marketing

The evolution of AI is clear because lately, the discussions within the data science space is not just crammed with data modelling issues; it involves building a platform for machine-specific learning so that the machine can perform beginning-to-end functioning through continuous specific learning. With the necessity for greater efficiency every day, marketing and sales are at the middle of the AI evolution. Companies that vastly believe in inbound leads and inbound marketing practices, believe that the customer data helps to know customer behaviour. The importance lies in understanding the customer's journey, and therefore, the need to improve customer experience continuously is a thing that does not need emphasis any longer. Similarly, outbound teams are also using AI to big advantage, in streamlining their CRM systems, thus ensuring that their sales teams are those that specialise in the proper leads with the highest sales propensity. From the machine learning perspective, it all starts with data processing, followed by the subsequent stages of model building, and deployment and monitoring.

Data Processing Stage: The information processing stage typically involves collecting, cleaning, and formatting data, which may be fed into the models. Models are as good as the data inputs, which makes info processing supremely critical for marketers and salespeople. At this

stage, most companies use a combination of SQL queries and Python scripts to aggregate and format data from multiple sources.

According to Teradata's 'State of AI for Enterprises' report in October 2017, 80% of the businesses have implemented artificial intelligence mechanisms to carry out production and other business operations; most of this adoption is happening in the Asian region.

With all the major tech companies reorienting themselves around AI and the advertisement of tone-driven buses from several machine majors, we can say with conviction that the AI surge has arrived. With its Azure platform, Microsoft is taking a big step forwards in helping businesses harness this technology. As Microsoft stated at the Ignite event, its ideal is to support businesses in the areas of client service and deals support. Through its Dynamics 365 AI result, which is being tested with companies similar to HP and Macy's, AI is being used to help guests get the products and installations they need.

The Way Forward: For marketers and salesmen, the factual pain point is getting the right information about the prospect or client at the right time, and intelligence on what interests them and why. For example, as a salesman, you might want to know the accounts that are likely to convert into deals. Also, a marketer might be interested in knowing what content will probably reverberate the most with the client.

Findings

It has been agreed by a majority of the respondents that artificial intelligence-grounded marketing has better effectiveness than traditional marketing. AI allows us to gain or sustain a competitive advantage; this is the positive side. It was understood that AI-grounded marketing is most effective when the product needs to be placed according to different classes. From the analysis, it was understood that AI-grounded marketing provides a better result when the product needs to be placed in a different position; and the position or platform impacts the results of the marketing crusade. Traditional marketing also has better effectiveness as artificial intelligence-grounded marketing. A majority of the respondents believe that artificial intelligence is not only the technology that powers the marketing channels, but is also the empowering tool for businesses thereafter. Artificial intelligence not only helps marketers in executing their marketing strategies, but also helps in forming them. AI operations are incorporated in all areas of marketing; different AI technologies are used within marketing practices.

Need of Conforming AI as a Marketing Strategy

Effective marketing strategy will need the right decisions to make a company successful online. To achieve a successful marketing strategy, it is necessary to follow up on new social trends and keep interacting with the client. Therefore, the power of artificial intelligence systems in digital marketing strategies enables a marketer to request his products or services, and succeed in his business operations.

Conclusion

We have to develop one-on-one connections with the consumer. That is the need of the hour; that is what will make us survive in the new world. Marketing, at its core, is about the mind and heart. It is about intelligence and emotion. Though we have to give the functional benefits, we also have to enthral the emotional space in the minds of the consumers.

The way it has been communicated with consumers has changed marketing. It is morphing every day and that is where the big shift has happened. The big change that is happening in marketing are artificial intelligence and machine literacy. This creates new openings for fabricator and marketing. It will change how people interact with information, technology, brands, and services. Therefore, marketers must acclimatise artificial intelligence systems in their marketing strategies to succeed in the present period of digital marketing. It saves both time and plutocrat for the marketers, guests, and prospects, and occupies the minds of guests without mortal intervention.

References

Benefits of Artificial Intelligence and Machine Learning in Marketing. Retrieved from researchgate.net

https://emarsys.com/learn/blog/artificial-intelligence-marketing-solutions

Marketing and Artificial Intelligence. Retrieved from researchgate.net

Marketing and Artificial Intelligence - Wikipedia

Muhammadian, R. (2020, July). *Artificial intelligence in marketing: How AI is revolutionizing digital marketing* (Thesis, Centria University of Applied Sciences Business Management).

Traditional Marketing vs. Digital Marketing. (2021, Updated Edition). Retrieved from simplilearn.com

Thiraviyam, T. (2018). Artificial intelligence marketing. *International Journal of Recent Research Aspects,* 449-452.

What is Artificial Intelligence Marketing? MaArketo Engage.

International Journal of Business Analytics & Intelligence
10 (1) 2022, 22-28
http://publishingindia.com/ijbai/

A Report on the Application of Drones in Infrastructure Safety

Sravan Kumar Boosala*

Abstract

The term 'drone' usually refers to any unpiloted aircraft. Sometimes referred to as 'unmanned aerial vehicles' (UAVs), these crafts can carry out an impressive range of tasks, ranging from military operations to package delivery. Drones are a valuable addition to any industrial facility's efforts, as they sanction a limitless aerial perspective. The opportunities for drones to have real worth are endless. A drone is mainly used in the construction industry for surveying and inspection purposes. Drones are equipped with downward-facing sensors, such as RGB, multi spectral, thermal, or LIDAR, and they can capture a great deal of aerial data in a short time. The main objective of drones in infrastructure is mainly in the area of safety. Drone technology makes the job of site inspectors safer, as they can conduct inspections remotely without entering hazardous areas. In addition, drone inspections are faster and cost-effective. The methodology of drone application in infrastructure is that they provide construction teams with an overhead view of job sites, materials, machinery, and people. Contractors are using the autonomous flying machines to record images and videos that help optimise everything, from grading plans and operations to identifying differences between as-designed and as-built site plans. Drones in construction allow contractors a chance to monitor any issue, track progress, and develop better plans on-site by providing an unrivalled view of a site at a fraction of the cost.

Keywords: Drones, Unmanned Aerial Vehicles (UAVs), Infrastructure Safety

Introduction

Definition

The term 'drone' usually refers to any unpiloted aircraft. Sometimes referred to as 'unmanned aerial vehicles' (UAVs), these crafts can carry out an impressive range of tasks, ranging from military operations to package delivery. They can be controlled by either a human or by a computer. Civilian UAVs have become more popular. Some recreational drone activities embrace photography and racing. UAVs have been used to smuggle drugs and alternative varieties of contraband. Several firms are currently pushing for drone delivery services. There are four major sorts of drones that have different characteristics to cater to different needs.

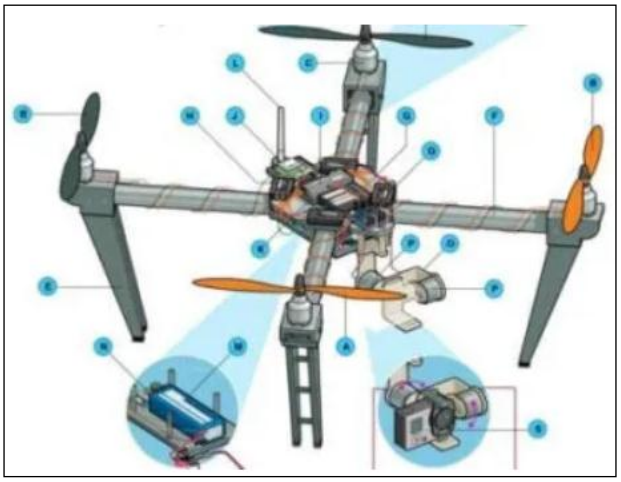


Fig. 1: Typical Image of a Simple Drone

* Symbiosis Centre for Management and Human Resource Development (SCMHRD), Symbiosis International (Deemed) University (SIU), Hinjewadi, Pune, Maharashtra, India. Email: sravan_boosala@scmhrd.edu

The basic uses of drones in day-to-day life are increasing rapidly and the signs of its growth in human life is significant. Some of the major uses are as follows:

- Delivery of supplies
- Emergency rescue
- Outer space activities
- Wildlife and historical conservation
- Military operations
- Medicine supply to hard-to-reach areas
- Construction projects
- Photography

Work Done and Lessons Learnt

In this chapter, the basic details of the drone are described. Starting from the components of a drone, with a brief detail about the different parts, to the construction and assembling of a drone are explained. There are different types of drones used, based on the purpose and functionality.

The components of drones should be known to understand the working of the drone.

Components of a Drone

- *Standard Prop*

  The 'tractor' propeller are the props at the front of the quadcopter. These props pull the quadcopter through the air like a tractor. Although some drones, like the DJI Phantom, look similar from any angle, there is a front and a back.

- *Pusher Prop*

  The pusher props are at the rear and push the UAV forward, thus the name 'pusher props'. These contra-rotating props precisely eliminate motor torques throughout stationary level flight. Opposite pitch offers downdraft. These will be plastic, with the higher pusher props made from carbon fibre.

- *Brushless Motors*

  Brushless motors take the craft into the sky and keep cameras level. They are fast, powerful, agile, extremely economical, and very reliable, and thus, ideal for everyday use. Practically, all the most recent drones use a brushless electrical 'out-runner' type of motor that is a lot more efficient, reliable, and quieter than a brushed motor.

- *Motor Mount*

  Discreetly concealing the wires inside the arm, the Universal Motor Mount is a sublime resolution for any multi-rotor drone or RC quadcopter. The drone motor mount is typically designed into the mix, fitting with the landing struts or a part of the UAV frame.

- *Landing Gear*

  The purpose of the landing gear in an aircraft is to supply a suspension throughout taxiing, take-off, and landing. It is designed to soak up and dissipate the K.E. of the landing impact, thereby reducing the impact hundreds transmitted to the airframe.

- *Boom*

  Shorter booms increase manoeuvrability, whereas longer booms increase stability. Booms should be strong enough to carry up in a severe crash while being busy-bodied and equipped with minimal prop draught. In several drones, the boom is a component of the most body. Alternatively, drones have an explicit boom as a separate part. The Parrot area unit 2.0 has the central cross boom.

- *Main Drone Body Part*

  This is the central hub from which booms radiate, like spokes on a wheel. It houses the battery, main boards, processors avionics, cameras, and sensors.

- *Electronic Speed Controllers (ESC)*

  An electronic speed controller or ESC is Associate in Nursing electronic circuit that varies an electrical motor's speed, its direction, and presumably additionally, acts as a dynamic brake. It converts DC battery power into three-phase AC for driving brushless motors.

  Electronic Speed Controllers are a vital part of the recent quadcopters (all multi-rotor), which provide high power, high frequency, high resolution the-phase AC power to the motors in an especially compact miniature package.

- *Flight Controller*

  The flight controller interprets input from the receiver, GPS module, battery monitor, and other sensors.

It regulates motor speeds via ESCs to produce steering, and furthermore, as triggering cameras or other payloads. It controls autopilot, waypoints, follow-me, failsafe, and plenty of other autonomous functions. The flight controller is central to the complete functioning of your UAV.

- *GPS Module*

  The GPS module usually combines the GPS receiver and the magnetometer to supply latitude, longitude, elevation, and compass heading from one device. The GPS is very important for waypoint navigation and several alternative autonomous flight modes. Without GPS, drones would have very restricted uses.

- *Receiver*

  The receiver on a drone is a device that uses built-in antennas to receive radio signals from the drone controller. This information is then sent to the control board, or flight controller, that puts the knowledge into action by dominating the drone as indicated by the first radio signals.

- *Antenna*

  An antenna is a transducer that converts electric power into magnetic waves and vice versa. An antenna can be used either as a transmitting antenna or a receiving antenna. A transmitting antenna is one which converts electrical signals into electromagnetic waves and radiates them.

- *Battery*

  An FPV drone battery is the foundational part of a quadcopter and should be with selected with consideration to attain a perfect balance between performance and flight time. Lithium batteries are the foremost common battery chemistry used to power quadcopters, thanks to their high energy densities and high discharge capabilities.

- *Battery Monitor*

  Provides in-flight power level observance to flight controller.

- *Gimbal*

  The drone gimbal is the pivoting mount that rotates with respect to the x, y, and z axes to supply stabilisation and inform about the cameras or alternative sensors.

- *Gimbal Motor*

  Brushless DC motors are used for direct-drive angular positioning, which needs specially-wound coils and dedicated management of the electronic equipment which have recently become commercially available.

- *Gimbal Controller Unit*

  Allows management of direct-drive brushless gimbal motors as if they were standard servo motors.

- *Camera*

  FPV cameras are small, lightweight, and fairly priced. The FPV camera is mounted onto a drone to send real-time video all the way down to the bottom, employing a video transmitter. The FPV camera allows you to visualise wherever the drone is flying and what it is seeing as if it had its own eyes.

- *Sensors*

  Tilt sensors, combined with gyros and accelerometers, offer input to the flight-control system, to keep up level flight. It is the gyro compensation that permits these tilt sensors to be used in moving applications like cars or drones.

- *Collision Avoidance Sensors*

  Drones these days will escort a pair of different kinds of sensors. The first ones are for making 3D pictures of the external world by LIDAR and thermal vision cameras.

  The second ones are on-board sensors for collision avoidance, using monocular vision, supersonic (Sonar), infrared, LIDAR, Time-of-Flight (ToF), and vision sensors.

- *Active Tracking Follow Mode and Safety Features*

  Many of the drone components adore the camera; collision dodging sensors send knowledge back to the flight controllers.

  The flight controller is additionally used for sending and receiving data from the motors, electronic speed controllers, satellite navigation systems, IMU, and gyroscope. The drone is also programmed with refined vision algorithms permitting it to be able to track objects and avoid obstacles while following a person, car, bike, or boat.

Briefing of Usage of Drones in Different Fields and its Applications

Delivery of Supplies

Drones can move small items quickly, reducing the necessity for forklifts, and probably substituting the conveyor systems often used to transport boxes around distribution centres. Outside of the warehouse, drones may additionally be used for supply chain deliveries.

Fig. 2

Emergency Rescue

UAVS's are utilised to move products on demand, give blood in urban areas, save drowning people, analyse the extent of damages, monitor crowded human gatherings, perform exploration tasks, deliver supplies, and provide different aid in case of emergencies.

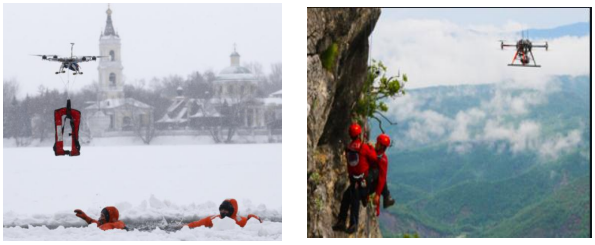


Fig. 3

Practical Reference

In March 2011, a strong earthquake caused a natural disaster, i.e. Tsunami that hit Japan, causing severe harm to the Fukushima Daiichi nuclear plant. The damage further led to a complete evacuation due to the quantity of dangerous nuclear material that was released. Drones were deployed in the air and on the ground at the primary potential instance to assess the extent of the destruction. These pilotless vehicles were able to offer aid in watching for radiation exposure, repairing destroyed areas, and reconstruction efforts, all while minimising the nuclear fallout exposure for relief workers.

Outer Space Activities

Drones are used for outer space research, where pin-point observation and accuracy is needed. Drones are mainly used by NASA; this is the budding technology mainly used in space missions to understand and observe the celestial bodies present in other planets.

Fig. 4

Although the propeller system of the drones does not work in vacuum, due to the presence of the thin atmosphere drones are being equipped with alternate technologies for further study.

Wildlife and Historical Conservation

Drones are used for getting a bird's eye view of the forest wildlife and animals present. Drones help in getting the images along with the live feed of the movement of the animals. They assist in controlling the illegal activities, monitoring the animals, keeping track of their population, increasing afforestation, and so on.

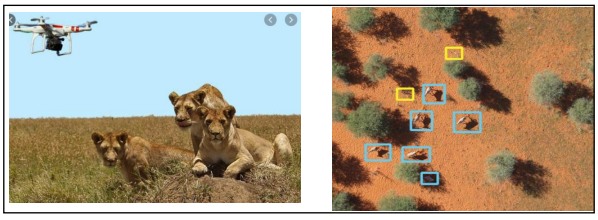


Fig. 5

Military Operations

In the military, these are UAVs (Unmanned Aerial Vehicles) or RPAS (Remotely Piloted Aerial Systems),

also called pilotless vehicles. Drones are mainly used in situations where human flight is considered to be too risky or difficult. Drones provide soldiers with a 24-hour 'eye in the sky', seven days a week.

Among the various uses of pilotless (UAV's) systems in defence operations, the following are a few important ones:

- Used in detection of chemical explosives.
- Used for delivering medical supplies and vaccines to restricted zones.
- Used as a means of communication and navigation substitute.
- IED detection and elimination.
- Base perimeter controlling and monitoring.
- Used in distant target observation.
- Used for target destruction.
- Used in close-quarters combat.

Drones can stay aloft for 34 hours straight, can fly at strikingly high altitudes of 60,000 feet, and have a range of more than 12,000 nautical miles.


Fig. 6

Medicine Supply to Isolated Areas

Common drone applications in medicine include the supply to disaster zones; they can be used as an alternative means of transport, where the access is severely restricted. They help in delivering aid packages, medicines, vaccines, blood, and other medical supplies to remote areas; and providing safe transport of unwell check samples and test kits in areas with high contagion.


Fig. 7

Literature Review

Applications of Multi-Rotor Drone Technologies in Construction

Lu and Lia (2018), Multi-rotor drones are one of the replacement and most advanced technologies. Therefore, several fields are showing increasing interest in utilising multi-rotor drones, mapping in mining, and security and surveillance in transportation. The infrastructure sector has been a slow adoptive parent of novel technologies. However, multi-rotor drones have the potential to facilitate construction in many aspects. There is, therefore, a necessity to extensively analyse their applications and analyse their roles in construction engineering and management. This paper aims to comprehensively investigate the applications of multi-rotor drones, analyse their edges, and explore their potential as the way forward for the construction industry. Many main aspects are reviewed and discussed, particularly land surveying, logistics, on-the-spot construction, maintenance, and demolition. The results reveal that the most contributions are in work safety, cost-effectiveness, and carbon emission reduction, whereas there are adverse impacts on the idea of current limitations of multi-rotor drones. However, it will be foretold that the employment fullness of drones can still increase on the way forward for the development of the construction industry. Thus, this study will profit construction managers in raising awareness of the use of those rising technologies, and researchers in additional exploring applications of multi-rotor drones in construction projects.

Same-Day Delivery with Heterogeneous Fleets of Drones and Vehicles

Ulmer and Thomasc (2018), in this paper, we analysed how drones are often combined with regular delivery vehicles to enhance same-day delivery performance. In the context, we present a dynamic vehicle routing downside with heterogeneous fleets. Customers' orders are delivered over the course of the day. These goods are delivered either by a drone or by a daily transportation vehicle within the delivery deadline. Drones are faster; however, they have a restricted capability as they need charging once used. In the same-day context, vehicle capacity is not a constraint, but vehicles are slow because of urban traffic. To come to a decision of whether an order is to be delivered by a drone or by a vehicle, we have to propose a policy to perform approximation-supported geographical districting. The results of the study reveal two major implications. First, geographical districting is very effective in increasing the expected variety of same-day deliveries. Second, a mix of drone and vehicle fleets could considerably scale back the desired delivery resources.

Use of Drones for Surveillance and Reconnaissance of Military Areas

Paucar et al. (2018), This analysis is meant to contribute to the look of management algorithms for static cameras and drones. These were modelled on the quadcopter Parrot Bebop 2 by using the communication software OS ROS to supply information and acknowledge the different drone stages (landed, on flight, and its manoeuvres: yaw, throttle, roll, and pitch). The controller was developed by conducting many tests concerning the perfect distance for effective drone operations that embrace image process for target detection or chase in real time. This study additionally analyses the advantages of the implementation of this technology among the Ecuadorian soldiers for police investigation and intelligence activity operations. Supporting the results, it is observed that the utilisation of drones in aspects of national security would have a positive impact resulting in optimising the human resources efficiently in military operations.

Drones for Conservation in Protected Areas: Present and Future

Lopez and Mulero-Pázmány (2019), National Park managers are entitled to cost-efficient and innovative solutions to handle the good kind of environmental issues that threaten diversity in protected areas. Recently, drones were relied upon to revolutionise conservation; they have the potential to evolve and lift better-informed selections to help management. Despite great expectations, the advantages that drones may foster effectiveness stay essentially unexplored. To deal with this gap, we performed a literature review concerning the utilisation of drones in conservation. They chose a 256 studies, of which 99 were distributed in protected areas. They classified the studies in five distinct areas of applications: wildlife observation and management; ecosystem monitoring; law enforcement; ecotourism; and environmental management and disaster response. They studied the known specific gaps and challenges that will yield the growth of vital analysis or monitoring. Their results support the proof that drones deserve to serve conservation actions and reinforce effective management; however, multidisciplinary research should resolve the operational and analytical shortcomings that undermine the prospects for the drone's integration in protected areas.

Analysis

Whether we name them as remote-controlled aerial vehicles (UAVs), non-pilot drones, or flying mini robots, drones are increasingly growing in popularity. They are still in the infancy stage in terms of mass adoption-associated usage. However, drones have already broken through rigid ancient barriers in industries that otherwise appeared impenetrable by similar technological innovations. Over the past few years, drones became central to the functions of varied businesses and governmental organisations, and have managed to pierce through areas wherever bound industries were either stagnant or lagged behind. From fast deliveries at time of day to scanning an out-of-reach military base, drones are proving to be extraordinarily helpful in places where man cannot reach, or is unable to perform in a timely and economical manner.

Increasing work potency and productivity, decreasing employment and production costs, rising accuracy, processing service and client relations, and partitioning security problems on an enormous scale are a couple of the important uses of drones in the supply industries globally. Adoption of drone technology across industries leapt from the furore stage to the mega-trend stage fairly quickly, as a lot of businesses began to understand its potential, scope, and scale of global reach.

Whether drones are controlled by a remote or accessed via a smartphone app, they possess the potential of reaching the foremost remote areas with very little to no personnel required; and they need the smallest amount of effort, time, and energy. This is often one of the most important reasons why they are being adopted worldwide, particularly by these four sectors: military, commercial, personal, and future technology.

Conclusions and Recommendations

Drones are a valuable addition to any industrial facility's efforts; they sanction a limitless aerial perspective. The chances for drones to have real worth are endless. Drones open up new opportunities and generate efficiencies in industries such as mining, sea ports, oil & gas, and other large industrial facilities.

Their need emerged as implausibly powerful, versatile industrial tools, capable of finishing a good variety of applications. Trade professionals are exploiting drones to boost and optimise industrial processes to enhance operational efficiencies. Drones are utilised throughout numerous phases of the facility's lifecycle. The nearly limitless visibility and information gathering and analysing capabilities make the machine-controlled drones valuable for many trade sectors. Drones are unambiguously qualified to capture aerial information for consistent use at massive industrial facilities, sanction a speedy and ocean-less data assortment, fuelling wise business call processes. An automatic drone system will increase potency by eliminating the requirement for a drone operator, while providing seamless access to routine and frequent and periodic data.

Automated drones are capable of finishing a good variety of applications. Automated drones are employed in the oil & gas facilities for security, surveillance, emergency response, and infrastructure inspection. In sea ports, drones perform applications such as mapping, surveying, operational oversight, and port observation and traffic control. In mining operations, drones can be utilised in stockpile management, tailings dams, inspections, and more.

References

Lu, Y., & Lia, C. (2018). Applications of multi rotor drone technologies in construction management. *International Journal of Construction Management, 9*(5), 401-412.

Ulmer, M. W., & Thomas, B. W. (2018, October). Same-day delivery with heterogeneous fleets of drones and vehicles. Retrieved from onlinelibrary.wiley.com/doi/abs/10.1002/net.21855

Paucar, C., Morales, L., Pinto, K., Sánchezet, M., Rodríguez, R., Gutierrez, M., & Palacios, L. (2018). Use of drones for surveillance and reconnaissance of military areas. *Smart Innovation, Systems and Technologies, 94,* 119-132. Retrieved December 24, 2020. doi:10.1007/978-3-319-78605-6_10

Lopez, J. J., & Mulero-Pázmány, M. (2019). Drones for conservation in protected areas: Present and future. *Drones, 3*(1), 10. doi:10.3390/drones3010010

https://www.medianama.com/2020/07/223-drone-guide-india/

https://www.airoboticsdrones.com/applications/

https://www.businessinsider.in/tech/news/drone-technology-uses-and-applications-for-commercial-industrial-and-military-drones-in-2020-and-the-future/articleshow/72874958.cms

https://www.iberdrola.com/innovation/drones-uses

https://www.tandfonline.com/doi/figure/10.1080/15623599.2018.1452101?scroll=top&needAccess=true

https://onlinelibrary.wiley.com/doi/abs/10.1002/net.21855

International Journal of Business Analytics & Intelligence
10 (1) 2022, 29-47
http://publishingindia.com/ijbai/

Investigating the Influence of Ethiopian National Culture on Information Security Policy (ISP) Violation: The Case of the Ethiopian Financial Institutions

Dakito Alemu Kesto*, Tilahun Muluneh**

Abstract

Nowadays, it is clear that information security is one of the most basic issues that organisations need to focus on. Despite huge investments made by companies to keep their information systems safe, there are many information security breaches that infiltrate companies' systems; consequently, these cost them their reputation, affect customers' confidence, and bring huge financial losses. Ethiopian companies are not immune to this security problem, and there are many signs of information security breaches. The literature suggests that almost all investments in information security related issues are for technological solutions. However, this type of solutions alone do not work well, and according to some researchers, there is one significant element that has been given very little attention, the human factor. Most of the information security breaches are caused by employees who are legitimate users of the company's systems. So 'how can we counter the illegal action of our own employees?' is the main objective this study tried to address. The findings showed strong evidence on the influence of contextual factors and national culture, on employees' information security behaviour, and consequently, it highlighted the importance of taking some level of precaution when organisations introduce new policies or standards that are copied from abroad. Policy makers and ISS managers in Ethiopia, particularly at the Information Network Security Agency (INSA), can learn how important it is to modify or adapt their ISP, which was copied from ISO 27002, based on the findings of this study.

Keywords: Contextual Factors, National Culture, Employees' Information Security Behaviour, Financial Institutions, Information Systems Security

Introduction

Many organisations around the world are faced with an increasing number of information security attacks on their systems. While the ISS world often focuses on analysing and counteracting threats of external origin (Magklaras et al., 2006), most of these threats originate from insiders (D'Arcy et al., 2009). The frequency of occurrence is not the only indicator of the impact of insiders' incidents; there are also considerable financial costs attributed to legitimate user actions (Magklaras et al., 2006). Many researchers (Magklaras et al., 2002; Theoharidou, 2005; Warkentin et al., 2009) report that the insider threat remains the greatest single risk to organisations, and most security experts agree that more successful attacks usually come from inside the organisation rather than from outside, and that insider attacks are potentially more costly (Schultz, 2002; Shaw et al., 1998). The internal incidents are here to stay and their mitigation should be a priority for IT professionals (Magklaras et al., 2006).

When we explore the information security breach problems in Ethiopia, due to lack of studies in the areas of information system security (ISS), it is difficult to know the exact figure with respect to the financial losses of the

* Head, Accounting & Finance Program Unit, School of Commerce, CoBE, Addis Ababa University, Ethiopia. Email: dakito.alemu@aau.edu.et
** Addis Ababa University, Ethiopia. Email: dalemu22@gmail.com

incidents. Interestingly, we tried to have an interview with IT security officers of different banks located in Addis Ababa, but they were not willing to state financial losses they incurred by ISS breaches. Even though there is lack of documented and published information with respect to security breaches in Ethiopia, there are some indications which show us the critical level to which ISS breaches reach the country. For example, according to a special programme that was broadcasted by the Ethiopian Radio and Television Agency (2012), the Ethiopian Revenue and Custom Authority junior database administrator used the password provided to him by his boss (because she went abroad), to deliberately delete the data related to a tax which the company is expected to collect from its customers. In return, he received 800,000 Birr, and this single incident cost the company 13,000,000 Birr.

In another instance of information security policy (ISP) violation, the Ethiopian Airlines terminated 11 employees working in different departments, citing violation of rules and procedures they were expected to abide by and abuse of the systems that they had privileged access to (Ethio_News_24, 2013). The alleged abuse of the systems is connected to its frequent-flyer programme called ShebaMiles, whereby Ethiopian Airlines customers can accumulate miles that would result in awards of free tickets, gifts, and privileges. The sources indicated that the alleged wrongdoing was uncovered following a complaint by a customer enrolled in the ShebaMiles programme, regarding irregularities in the frequent-flyer's account. Obviously, this incident may have damaged the good image of the airlines, which in turn may bring some kind of financial loss to the company.

The main research problem that initiated this research work was the lack of studies in every corner of the world in general, and Africa in particular, that investigates how national culture moderates the influence of formal sanctions (in this research we use security counter measures interchangeably with formal sanctions), perceived benefits, moral beliefs, and shame on employees' intention to violate ISSP. Despite critical ISS problems in Africa, and particularly in Ethiopia (Gardachew, 2010; Bultum & Ayana, 2012; Taddesse & Kidan, 2005), there is hardly any research that tries to consider non-technical solutions to the problem. Specifically, one of the non-technical elements gaining increasing attention is the human element. According to researchers, one of the most common factors to shape human behaviour is culture, and to this end, there is hardly any attempt to explore the influence of national culture on ISSP compliance.

To clearly show the ever-increasing number of ISS breaches, it is important to see some figures in the global perspective. The ISS threat that is caused by insiders or employees' non-compliance is not limited to Africa; literature shows the existence of many information security breaches problems all over the world. According to Garg (2003), companies all over the world are losing more than $2 trillion due to security breaches. This problem will be more frustrating when we realise that most of the breaches are caused by insiders. Between one-half and three-quarters of all information security incidents originate from within the organisation (Ernst & Young, 2003; Information Week, 2005). Since only a fraction of information security incidents are actually discovered (Hoffer & Straub, 1989; Whitman, 2003), the figures from different reports and studies may be lower than the actual fact. As insiders have better access to the companies' secured information, they can bring catastrophic consequences to their company, in terms of financial as well as non-financial aspects, such as destroying the good image of the company, customers' confidence, and many more (D'Arcy et al., 2009). In this research, an insider is defined as a person that is legitimately given the capability of accessing one or more components of IT infrastructure (Magklaras et al., 2006, pp. 3). The CyberSecurity Watch Survey (2010) annual report indicates more than $2 billion in losses to organisations due to ISS breaches between 1997 and 2007. According to the survey, companies may continue to suffer more losses in the future, if the overall types of attacks are doubled in the specified time period. More recently, CyberSecurity Watch Survey (2012) annual report indicates that insider attacks increased from 41% in 2004 to 53% in 2011. In addition to this, according to a report by Verizon (2012), the security breaches caused by insiders increased on average from 33% (2004-2007) to 48% (2009). To make matters worse, insider abuse of company systems is the second-most frequent (44%) security problem, next to virus incident (49%), and well above outsiders (29%) (Richardson, 2008). Therefore, the objective of this study is to identify the moderating impact of national culture on the influence of information formal sanctions (security countermeasures), perceived benefits, moral beliefs, and shame on employees' intention to violate ISSP. This valuable output allows information security personnel and managers to make better decisions

on 'how to develop and implement ISSP that best fit one's (Ethiopian) culture?'.

Research Questions

The major purpose of this study was to examine whether cultural differences moderate the influence of formal sanctions (security countermeasures), perceived benefits, moral beliefs, and shame on employees' intention to violate ISSP. In addition to this, we investigated the influence of formal sanctions (security countermeasures), perceived benefits, moral beliefs, and shame on employees' ISSP violation. Thus, the following research questions guided this research:

RQ1: What is the influence of security countermeasures (formal sanctions), perceived benefits, moral beliefs, and shame on employees' intention to violate their organisational ISSP?

RQ2: What is the moderating impact of national culture on the influence of security countermeasures (formal sanctions), perceived benefits, moral beliefs, and shame on employees' intention to violate their organisational ISSP?

Hypotheses

To answer the research questions mentioned above, we formulated several hypotheses. Even though there are five national cultural dimensions according to the Hofstede (1980) model of national culture, our cultural hypotheses addressed only four of them, namely power distance, uncertainty avoidance, individualism/collectivism, and masculinity/femininity. This decision was based on the fact that Ethiopia does not have a score for the long-term orientation dimension in Hofstede's study. In addition to the cultural dimensions, we include four RCT (rational choice theory) constructs, namely formal sanctions, perceived benefits, moral beliefs, and shame. As can be seen from the research model (Fig. 1) there are 11 hypotheses.

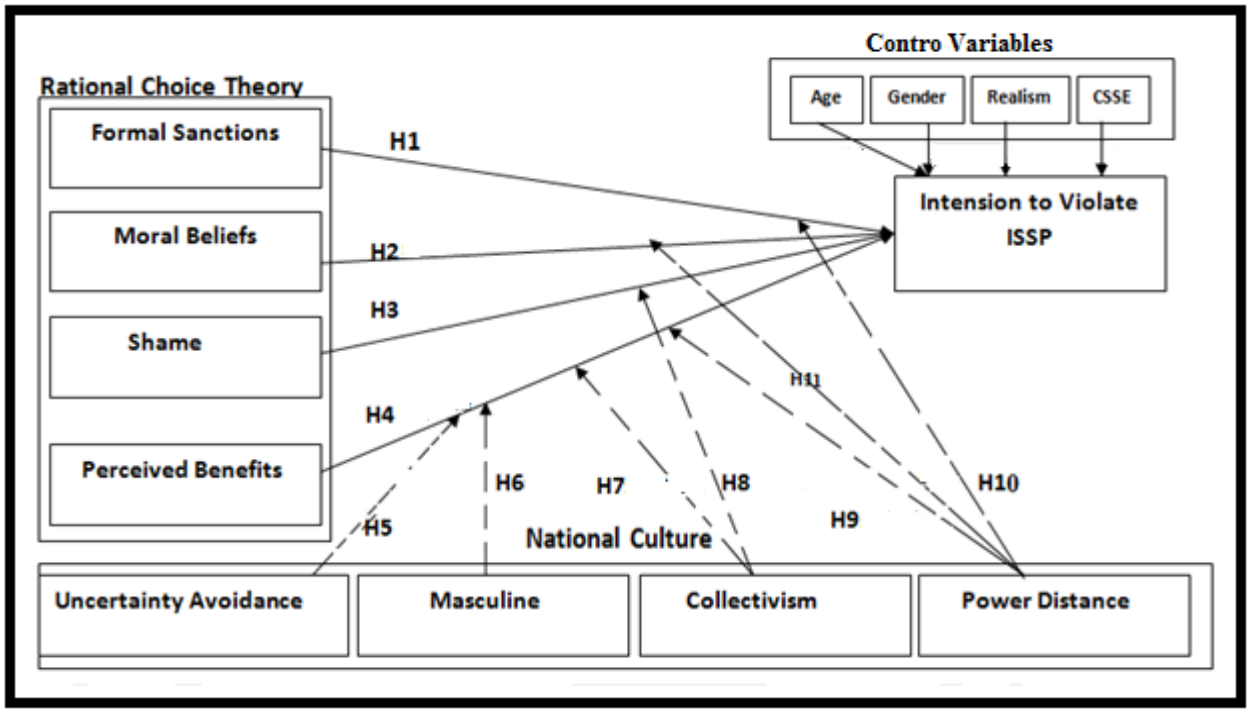


Fig. 1: The Research Model

H1: There is a negative association between formal sanctions and employees' intention to violate ISSP.

H2: There is a negative association between moral beliefs and employees' intention to violate ISSP.

H3: There is a negative association between shame and employees' intention to violate ISSP.

H4: There is a positive association between perceived benefits and employees' intention to violate ISSP.

H5: The higher the degree of uncertainty avoidance, the weaker the impact of perceived benefits on employees' intention to violate ISSP.

H6: The higher the degree of masculinity, the stronger the impact of perceived benefits on employees' intention to violate ISSP.

H7: The higher the degree of collectivism, the stronger the impact of perceived benefits on employees' intention to violate ISSP.

H8: The higher the degree of collectivism, the stronger the impact of shame on employees' intention to violate ISSP.

H9: The higher the degree of power distance, the stronger the impact of perceived benefits on employees' intention to violate ISSP.

H10: The higher the degree of power distance, the weaker the impact of formal sanctions on employees' intention to violate ISSP.

H11: The higher the degree of power distance, the weaker the impact of moral beliefs on employees' intention to violate ISSP.

Methods and Materials

Since researchers are expected to clearly formulate their research methodology in advance, we illustrate the research's underlying philosophies, epistemology, ontology, and method (see Fig. 2). Ontology focuses on the question of what is taken as real and how to know whether something is real (Orlikowski & Baroudi, 1991; Guba & Lincoln, 2005; Merterns, 2007). The underlying ontology used here lies in the positivist paradigm. The choice for the positivist paradigm was done because the purpose of the current research was to develop and validate an empirical model consisting of testable hypotheses to evaluate the effect of national culture and other important variables on employees' intention to violate ISSP. Orlikowski and Baroudi (1991) classified IS research as positivist when there is evidence of formal propositions, quantifiable measures of variables, hypothesis testing, and the drawing of inferences about a phenomenon from the sample to a stated population.

The epistemological assumptions are concerned with the nature of knowledge and how it can be obtained. Crotty (1998) distinguishes between three epistemological positions: objectivism, constructivism, and subjectivism. Our research epistemological view is objectivism. In the objectivism view, knowledge exists out there whether we are conscious of it or not. Researchers with the objectivism position always try to look for causes and effects and explanations. They rely upon experimental, quasi-experimental, and survey methods. When we come to the research approach, we used a quantitative method. The rationale for adopting a quantitative approach was because it has the ability to produce objective, quantifiable, and reliable data that are usually generalisable to some larger population. Whenever the purpose of a study is hypothesis testing using statistical methods and generalisation to a larger population from the sample based on numerical data, quantitative survey research is the preferred option (Creswell, 2009).

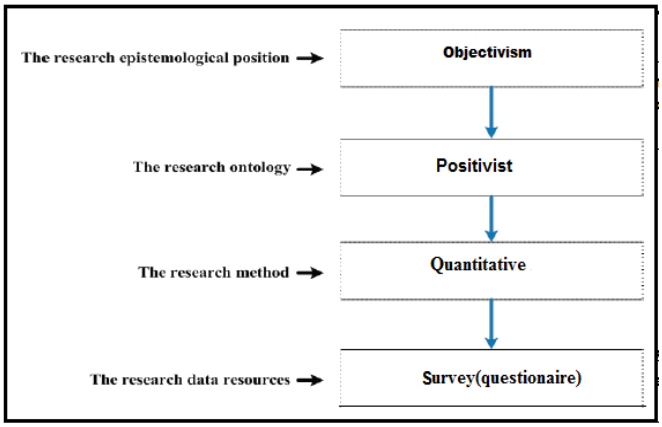


Fig. 2: The Research's Underlying Philosophies, Epistemology, Ontology, and Method

The research utilised questionnaire-based data-gathering techniques to collect the data needed to investigate and test the research hypotheses. Surveys are widely accepted and used in the IS field for empirical research; specifically, quantitative researchers frequently use data from surveys (Linda & Thomas, 2008). The sample survey methodology also leads to greater generalisability of the results, when compared to other research methods (McGrath, 1981). We used Hofstede's model of cultural dimensions because it has been rigorously validated in previous cross-cultural studies over time and in many of countries (Sondergaard, 1994). We used SEM-based statistical analysis to evaluate the relationship among the national cultural dimensions, RCT constructs, and employees' intention to violate ISSP. When we come to the population and sampling procedure, according to Singleton and Straits (2005), sampling has to be executed in two separate steps: the first step is to

select the population we were interested in so that we are in a better position to select some representatives. Most of the time, experienced researchers try to come up with a concise picture of their population before proceeding with the selection of sample, thus starting from the top at the population and working down to the sample (Bailey, 1982). In our research, the population includes organisations located in different parts of Ethiopia (i.e., Addis Ababa, Mekele, Bahir Dar, Adama, Diredaw & Hawassa), which have an established ISSP. In each company, individuals were selected randomly. We believe that there is a possibility of the threat of common method bias (CMB), which can occur, among other causes, when the dependent and independent variables are collected at the same time in the same survey instrument (Podsakoff et al., 2003).

Researchers have checked whether the sample size was likely to be sufficient prior to actually conducting the study. This is because small sample sizes can result in non-convergence and improper solutions (Anderson & Gerbing, 1984; Fornell & Larcker, 1981). Anderson and Gerbing (1984) suggest that a sample size of 150 or more will be needed to obtain parameter estimates that have standard errors small enough to be of practical use. Researchers used previously validated instruments wherever possible, being careful not to make significant alterations in the validated instrument without revalidating instrument content, constructs, and reliability (Boudreau et al., 2001). Thus, in our research, we used previously validated instruments. Statistical Package for the Social Sciences with Amos (SPSS Amos) software was used to run different types of statistical analysis.

The Full CFA Measurement Model

Now we proceed to the final stage of constructing the measurement model: bringing together all the individual theoretical constructs so that we can assess the validity of the full CFA measurement model. In this regard, the convergent validity of the full measurement model was evaluated based on the goodness-of-fit statistics, while the discriminant validity of the theoretical construct was assessed by comparing the AVE value of every construct with the squared inter-construct correlation of that factor (Hair et al., 2010). According to Hair et al. (2010), discriminant validity is exhibited if the AVE value is consistently higher than the squared inter-factor correlation. By using these techniques, we assessed the discriminant validity of every construct shown in the full measurement model. The full measurement model consists of eight constructs and 33 items. In addition to this, we present all the necessary goodness-of-fit statistics of the full measurement model, while Table 1 shows the result of the discriminant validity. All the CR values were within the acceptable range and all AVE values consistently higher than the squared inter-factor correlation. Hence, discriminant validity was supported.

Table 1: Construct Correlation Matrix for the Main Survey

	CR	AVE	Power Distance	Perceived Benefit	Masculinity	Formal Sanction	Shame	Moral Beliefs	Collectivism	Uncertainty Avoidance
Power Distance	0.891	0.672	0.820							
Perceived Benefit	0.928	0.765	0.360	0.875						
Masculinity	0.809	0.523	0.413	0.247	0.723					
Formal Sanction	0.878	0.547	-0.474	-0.275	-0.343	0.740				
Shame	0.931	0.772	-0.370	-0.563	-0.350	0.320	0.878			
Moral Beliefs	0.923	0.800	-0.425	-0.399	-0.397	0.217	0.340	0.895		
Collectivism	0.872	0.633	0.313	0.270	0.063	0.024	-0.300	-0.268	0.796	
Uncertainty Avoidance	0.860	0.608	-0.384	-0.203	0.036	0.312	0.326	0.419	0.084	0.779

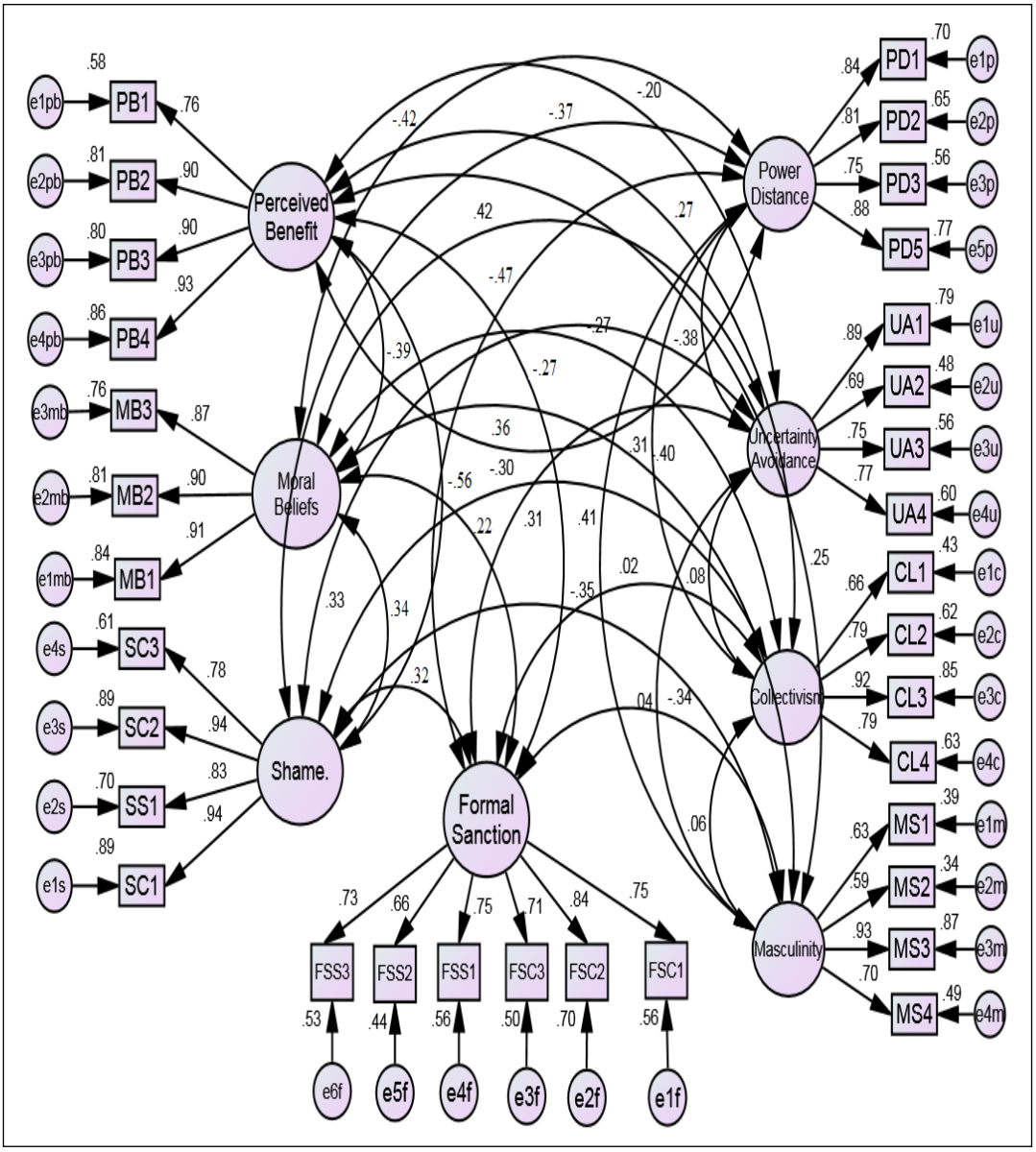


Fig. 3: The Proposed Full Measurement Model for the Main Survey

Table 2: The Goodness-of-Fit Statistics of the Full Measurement Model for the Main Survey

Absolute Fit Index		*Incremental Fit Index*		*Parsimony Fit Index*	
X2(P-value)	874.14 (.14)	CFI	.93	PCFI	.81
DF	467	IFI	.93	PNFI	.74
X2/DF	1.87	TLI	.92		
RMSEA	.065				
RMR	.025				
SRMR	.05				
GFI	.91				
AGFI	.80				

Final Reliability

In this section, we conduct an internal consistency check for each construct by using the data collected from the main survey. Before constructing the final structural model, researchers are expected to make sure that they already conducted the instrument reliability test (Straub et al., 2004). Reliability measures how consistently instrument items measure a construct of interest. In this regard, we use a type of reliability test called internal consistency. Accordingly, the Cronbach's α is used to test the construct reliability of every construct and Table 3 shows the result. According to Hair et al. (2010), a Cronbach's α of .7 or more is the most commonly accepted threshold. As can be seen from Table 3, all the values are greater than the minimum value, and hence, the internal consistency of instruments or construct reliability is satisfied.

Table 3: Instrument Reliability

Constructs	*No. of Items*	*Cronbach's α Value*
Power Distance	4	.90
Uncertainty Avoidance	4	.83
Collectivism	4	.87
Masculinity	4	.84
Perceived Benefits	4	.87
Moral Beliefs	3	.91
Shame	4	.91
Formal Sanction	6	.89

Results and Discussion

Once the validity and reliability of the measurement model are checked, the next step is to test the structural model. Hence, in this section, we focus on assessing the structural model, which is testing the relationship between the theoretical constructs shown in the research model. We use the structural equation modelling (SEM) methodology for representing, estimating, and testing the network of relationships between the theoretical constructs. In addition, we present and discuss the main findings of the research against the research questions shown in the second chapter. The main research question (from the second chapter) this study raised is "to what extent, if any, does cultural difference moderate the influence of security countermeasures (formal sanction), perceived benefit, moral beliefs, and shame on employees' intention to violate ISSP?" Thus, in the upcoming sections we discuss the following topics in detail: in section 1.9.4 we present the final result of the structural model validity, hypothesis testing and we discuss the findings of the research.

Assessment of the Structural Model Validity and Hypothesis Testing

Unlike the traditional statistical methods, which are mainly dependent on a single statistical test, SEM relies on many statistical tests to investigate how well a proposed theoretical model fits the reality or the collected data (Suhr, 2006). Thus, to evaluate the validity of the structural model, we use different types of statistical tests available in SEM. As clearly shown in the process of constructing the full measurement model, we depict how well each of the theoretical constructs relate or correlate with each other. However, the correlation shown in the full measurement model is a simple correlation and it does not provide other important statistical information about the nature of the relationship between the theoretical constructs. In this regard, a measurement model could only be taken as a first step towards constructing the structural model (Hair et al., 2006). Since we have already finalised the construction and testing of the measurement model, our next job is to construct and test the structural model. According to Byrne (2001), the structural model depicts which construct directly or indirectly influences the value of the other constructs in the research model.

To test the structural model validity, reliability, and acceptability, researchers usually go through the following activities (Kassahun, 2012): (1) analysing the goodness-of-fit statistics (see previous chapter Table 2); (2) evaluating the R-squared coefficient of determination and according to Chin (1998), a value of .5 or above is considered very good; (3) evaluating the magnitude level, significance (based on the P-value), and direction of the estimated structural values – Hair et al. (2006) state that the significance level of a parameter estimate should be less than .05. Fig. 4 shows the theoretical structural model of the research.

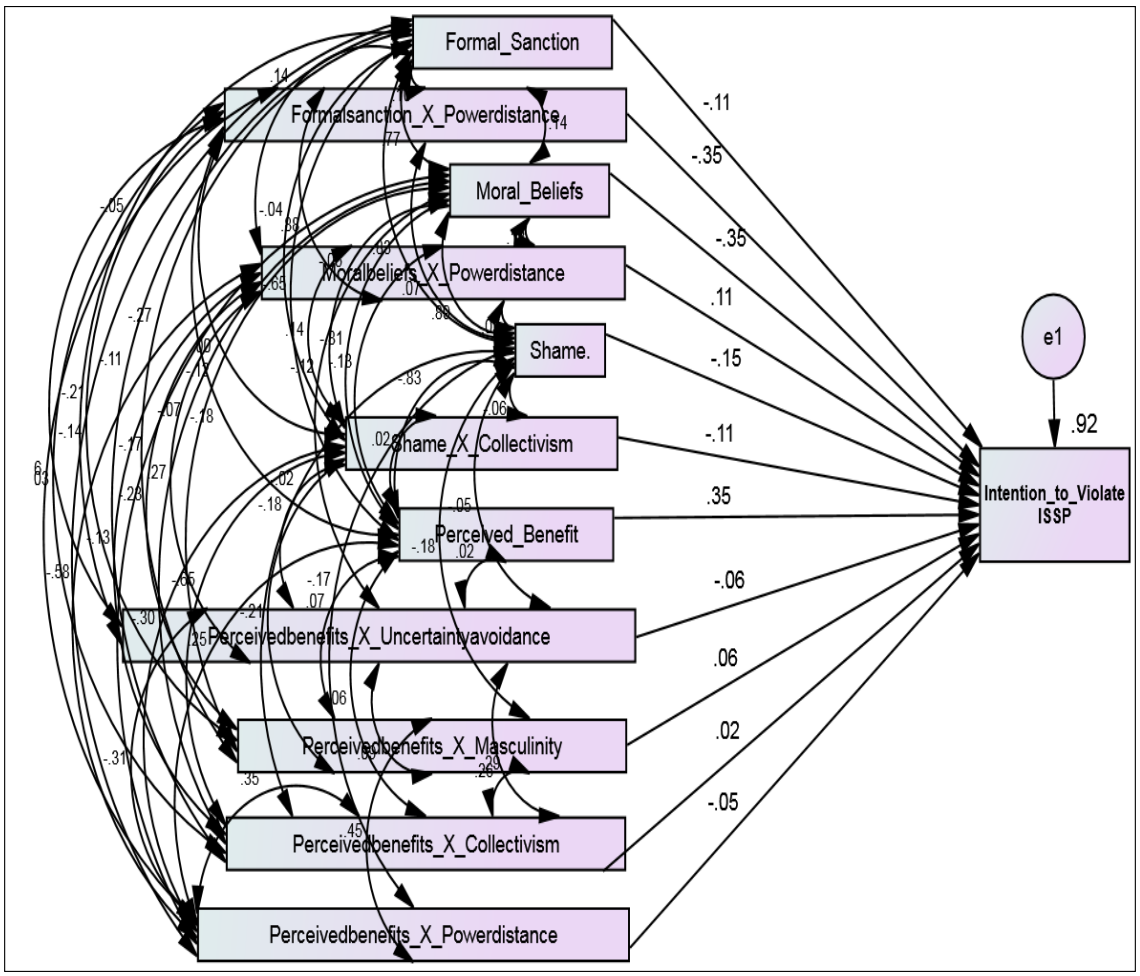


Fig. 4: The Full Structural Model

We evaluate the structural model against those three criteria. Table 4 shows the goodness-of-fit for the whole structural model.

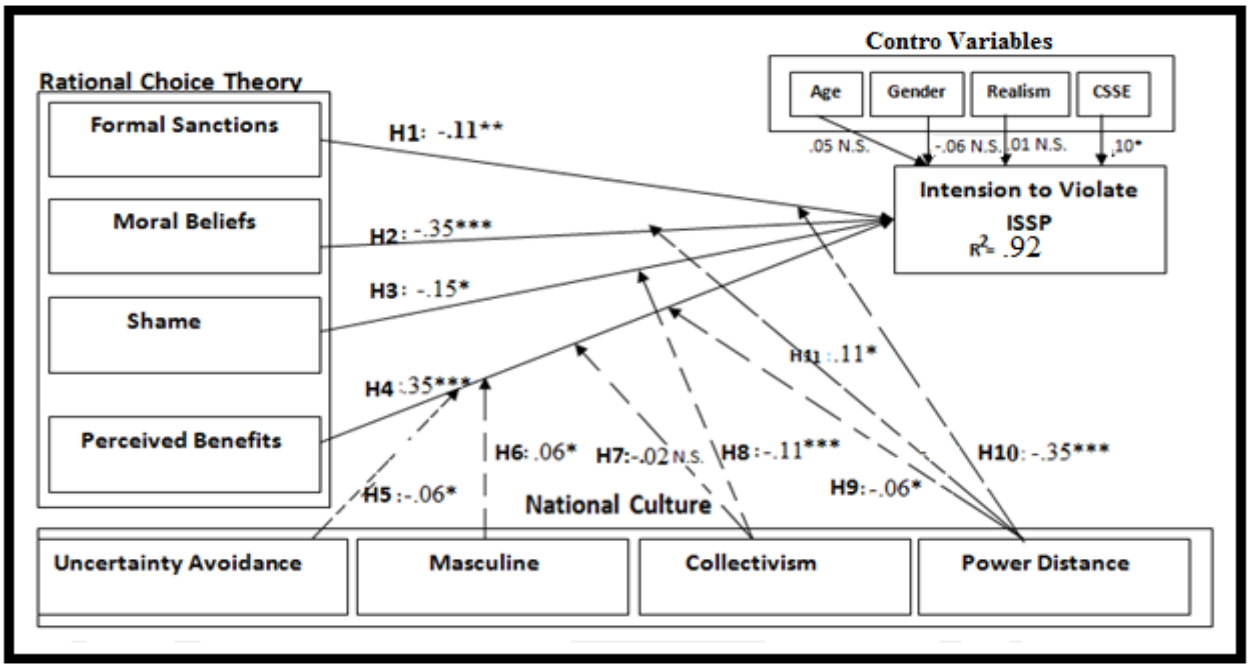
Table 4: The Goodness-of-Fit Statistics for the Structural Model

Absolute Fit Index		*Incremental Fit Index*		*Parsimony Fit Index*	
X2(P-value)	292.2	CFI	.93	PCFI	.67
DF	(.23)	IFI	.94	PNFI	.66
X2/DF	75	TLI	.92		
RMSEA	3.9				
RMR	.08				
SRMR	.04				
GFI	.06				
AGFI	.91				
	.82				

As can be seen from the goodness-of-fit statistics in Table 4, all the values satisfy the criteria for a good model. The chi-square value of 292.2 (at P > .05), with 72 degrees of freedom indicates a good fit. With respect to the absolute fit index, all the statistics meet the minimum requirements (GFI > .90, AGFI > .80, RMR & SRMR < .09, and RMSEA < .08/.1), and the incremental fit index statistics (IFI, TLI, and CFI) have values greater than or equal to .92, while the parsimonious fit indices (PCFI and PNFI) score above .05. Thus, all the selected statistics indicate the existence of best fit between the structural model and the collected data.

Following the goodness-of-fit test, we proceed with the next statistical test, which is the assessment of the coefficient of multiple determination (R-squared). Thus, we assessed the proportion of variance in the dependent variable, which is employees' intention to violate ISSP, accounted for by the model. Fig. 4 shows that 92% of

the variance in employees' intention to violate ISSP is explained by the model, and according to Chin (1998), R-squared value of .5 or above is considered to be very good. The last statistical test conducted to further strengthen the validity of the structural model is to evaluate the standardised factor loadings, the direction of the relationships, and the level of significance. To this end, Fig. 5 and Table 5 show these statistics.



Notes: N.S. = non-significant; ***p-value < 0.001; **p-value < 0.01; *p-value < 0.05.

Fig. 5: The Final Path Diagram for the Research Model

Table 5: The Result from the Final Structural Diagram

Path	*Hypothesis*	*Standardised Estimate*	*S.E.*	*C.R.*	*P*
Intention_to_Violate_ISSP ← Formal_Sanction	H1	−0.107	0.065	−2.808	0.005
Intention_to_Violate_ISSP ← Moral Beliefs	H2	−0.352	0.054	−7.513	***
Intention_to_Violate_ISSP ← Shame	H3	−0.149	0.054	−2.529	0.011
Intention_to_Violate_ISSP ← Perceived Benefit	H4	0.349	0.063	8.789	***
Intention_to_Violate_ISSP ← Perceivedbenefits_X_UncertaintyAvoidance	H5	−0.061	0.023	−2.501	0.012
Intention_to_Violate_ISSP ← Perceivedbenefits_X_Masculinity	H6	0.063	0.021	2.573	0.01
Intention_to_Violate_ISSP ← Perceivedbenefits_X_Collectivism	H7	−0.016	0.026	0.553	0.58
Intention_to_Violate_ISSP ← Shame_X_Collectivism	H8	−0.112	0.027	−4.176	***
Intention_to_Violate_ISSP ← Perceivedbenefits_X_Powerdistance	H9	−0.055	0.028	−1.986	0.049
Intention_to_Violate_ISSP ← Formalsanction_X_Power distance	H10	−0.354	0.036	−7.303	***
Intention_to_Violate_ISSP ← Moral beliefs_X_Power distance	H11	0.106	0.035	2.265	0.024

The entire stated hypotheses, except three, are found to be significant at least at 95% confidence interval, and hence, they are accepted. More specifically, hypothesis 7 failed to be significant, while hypotheses 9 and 10 were found to be significant, but in the opposite direction to what was stated in the research.

Discussion

In this section, we discuss the result of each hypothesis. As indicated in the first chapter, the main purpose of this study is to examine the moderating influence of national culture on the impact of security countermeasures (formal sanctions), perceived benefits, moral beliefs, and shame on employees' intention to violate ISSP. By using a sample of data collected from medium- and large-sized organisations in Ethiopia, we found strong evidence on the considerable influence of national culture dimensions in strengthening or weakening the relationship between ISS countermeasures and other important variables, as depicted by RCT, and employees' intention to violate ISSP. Thus, in the following paragraphs, we highlight the main findings of the study.

As can be understood from the result of the first hypothesis, formal sanction is found to have a negative influence on employees' intention to violate ISSP. This means when organisations use deterrence mechanisms, in the form of formal rules and policies, it is more likely to be associated with reduced employees' intention of violating their organisation's ISSP. As indicated in the IS literature, there exists inconsistent findings concerning the impact of formal sanctions on reducing computer abuse or IS misuse (D'Arcy & Herath, 2011). The results of our study are consistent with many research outputs in the area of criminology (e.g. Paternoster & Simpson, 1996; Pratt et al., 2006) and, more importantly, in the ISS area. For example, previous studies report the ability of formal sanctions to reduce IS misuse intention (D'Arcy et al., 2007), unauthorised access intention (D'Arcy & Hovav, 2009), ISSP non-compliance (Siponen et al., 2007), and computer abuse incidents (Straub, 1990; Kankanhalli, 2003). In our review of the IS literature, we could not find any empirical studies that explore this relationship in the context of developing economies.

Second, moral belief is found to have a strong negative impact on employees' intention to violate their organisation's ISSP. This means as employees have strong moral beliefs or commitment, they will intend not to violate their organisation's ISSP. This finding is not only consistent with the basic principle of rational choice theory (Becker, 1968), but also with criminology studies, which report that people with low moral beliefs or personal norms are more inclined to engage in deviant behaviour like corporate crime (Paternoster & Simpson, 1996) and tax evasion (Wenzel, 2004). Further, research outputs in psychology (e.g. Blasi, 1980; King & Mayhew, 2002; Rest, 1986 as cited in Myyry et al., 2009) also report that good moral reasoning helps people develop desirable behaviour. More importantly, in the area of ISS, personal norms (Li et al., 2010) and moral beliefs (Siponen & Vance, 2012) are reported as having a positive impact on employees' compliance intention to Internet use policy and a negative impact on intentional violation of ISSP, respectively.

Third, shame is found to have a strong negative effect on employees' intention to violate their organisation's ISSP. This result indicates that as employees feel that violating ISSP is a shameful activity, they will distance themselves from such acts. When we compare our findings against previous studies, it is consistent with studies in the criminology literature (e.g. Grasmick & Bursik, 1990; Nagin & Paternoster, 1993; Tibbetts, 1997). However, when we come to ISS literature, we can only find a single empirical study by Siponen and Vance (2010) that investigates the impact of shame as a deterrent construct, and in that same study, they report the inability of shame to reduce employees' non-compliance to their organisation's ISSP. A plausible reason for the contradiction of our findings with Siponen & Vance (2010) may be due to the difference in the cultural makeup of the sample respondent in the two studies. In this respect, our sample is taken from a more collective society where violating norms leads to a feeling of shame, while the sample for the study conducted by Siponen and Vance (2010) were taken from an individualistic society (Finland) where breaking norms resulted in feelings of guilt, not shame (Hofstede, 1980).

Fourth, perceived benefit is found to be an excellent predictor of employees' violation of ISSP. This means when employees perceive that violating their organisation's ISSP helps them achieve some sort of benefits, they will most probably engage in violating those rules. This finding is similar to what the RCT states: when people make choices, they analyse the outcome of each of the alternatives and choose the one that is perceived to bring more satisfaction/perceived benefits (McCarthy, 2002). Moreover, the finding is consistent with empirical studies in ISS literature: Vance and Siponen (2012) report the significant positive impact of perceived benefits on employees' intention to violate ISSP, while Li et al.

(2010) report a significant negative influence of perceived benefits on employees' compliance intention to Internet use policy.

Hypothesis 5 proposes that the higher the degree of uncertainty avoidance, the weaker the impact of perceived benefits on employees' intention to violate ISSP; as can be seen from Fig. 5, this hypothesis is supported. This means that, even though the perceived benefits of non-compliance initiate employees to violate their organisation's ISSP, the strength of this relationship is weaker for high uncertainty avoidance employees than their low uncertainty avoidance counterparts. In this regard, researches in the area of sociology (e.g. Hofstede, 2003, 2011) found that people who score high in uncertainty avoidance give primary emphasis for the enforcement of rules and regulations, than their low uncertainty avoidance counterparts. If we bring this same scenario to ISS, we may be inclined to say that low uncertainty avoidance employees may violate their organisation's ISSP more often than their high uncertainty avoidance counterparts, as long as there are perceived benefits of violating the policies. In the ISS literature, this result is consistent with those of Timo (2009), who reported that low degree of uncertainty avoidance might lead to ISS problems. To the best of our knowledge, our study is the first empirical study to research the moderating influence of uncertainty avoidance in the relationship between perceived benefits and employees' intention to violate ISSP.

When we come to the sixth hypothesis, it proposes that the higher the degree of masculinity, the stronger the impact of perceived benefits on employees' intention to violate ISSP; this is supported. The finding of this research is consistent with conceptual cultural studies in the field of sociology. Hofstede (2001) states that for people in highly masculine society, the world is "unjust", and if any activity helps them achieve wealth then they will struggle to get it done in any way they can. On the other hand, a financial reporting study by Doupnik and Tsakumis (2004) has found that as masculinity increases people show a tendency to disclose their organisation's secret financial information to outsiders in response to some benefits. Our finding is also consistent with findings in the area of ISS. For example, Timo (2009) found that higher masculinity is most often associated with ISS problems. While the role of masculinity has been studied in different disciplines, to the best of our knowledge, there is no single study in the area of ISS that investigates the moderating influence of masculinity in the relationship between perceived benefits and employees' intention to violate their organisation's ISSP.

The seventh hypothesis claims that the higher the degree of collectivism, the stronger the impact of perceived benefits on employees' intention to violate ISSP. Unfortunately, this hypothesis is not supported. Even though this result is consistent with the findings of some studies that are conducted in various disciplines, the literature indicates that many of the findings related to collectivism have got mixed support. In this regard, Husted (2000) found that the rate at which individualistic societies engage in software piracy is higher than for the less individualistic societies. Contrary to this, Timo (2009), in the area of ISS, Tan et al. (2003), in the area of IS development projects, and Leidner and Kayworth (2006), in the aviation industry, reported that for the perceived benefit of being in harmony with friends and colleagues, peoples in collective society tend not to report their group's wrongdoings. From this we may infer that, for the perceived benefit of being in harmony with friends and colleagues, employees in a collective society may not expose their friends for violating rules, and this may initiate employees to engage in violating their organisation's policies themselves. However, in our study, the perceived benefits of violating organisation's ISSP are measured in terms of saving employees personal and work time, and it has very little, if any, relationship with the perceived benefit of being in harmony with friends. And hence, in such a scenario, as the perceived benefit of saving time increases, employees in a more collective society may not violate their organisation's ISSP more often than employees in less collective societies do. This is because people in an individualistic society are more inclined to show a self-centred character (Hofstede, 2011). This fact might initiate them to override their organisation's rules in exchange for the perceived benefit of saving time.

The eighth hypothesis proposes that the higher the degree of collectivism, the stronger the impact of shame on employees' intention to violate ISSP; this is supported by the collected data. In part, this finding is substantiated by Hofstede's (2011) cultural theory, which states that if people bypass rules in collective societies, then they feel ashamed, while the same action leads to a feeling of guilt in an individualistic society. If we bring this same reality

into ISS, we are inclined to say that shame decreases employees' intention to violate their organisation's ISSP and the strength of this relationship will get stronger and stronger for more collective societies than less collective societies.

In the ninth hypothesis, we propose that the higher the degree of power distance, the stronger the impact of perceived benefits on employees' intention to violate ISSP. This hypothesis is found to be significant, but in the opposite direction to what is being hypothesised, and hence, it is not supported by the collected data. Previous researches in the area of corruption (Husted, 1999) and tax evasion (Tsakumis, 2007) highlighted that as people in high power distance societies perceive that there exists financial benefits for violating rules, they will engage in such activities more often than low power distance societies. Unlike the above two researches, in our study the perceived benefit of violating ISSP is not monetary value, but time, and this may in part influence the finding of our study, because saving time is different from getting money and the two societies may give different levels of importance for these perceived benefits. The result of this research implies that as perceived benefits of saving time increase, employees' intention of violating their organisation's ISSP also increases, and this relationship is stronger for low power distance than high power distance employees. To the best of our knowledge, this is the first study to empirically investigate the moderating impact of power distance between perceived benefits and employees' intention to violate their organisation's ISSP.

In the tenth hypothesis, we propose that the higher the degree of power distance, the weaker the impact of formal sanctions on employees' intention to violate ISSP. The result is found to be significant in the opposite direction from what has been proposed. Even though this result is consistent with some studies, the outputs from different researches show mixed support. In this regard, Husted (1999), in the area of corruption, Tsakumis (2007), in the area of tax evasion, and D'Arcy et al. (2007), in the area of ISS, found that in high power distance societies, people break formal rules and procedures more often than people in low power distance societies. On the other hand, in an empirical work by Dols and Silvius (2010), it is reported that employees in high power distance society are found to be more obedient than low power distance people, to their organisation's rules, given that they are ordered by their boss. In another study by Ifinedo (2009), in the area of IT security management, it is reported that a government-driven security regulation is more successful in high power distance society than in low power distance. Moreover, according to Hofstede (2001), the way bosses behave or act can play a critical role in creating compliance to rules in high power distance society. In this regard, what may be implicit in the mind of our sample respondents is that they feel they are expected/ordered by their boss to comply with their organisation's ISSP.

In the last hypothesis, we proposed that the higher the degree of power distance, the weaker the impact of moral beliefs on employees' intention to violate ISSP. This hypothesis is supported. This finding is consistent with conceptual works in different disciplines. In this regard, in low power distance societies, there exists a participatory management style (Moore, 2003) and it is a good predictor of organisational citizenship behaviour (OCB), which interns associated with a higher degree of compliance with rules, by creating an environment where every individual feels a sense of belonging and is morally more tied up to the wellbeing of their company (Organ & Konovsky, 1998). This means as employees' moral beliefs increase, their intention to violate their organisation's ISSP decreases, and this relationship is stronger for lower power distance employees than their higher power distance counterparts. This idea is partly strengthened by Peterson et al. (2001), who state that, even though the degree of influence varies, both individual's supervisors and people at home do have an influence on an individual's decisions concerning ethical dilemmas like non-compliance with organisation's rules (Peterson et al., 2001).

Finally, the effect of the four control variables (age, gender, CSSE, and realism) on employees' intention to violate their organisation's ISSP was also examined and one of them is found to be significant. The reason to include these variables as a control variable is because the data was collected from different organisations that are located in different parts of Ethiopia. More specifically, CSSE is included as a control variable because the respondents might have a different level of CSSE, while realism is included because each respondent is given a randomly selected scenario (from three scenarios), and we need to investigate if the response of the employees significantly vary based on their assumption of how realistic the given scenario is. In this regard, we found that employees' CSSE

has a considerable positive influence on their intention to violate their organisation's ISSP, while the remaining variables (age, gender, and realism) are found to have an insignificant influence.

Conclusion

As clearly discussed in this paper, even though there exist a number of ISS standards around the world, protecting the ISS becomes a moving target for most organisations. To shed light on this problem (i.e., non-compliance), researchers in the area of ISS have been conducting a number of studies by using different theoretical lenses (e.g. GDT, PMT, RCT); based on their findings, they reported on factors that might have a significant influence on improving employees' information security behaviour. Almost all of these attempts are focused in the western context and what is implicit in most of these studies is that factors that work in one country will also work in another country. Contrary to this, there exist few studies that indicate how country-dependent factors like national culture affect the findings of such studies. Hence, there is an increasing call for researchers around the world to embark on exploring the impact of national culture on employees' information security behaviour. Thus, our study could be taken as an attempt to respond to this timely and critical call for research. In this respect, this study empirically investigated how constructs of rational choice theory (formal sanction, shame, perceived benefits, and moral beliefs) influence employees' intention to violate their organisation's ISSP. In addition to this, the study has also empirically tested the direct moderating influence of national culture dimensions (power distance, uncertainty avoidance, masculine/feminine, and collectivism/individualism) between rational choice theory constructs and employees' intention to violate their organisation's ISSP. Our proposed empirical model is sufficiently supported by the collected data. In this regard, we got a very important empirical evidence on factors that inhibit and also initiate employees to violate their organisation's ISSP. Moreover, the findings show strong evidence on the influence of contextual factors and national culture on employees' information security behaviour, and consequently, highlights the importance of taking some level of precaution when organisations introduce new policies or standards that are copied from abroad. Policy makers and ISS managers in Ethiopia, particularly at INSA, can learn how important it will be to modify or adapt their ISSP, which was copied from ISO 27002, based on the findings of this study.

In addition to the practical implications of our findings, we also highlighted the contribution of our study to research and theory. Based on the limitations of the study, we recommend suggestions for future researchers in the area of ISS, to further enrich the existing knowledge around factors affecting employees' information security behaviour.

Limitations of the study

Just like most empirical researches, this study has got its own limitations. These limitations are discussed below.

The first limitation of this study is the use of only four of the national culture dimensions, namely power distance, uncertainty avoidance, collectivism, and masculinity. The main reason to exclude long-term orientation is due to the fact that Ethiopia does not have a score for this dimension of Hofstede's (1980, 2001) work. Since our research includes a majority of the national culture dimensions, we believe that the absence of one dimension does not have a considerable influence on the research findings.

The second limitation of this study is the use of companies that only have established ISSP. Particularly, each organisation was included in the sample after the ISS officers of the organisations were asked if they have a well-documented and communicated ISSP; we left out organisations that do not have ISSP. This might raise a question on the representativeness of the selected organisations. However, this study could not be realised by including employees who do not work under any ISSP. Moreover, previous studies in the area of ISS also use the same procedures (e.g. Li et al., 2010; Vance & Siponen, 2012).

The third limitation of this study might be the lack of a measure of the actual behaviour of employees, and hence, the use of intention as the dependent variable might raise the question "Whether intention indicates the actual behaviour of employees?" Many researchers argue in favour of using intention as the valuable approximation that provides a good explanation for behaviour. The psychological theory of planned behaviour suggests that

people frequently behave as they predict (Ajzen, 1991). In this respect, researchers such as Paternoster & Simpson (1996), Wenzel (2004), Pahnila et al. (2007), and Siponen and Vance (2010) use intention as a proxy to actual behaviour in their study to predict employees' behaviour in the workplace.

Fourth, due to the sensitive nature of the topic, respondents might intend to provide socially desirable responses to the questions instead of what is prevailing. This may result in relationships between variables in the research model which are against the literature. To reduce this limitation, we use a scenario method. According to Harrington (1996), since the scenario describes others' behaviour in hypothetical cases, respondents will not be intimidated to report their real intentions to agree or disagree with what the scenario illustrates.

Fifth, in addition to the above limitations, since national culture is found to have a significant influence in IS studies (Leidner & Kayworth, 2006), it is important to note that the result of this study may not be applicable to countries outside Ethiopia.

In spite of these limitations, the study has managed to provide very important and timely insight into the problem of employees' violation of their organisational ISSP and how national culture influences employees' compliance behaviour towards ISSP. In this regard, we do believe that this study adds to the growing body of knowledge in the area of ISS and it has met its objective.

Recommendation for Future Studies

In this research, the survey method was used to investigate the moderating influence of national culture between rational choice theory constructs and employees' intentions to violate their organisational ISSP. Although this study answers the research questions stated in the first chapter, there are other issues that need further investigation by future researchers in the field of ISS.

First, this study used a quantitative research method, and we encourage future researchers to complement the survey method with interviews so that the results can be further explained and triangulated.

Second, researchers can repeat this same study in different countries, so that they can test the generalisability of the findings of this study across different countries with a similar national culture profile. As can be understood from the literature, researches in the area of ISS use Hofstede's (1980) cultural values without measuring culture at the individual level, and their output shows inconclusive findings concerning the impact of national culture dimensions across different countries with a similar cultural makeup. Thus, we advise future researchers to conduct similar studies in the context of a developing country (a country with similar cultural makeup as Ethiopia) and see if the findings are generalisable in the context of developing countries with a similar cultural profile. Moreover, since ISSP is a new and sensitive area of research in developing countries, repeating this same study will help secure matured knowledge of ISSP and national culture in the context of a developing country.

Third, further studies are needed to investigate the moderating influence of the collectivism cultural dimension between perceived benefits and intention to violate organisational ISSP. Contrary to our expectations, collectivism is found to dampen the positive relationship between the perceived benefits and intention to violate organisational ISSP. Different research outputs in IS reported that for the perceived benefit of being in harmony with friends, employees in a collective society may not expose their friends for violating the organisation rules, and this may initiate employees to engage in violating organisational policies on their own. In this regard, we do believe that the instrument used to measure perceived benefits needs further research. In our study, the instruments that are used to measure the perceived benefit of non-compliance are mainly confined to saving personal and work time. Thus, we encourage researchers to use a new instrument to find out if the sense of being in harmony with friends overrides employees' intention to follow their organisational ISSP.

Fourth, it could be a very good research avenue if future researchers investigate the impact of constructs that are not included in this study (e.g. informal sanctions and long-term orientation) on employees' ISSP violation intention. This will help enrich the knowledge around factors that contribute to the successfulness of organisational ISSP.

Fifth and finally, even though the theory of reasoned action states that behavioural intention predicts actual behaviour (Ajzen, 1975), future studies could be conducted by

using the actual compliance behaviour as the dependent variable. In this regard, the result obtained from reported compliance can be compared against the result obtained from monitoring employees in their workplace. Even though it is very difficult to objectively measure the actual compliance behaviour of employees, there exists some mechanism, like examining the activity log of employees on their computer or monitoring employees' computer at the end of their work hour, to confirm if they obey some of the organisational security policies (e.g. lock their computer).

References

Abu-Musa, A. A. (2004). Investigating the security controls of CAIS in an emerging economy: An empirical study on the Egyptian banking industry. *Managerial Auditing Journal, 19*(2), 272-302.

Afroprofile. (2013). Africa's top 50 banks. Retrieved from http://www.afroprofile.com/index.php/jobs-in-nigeria/africa-s-top-100-banks.html

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50*(2), 179-211.

Al-Awadi, M., & Renaud, K. (2007, July). *Success factors in information security implementation in organizations.* In IADIS International Conference e-Society.

Alexander, C. S., & Becker, H. J. (1978). The use of vignettes in survey research. *Public Opinion Quarterly, 42*(1), 93-104.

Alfawaz, S., Nelson, K., & Mohannak, K. (2010, January). Information security culture: A behaviour compliance conceptual framework. In *Proceedings of the Eighth Australasian Conference on Information Security* (vol. 105, pp. 47-55). Australian Computer Society, Inc.

Alghazzawi, D. M., Hasan, S. H., & Trigui, M. S. (2014). Information systems threats and vulnerabilities. *International Journal of Computer Applications, 89*(3), 25-29.

All Africa Global Media Publisher. (2007). Dashen to resume issuing visa cards. Retrieved June 13, 2013, from http://www.allafrica.com/stories/200708271429.html

Alreck, P. L., & Settle, R. B. (2004). *The survey research handbook* (3rd ed.). Boston, MA: McGraw-Hill.

Anderson, J. C., & Gerbing, D. W. (1984). The effect of sampling error on convergence, improper solutions, and goodness-of-fit indices for maximum likelihood confirmatory factor analysis. *Psychometrika, 49*(2), 155-173.

Armstrong, J. S., & Overton, T. S. (1977). Estimating nonresponse bias in mail surveys. *Journal of Marketing Research,* 396-402.

Birch, D. G., & McEvoy, N. A. (1995). Structured risk analysis for information systems. *Hard Money-Soft Outcomes,* 29-51.

Choe, J. M. (2004). The consideration of cultural differences in the design of information systems. *Information & Management, 41*(5), 669-684.

Chow, C. W., Deng, F. J., & Ho, J. L. (2000). The openness of knowledge sharing within organizations: A comparative study of the United States and the People's Republic of China. *Journal of Management Accounting Research, 12*(1), 65-95.

Chua, W. (1986) Radical developments in accounting thought. *Accounting Review, 61,* 601-632.

Clarke, M. (2011). The role of self-efficacy in computer security behavior: Developing the construct of computer security self-efficacy (CSSE). ProQuest LLC.

Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, 189-211.

Converse, J. M., & Presser, S. (1986). *Survey questions: Handcrafting the standardised questionnaire.* SAGE Publications.

D'Arcy, J., & Hovav, A. (2007). Deterring internal information systems misuse. *Communications of the ACM, 50*(10), 113-117.

D'Arcy, J., Hovav, A., & Galletta, D. (2009). User awareness of security countermeasures and its impact on information systems misuse: A deterrence approach. *Information Systems Research, 20*(1), 79-98.

D'Arcy, J., & Herath, T. (2011). A review and analysis of deterrence theory in the IS security literature: Making sense of the disparate findings. *European Journal of Information Systems, 20*(6), 643-658.

De Mooij, M., & Hofstede, G. (2010). The Hofstede model: Applications to global branding and advertising strategy and research. *International Journal of Advertising, 29*(1), 85-110.

De Vreede, G. J., Jones, N., & Mgaya, R. J. (1998). Exploring the application and acceptance of group support systems in Africa. *Journal of Management Information Systems*, 197-234.

Devamohan, A. (2008). E-banking problems and prospects in Ethiopia. Retrieved from http://wA.Devamohan%20-%20E-banking.htm.

Dhillon, G. (1999). Managing and controlling computer misuse. *Information Management & Computer Security, 7*(4), 171-175.

Dhillon, G., & Moores, S. (2001). Computer crimes: Theorizing about the enemy within. *Computers & Security, 20*(8), 715-723.

Ethiopian Radio and Television Agency. (2012). The Ethiopian radio and television agency. Retrieved from http://www.ertagov.com/news/

Ferketich, S., Phillips, L., & Verran, J. (1993). Development and administration of a survey instrument for cross-cultural research. *Research in Nursing & Health, 16*(3), 227-230.

Field, A. (2009). *Discovering statistics using SPSS.* Sage Publication.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2010). *Multivariate data analysis* (6th ed.). NY: Pearson.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2010). *Multivariate data analysis* (7th ed.). NY: Pearson.

Hamill, J. T., Deckro, R. F., & Kloeber, J. M. (2005). Evaluating information assurance strategies. *Decision Support Systems, 39*(3), 463-484.

Harrington, S. J. (1996). The effect of codes of ethics and personal denial of responsibility on computer abuse judgments and intentions. *MIS Quarterly, 20*(3), 257-278.

Hasan, H., & Ditsa, G. (1999). The impact of culture on the adoption of IT: An interpretive study. *Journal of Global Information Management (JGIM), 7*(1), 5-15.

Hechter, M., & Kanazawa, S. (1997). Sociological rational choice theory. Annual review of 9 to 5 underground: Are you policing computer crimes? *MIT Sloan Management Review, 30*(4), 35.

Hofstede, G. (1980). *Culture's consequences: International differences in work-related values.* Beverly Hills, CA: Sage Publications.

Hofstede, G. (1983). Dimensions of national cultures in fifty countries and three regions. In *Expiscations in Cross-Cultural Psychology*. Lisse, Netherlands: Swets & Zeitlinger.

Hofstede, G., (1991). *Cultures and organizations: Software of the mind: Intercultural cooperation and its importance for survival*. London: McGraw-Hill.

Hofstede, G. (2000). The information age across cultures. *Proceedings of 5th AIM Conference: Information Systems and Organizational Change.*

Johns, S. K., Smith, M., & Norman, C. S. (2002). How culture affects the use of information technology. In *Accounting Forum* (vol. 27, no. 1, pp. 84-109).

Jones, M. L. (2007). Hofstede-culturally questionable?

Kohlberg, L. (1984). *Essays on moral development: The psychology of moral development* (vol. 2). New\Brk: Harper & Row.

Krueger, N., & Dickson, P. R. (1994). How believing in ourselves increases risk taking: Perceived self-efficacy and opportunity recognition. *Decision Sciences, 25*(3), 385-400.

Lafree, G., Ducan, L., & Piquero, A. R. (2005). Testing a rational choice model of airline hijackings. *Criminology, 43*(4), 340-361.

Morgan, G. A., & Griego, O. V. (1998). *Easy use and interpretation of SPSS for Windows: Answering research questions with statistics*. Psychology Press.

Shore, B., Venkatachalam, A. R., Solorzano, E., Burn, J. M., Hassan, S. Z., & Janczewski, L. J. (2001). Softlifting and piracy: Behavior across cultures. *Technology in Society, 23*(4), 563-581.

Singleton, J., & Straits, B. C. (2005). *Approaches to social research.* New York, NY: Oxford University Press.

Siponen, M. T. (2000). A conceptual foundation for organizational information security awareness. *Information Management & Computer Security, 8*(1), 31-41.

Siponen, M. T. (2001). Five dimensions of information security awareness. *Computers and Society, 31*(2), 24-29.

Siponen, M. T. (2005). An analysis of the traditional IS security approaches: Implications for research and practice. *European Journal of Information Systems, 14*(3), 303-315.

Siponen, M., & Vance, A. (2010). Neutralization: New insights into the problem of employee information

systems security policy violations. *MIS Quarterly, 34*(3), 487.

Siponen, M., Pahnila, S., & Mahmood, A. (2006). Factors influencing protection motivation and IS security policy compliance. In *Innovations in Information Technology* (pp. 1-5). IEEE.

Siponen, M., Pahnila, S., & Mahmood, A. (2007). Employees' adherence to information security policies: An empirical study. In *New Approaches for Security, Privacy and Trust in Complex Environments* (pp. 133-144). US: Springer.

Slay, J. (2003). IS security, trust and culture: A theoretical framework for managing IS security in multicultural settings. *The Emerald Research Register, 20*(3), 98-104.

Soares, A. M., Farhangmehr, M., & Shoham, A. (2007). Hofstede's dimensions of culture in international marketing studies. *Journal of Business Research, 60*(3), 277-284.

Sommestad, T., Hallberg, J., Lundholm, K., & Bengtsson, J. (2014). Variables influencing information security policy compliance: A systematic review of quantitative studies. *Information Management & Computer Security, 22*(1), 42-75.

Son, J. Y. (2011). Out of fear or desire? Toward a better understanding of employees' motivation to follow IS security policies. *Information & Management, 48*(7), 296-302.

Straub, D. W., & Nance, W. D. (1990). Discovering and disciplining computer abuse in organizations: A field study. *MIS Quarterly,* 45-60.

Straub, D. W. (1994). The effect of culture on IT diffusion: E-Mail and FAX in Japan and the US. *Information Systems Research, 5*(1), 23-47.

Straub, D. W., & Welke, R. J. (1998). Coping with systems risk: Security planning models for management decision making. *MIS Quarterly,* 441-469.

Straub, D. W., Boudreau, M. C., & Gefen, D. (2004). Validation guidelines for IS positivist research. *The Communications of the Association for Information Systems, 13*(1), 63.

Zhang, Z., Wong, D. S., Xu, J., & Feng, D. (2006, June). *Certificateless public-key signature: Security model and efficient construction*. In International Conference on Applied Cryptography and Network Security (pp. 293-308). Springer Berlin Heidelberg.

APPENDICES

Appendix 1: Scenario and Instrumentation

Information Systems Security Survey

	Section One **Please provide your level of agreement or disagreement** *with the following statements. (Please mark only one 'X' for each line in the labelled column.)* **Strongly Disagree = 1; Disagree = 2; Neutral = 3; Agree = 4; Strongly Agree = 5**	**1**	**2**	**3**	**4**	**5**
1	I would feel comfortable following most of my organisation's information systems security policies on my own.					
2	If I wanted to, I could easily follow my organisation's information systems security policies on my own.					
3	I would be able to follow most of my organisation's information systems security policies even if there was no one around to help me.					
4	People in higher organisational positions should make most decisions without consulting people in lower positions.					
5	People in higher organisational positions should not ask the opinions of people in lower positions too frequently.					
6	People in higher organisational positions should avoid social interaction with people in lower positions.					
7	People in lower organisation positions should not disagree with decisions by people in higher positions.					
8	People in higher organisational positions should not delegate important tasks to people in lower positions.					
9	People should avoid making changes because things could get worse.					
10	Change should be avoided when its outcomes are uncertain.					

11	It is better to work in an organisation with specific rules and regulations as opposed to a more flexible organisation.					
12	I would prefer a bad situation that I know about to an uncertain situation which might be better.					
13	Providing opportunities to be innovative is more important than requiring standardised work procedures.					
14	It is important that people take initiative in their work rather than always following step-by-step instructions.					
15	Individuals should sacrifice self-interest for the group.					
16	Individuals should stick with the group even through difficulties.					
17	Group welfare is more important than individual rewards.					
18	Group success is more important than individual success.					
19	Individuals should only pursue their goals after considering the welfare of the group.					
20	Group loyalty should be encouraged even if individual goals suffer.					
21	It is more important for men to have a professional career than it is for women.					
22	Men usually solve problems with logical analysis; women usually solve problems with intuition.					
23	Solving difficult problems usually requires an active, forcible approach, which is typical of men.					
24	There are some jobs that a man can always do better than a woman.					
25	Non-compliance with an organisation's information systems security policies saves work time.					
26	Non-compliance with an organisation's information systems security policies saves employees' time.					

Section Two *Please Read the Following Scenario*						
Jack is working in a position that requires access to customers' personal information. However, his company's information security policy prohibits him from giving customers' personal information to anyone, except the main office. Jack is expected to send some of the customers' personal information to the main office but the Internet connection in his office is too slow to send the data. So Jack believes that asking his friend to send the customer information from his office with a convenient Internet connection could save a lot time and money for the company. He also knows that an employee was recently reprimanded (criticised) for sending data through an unauthorised person. Jack gives the data to his friend to send to the main office.						
Please provide your level of agreement or disagreement with the following statements. (Please mark only one 'X' for each line in the labelled column.) *Strongly Disagree = 1; Disagree = 2; Neutral = 3; Agree = 4; Strongly Agree = 5*		*1*	*2*	*3*	*4*	*5*
27	I would do what Jack did in the scenario.					
28	I feel that Jack acted wrongly by violating the company's information systems security policy.					
29	It is morally wrong to do what Jack did in the scenario.					
30	It is morally wrong to violate company information systems security policies.					
31	If I did what Jack did, I would save personal time.					
32	If I did what Jack did, I would save work time.					
Based on the above scenario, please rate how problematic the following statements are. *(Please mark only one 'X' in the column.)* *Not problematic = 1, Somewhat problematic = 2, Neutral = 3, Problematic = 4, Very problematic = 5*						
33	How much of a problem would it create in your life if you were sanctioned (punished) for doing what Jack did?					
34	How much of a problem would it create in your life if you were formally reprimanded (**criticised**) for doing what Jack did?					

	Section Three					
	Please rate the likelihood *of the following statements. (Please mark only one 'X' in the column.)* **Highly Unlikely = 1; Unlikely = 2; Neutral = 3; Likely = 4; Highly Likely = 5**	*1*	*2*	*3*	*4*	*5*
35	How likely is it that you would be ashamed if co-workers knew that you had violated company information security policy?					
36	What is the likelihood that you would be formally reprimanded (criticised) if management learned you had violated the company's information security policy?					
37	What is the likelihood that you would be formally sanctioned if management learned you had violated the company's information security policy?					
38	What is the likelihood that you would receive sanctions if you violated the company's information security policy?					
	Please rate how problematic the following statements are. *(Please mark only one 'X' in the column.)* **Not problematic = 1, Somewhat problematic = 2, Neutral = 3, Problematic = 4, Very problematic = 5**	*1*	*2*	*3*	*4*	*5*
39	How problematic would it be if you felt ashamed that co-workers knew you had violated the company information security policy?					
40	How much of a problem would it be if you received severe sanctions if you violated the company information security policy?					

	Please rate the likelihood of the following statement. (Please mark only one 'X' in the column.) Highly Unlikely = 1; Unlikely = 2; Neutral = 3; Likely = 4; Highly Likely = 5	*1*	*2*	*3*	*4*	*5*
41	How likely is it that you would be ashamed if others knew that you had violated the company information security policy?					
	Please rate how problematic the following statement is. *(Please mark only one 'X' in the column)* **Not problematic = 1, Somewhat problematic = 2, Neutral = 3, Problematic = 4, Very problematic = 5**	*1*	*2*	*3*	*4*	*5*
42	How problematic would it be if you felt ashamed that others knew you had violated the company information security policy?					
	Please rate the likelihood of the following statement. (Please mark only one 'X' in the column.) Highly Unlikely = 1; Unlikely = 2; Neutral = 3; Likely = 4; Highly Likely = 5	*1*	*2*	*3*	*4*	*5*
43	How likely is it that you would be ashamed if managers knew that you had violated the company information security policy?					
	Please rate how problematic the following statement is. (Please mark only one 'X' in the column.) Not problematic = 1, Somewhat problematic = 2, Neutral = 3, Problematic = 4, Very problematic = 5	*1*	*2*	*3*	*4*	*5*
44	How problematic would it be if you felt ashamed that managers knew you had violated the company information security policy?					

Section Four

General Questions (for classification purposes only)

Please indicate your gender ___ Female ___ Male

How realistic is the given scenario?

___Non-realistic _____Somewhat realistic ____Realistic

What is your highest completed education certification?

___ High school certificate/diploma

___ Bachelor's degree

___ Master's degree

___ Doctoral degree

___ Others, please specify _____

What is your age? _____ years

Years of computer usage:

___ ≥ 10years ___ ≥ 5 years ___ ≥ 2 years ___< 2 year

What is your current employment status?

_____ Student ____ Employee _____ Retired _____ Others

International Journal of Business Analytics & Intelligence
10 (1) 2022, 48-60
http://publishingindia.com/ijbai/

Macroeconomic Stability in India: Vector Error Correction Estimation of the Causal Relationship between Inflation, GDP, Money Supply, Interest Rate, Exchange Rate, and Fiscal Deficit

T. Lakshmanasamy*

Abstract

The significance, nature, and direction of the effect of inflation on economic growth and macroeconomic stability are contentious both in theory and empirical analysis. This paper examines the causal relationship between inflation and macroeconomic variables – interest rate, exchange rate, money supply, GDP, and fiscal deficit – in India, during the period 1986 to 2016, applying the vector correction (VECM) estimation method. The macro variables are stationary at first difference, and a cointegrating and causal relationship exists between the wholesale price index and interest rate, exchange rate, GDP, broad money, and gross fiscal deficit. The VECM estimates reveal that money supply and GDP are the most important macro variables in explaining the variations in inflation. The estimated error correction term shows that the short-run disequilibrium is corrected by about 20% every period towards the long-run equilibrium. The impulse response results show that inflation responds positively to the money supply from the start to the 9th period. To promote economic growth and keep inflation low, money supply and budget deficits need to be rationalised.

Keywords: GDP, Inflation, Interest Rate, Exchange Rate, Money Supply, Fiscal Deficit, VECM Estimation

Introduction

The significance of inflation to economic growth is contentious both in theory and empirical findings. Originating in the 1950s in the Latin American context, the issue has soon become a sizzling structuralist vs. monetarist debate. The structuralists emphasise that inflation is essential for economic growth; however, for monetarists, inflation is detrimental to economic progress. At the heart of the controversy lies two aspects of this debate: the nature of the relationship if one exists and the direction of causality. Theoretical models on the relationship between money and growth analyse the impact of inflation on growth, focusing on the effects of inflation on the steady-state equilibrium of capital and output per capita. Classical economics emphasises the supply-side theories, while structuralists argue for the institutional features and the structure of the economy. Keynesian and Neo-Keynesian theories attach a significant role to the aggregate output, while the monetarist theory insists on the role of monetary growth in determining the rate of inflation. The open economy models subscribe to the internationalisation of inflation, in that, an increase in the money supply for an individual country leads to an increase in the world money stock, which then transmits to world prices. The open models include not only domestic factors, but also outside factors like exchange rate, and exports and imports of an economy as affecting the price stability of an economy.

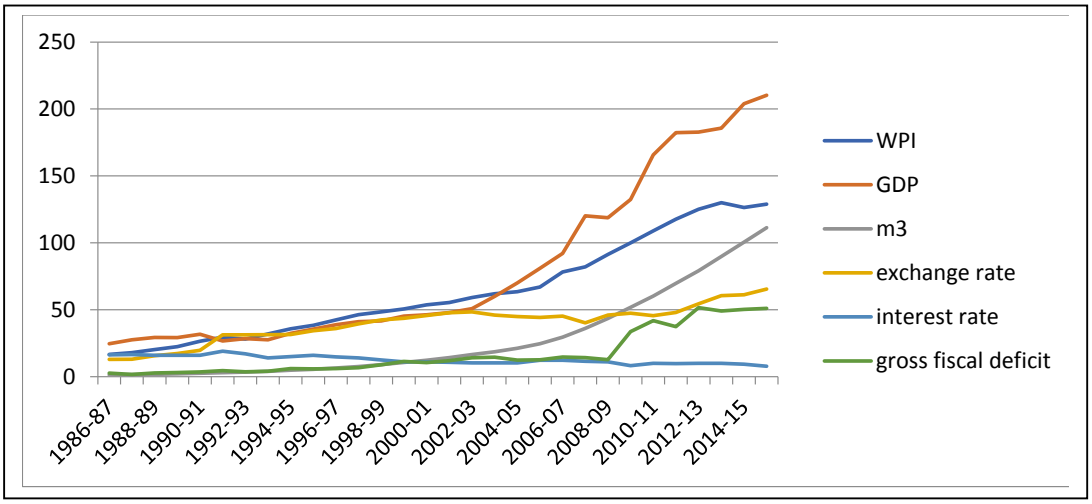
Whatever be the theoretical basis of the inflation-growth relationship, most economists recommend that macroeconomic stability, specially defined as a low rate of inflation, is positively related to economic growth, but the high rate of inflation imposes negative externalities on the economy when it interferes with the efficiency of the economy. For every economy around the world,

* ICSSR Senior Fellow and Formerly Professor and Head, Department of Econometrics, University of Madras, Chennai, Tamil Nadu, India. Email: tlsamy@yahoo.co.in

high economic growth and low inflation are the avowed objectives for macro stability. To maintain macroeconomic stability, it is necessary and sufficient to reduce the rate of inflation for price stability and achieve high economic growth.

The most important disturbing concern for a common man with regard to inflation is that it creates more burdens on the cost of living and makes life more miserable. For a businessman, inflation leads to uncertainty about the future profitability of investment projects, especially those that have a long gestation period. The increased price variability may lead to an increase in the cost of production and less profitability. Besides this, inflation may lead to uncertainty over competitiveness, as the export prices of that country may become relatively more expensive than the prices of the competitors, and thus, adversely affect the balance of payments. Inflation also undermines the confidence of domestic and foreign investors about the future course of monetary policy. In addition, inflation also affects the other determinants of economic growth, like investment in research and development (R&D).

Like many countries in the world, India focuses on sustaining high growth with low inflation. Fig. 1 presents the trends in the inflation rate and the important macro variables in India, over time. All macro variables except interest rate show upward trends implying a negative relationship between inflation and interest rate and a positive relation of inflation with other macro variables. The GDP and fiscal deficit show a fluctuating trend over the years. The WPI is rising with a falling interest rate, implying a negative relationship between interest rate and inflation. The sharp increase in the gross fiscal deficit since 2008-09 is due to the interest burden on government borrowings.



Source: Statistical Handbook of RBI (2017-18) and World Development Indicators of World Bank (2018).

Fig. 1: Trends in Inflation, Interest Rate, Exchange Rate, Money Supply, and Fiscal Deficit

Therefore, it is important to understand how inflation impacts the cost of living, which in turn affects the growth of the economy, and the relation of inflation with other macroeconomic variables in the Indian economy. Hence, this study attempts to examine the causal relationship between inflation and macroeconomic variables like interest rate, exchange rate, money supply, GDP, and fiscal deficit in India. The study period is from 1986 to 2016, and the data are derived from the RBI and World Bank world development indicators. Empirically, the study employs the Vector Error Correction (VECM) method to examine the relationship between inflation and macroeconomic variables.

Review of Literature

Bruno and Easterly (1998) analyse the relationship between inflation and economic growth for 100 countries for the period 1960-1990 using the instrumental variable estimation method. The estimated effects of inflation on growth and investment are significantly negative in the long run. The study observes that there is not enough information in the low inflation context, to isolate precisely the effect of inflation on growth; however, this does not necessarily mean that this effect is small at low rates of inflation. The study proposes that about a 40% threshold

inflation has a significant effect on growth. They find that growth falls sharply during discrete high inflation crises, then recovers rapidly and strongly after inflation falls.

Bishnoi and Koirala (2006) try to identify the appropriate inflation model for Nepal, applying the robustness and stability criteria. Unit root tests are applied to investigate the validity of random walk of macro variables that determine inflation, and cointegration test to examine the long-run relationship between inflation and its determinants. The error correction estimates reveal the existence of both short- and long-run relationships in Nepal. The error correction model is stable and robust.

Jha and Dang (2012) examine the relationship between inflation variability and growth, covering the period 1961 to 2009 for 182 developing countries and 31 developed countries, using two-stage least squares method and generalised least square with fixed effects method. The study finds significant evidence in developing countries for a negative effect of inflation variability on growth when the inflation rate exceeds 10% inflation variability; an increase in inflation is followed by a decrease in growth, only if inflation is stable. In developed countries, there is no significant evidence that inflation variability is detrimental to growth.

Tabi and Ondoa (2011) analyse the relationship between economic growth, money in circulation, and inflation in Cameroon for the period 1960-2007 using the VAR estimation method. In Cameroon, despite the low inflation level, economic growth is fragile. The results of the study show that there exists a causal relationship between growth and inflation; an increase in money supply increases growth and that growth causes inflation, but an increase in money in circulation need not necessarily increase the general price level in the economy.

Gullapalli (2013) analyses the non-linear effects of inflation on growth for 2l4 countries for 1990-2011. The study notes that many central banks around the world have settled for low inflation targets – 2-5%, with no regard for the economic context of the countries. Such low inflation targets lead to unnecessary monetary tightening and drying up of economic activity. The study finds a structural break at 20% in the average annual rate of inflation. Inflation rates below this have no significant effect on growth, while inflation rates above this have a significantly negative impact on growth. The identified threshold inflation rate for groups of countries are low-income countries at 14.5%, lower-middle-income countries at 9%, upper-middle-income countries at 10%, high-income countries at 2.25%, fast-growing countries at 16%, and slow-growing countries at 14%. The empirical results of the paper indicate that price stability does not have to be captured around the central bank's attempt to make monetary policy to enable growth in the economy. The role of central banks is to be justified in monetary easing, and even working with the government to spur economic growth in high inflation thresholds.

Bozkurt (2014) investigates the relationship between inflation, money supply, and growth in Turkey, for the period 1999 to 2012, applying the VAR model. The study finds that increase in money supply and velocity of money causes inflation in the long run in Turkey. However, a 1% decrease in income directly reduces inflation equally by 1%. The study emphasises planning and implementing structural arrangements that will decrease the dependence on foreign markets in the short run and eliminate it in the long run.

Ghosh and Phillips (1998) estimate the relationship between inflation and growth for 145 countries, during the period 1960 to 1996, using panel regressions and non-linear specifications. A decision-tree technique identifies inflation as one of the most important determinants of growth. The results show a statistically and economically negative relationship between inflation and economic growth, but only after a threshold level. At the single-digit level of inflation, short-run growth is possible.

Malik and Chowdhury (2001) examine the short- and long-run relationship between inflation and GDP growth for four South Asian countries, viz. Bangladesh, India, Pakistan, and Sri Lanka, applying the cointegration and error correction models. The study finds that inflation and economic growth are positively and statistically significantly related for all four countries, and the sensitivity of growth to changes in inflation rates is smaller than that of inflation to changes in growth rates. The fast-growing South Asian economies are on the knife-edge as moderate inflation increases growth, but faster economic growth feeds back into inflation.

Burdekin et al. (2004) analyse the effect of inflation on growth for 21 industrial and 51 developing countries during 1967-1992. The study considers nonlinearities

and threshold effects of inflation on growth in different economic settings. The analysis shows that the effects of inflation on growth change substantially as the inflation rate rises. The empirical results support the view that the effect of inflation on growth is non-linear, and the nonlinearities are quite different for industrial countries than for developing countries. This study finds that the threshold inflation rate is 8% for industrial countries and 3% or less for developing countries, at which inflation begins to seriously affect economic growth. Further, the marginal growth costs for developing countries decline significantly above 50% inflation.

Gillman et al. (2004) analyse the relationship between inflation and growth in a cross-section of Organization for Economic Cooperation and Development (OECD) and Asia-Pacific Economic Cooperation (APEC) member countries, for the period 1961-1967, using a monetary model of endogenous growth. The study observes that the economic model suggests a negative inflation-growth effect and the effect is stronger at lower levels of inflation. The empirical results of the study validate the negative inflation effect for the OECD countries, wherein growth increases marginally as the inflation rate declines. The instrumental variables estimation also reveals significant evidence of similar behaviour for APEC countries.

Faria and Carneiro (2001) examine the relationship between inflation and output, both in the short and long run in Brazil, a country with constant high inflation, applying the bivariate vector autoregression method. The results show a negative effect of inflation on output in the short run, but in the long run, inflation does not impact the real output in Brazil. The results also reveal super neutrality of money in the long run, but doubtful short-run implications.

Gokal and Hanif (2004) examine the relationship between inflation and economic growth in Fiji. The study also reviews the theoretical and empirical literature in search of a consensus on the meaningful inflation-growth relationship. The study tests whether the inflation-growth relationship holds for Fiji, by estimating the effect of inflation on economic growth using an extended view of the neoclassical model and regression equations. The results indicate a weak negative correlation between inflation and growth, and the causality between the two variables runs one way from GDP growth to inflation.

Berument et al. (2008) examine how inflation affects economic growth in Turkey, using the unrestricted vector autoregression technique and generalised impulse response method, identifying the sources of shocks and controlling for external factors. The study finds that inflation adversely affects output growth in Turkey and the main underlying factor is the real exchange rate.

Erbaykal and Okuyan (2008) analyse the relationship between inflation and economic growth in Turkey over the period 1987-2006 using the Pesaran Bound Test and ARDL methods. The existence of a cointegrating relationship and the direction of causality are examined. The existence of a cointegration relationship between the two series is detected by the Bounds Test, and a unidirectional causality running from inflation to economic growth is identified by the Yamamoto approach. The study finds no statistically significant long-term relationship; however, there is a negative and statistically significant short-term relationship between inflation and growth.

In the Indian context, the study conducted by Balakrishnan (1991) is an early attempt to understand the effect of inflation on output growth. The study uses data on the Indian manufacturing sector from 1950 to 1980, and regresses inflation on the output gap or the activity variable. The study finds a significant negative effect of inflation on output growth in open pre-reforms India. However, the study notes that inflation is not purely a monetary phenomenon, as the continuous slowing down of money (M3) growth has not been able to dampen the inflationary pressure in India.

Krishna Veni and Choudhury (2007) examine the relationship between inflation and the growth of the Indian economy during 1981-2004, applying causality and cointegration tests. The causality test shows the independence of growth and inflation, and the cointegration test shows no cointegration between inflation and growth in India. Therefore, the study concludes that there is no long-run relationship between inflation and growth in India.

Batura (2008) looks into the trends of inflation surge in India. The study tracks the movements in the wholesale price index to identify when inflation began to accelerate, and analyses the causes for across-the-board price increase and compares consumer prices with wholesale prices.

Patnaik (2010) examines inflation in India as a mix of demand- and supply-side factors, the stabilisation policies that focus on both demand control and supply management, for the period 1991 to 2008, applying the VAR model. The study finds that money supply does influence inflation, but the impact is short-lived. The impact on inflation due to the external sector is also very immediate and short-lived. The study concludes that the Indian inflation is largely demand-pull inflation, and therefore, the stabilisation policies should focus on demand management policies on a long-term basis and supply management policies for short-term impact on inflation.

Sahadudheen (2012) studies the determinants of inflation in India using quarterly data, for the period 1996Q1 to 2009Q3, applying the VECM approach. The VECM results show that GDP and broad money have positive effects on inflation, while exchange rate and interest rate have a negative impact on inflation. While income increases contribute to a 0.37% increase in inflation, money supply leads to a 5% increase in the price level in India.

Kumar (2013) studies inflation dynamics in the Indian economy after the new economic policy, using monthly data between 1992 and 2012 and employing the restricted autoregression method. The money supply is identified to be the most important variable in explaining the variation in inflation over time, followed by the imports. Inflation is negatively related to the industrial output and imports, and inflation has an unstable and explosive relationship with the money supply.

Pattanaik and Nadhanael (2013) try to find the threshold inflation level in the short-run growth-inflation trade-off for India using annual data over the period 1972-2010. The VAR estimation is used to capture the impact of the determinants of growth by lags of growth and the inflation threshold. The study argues that because of the excessive emphasis on growth maximising level of inflation, the welfare costs of inflation and risks to inclusive growth are often ignored. The inflation target that balances both welfare and growth is the inflation target below the threshold level. The estimate of the study suggests a threshold of about a 6 per cent inflation rate for India. The study suggests that the inflation target for monetary policy may have to be lower than the growth maximising threshold, since any positive inflation could be a risk to inclusive and sustainable growth objectives.

Bhowmik (2015) examines inflation and its determinants in India during the time period 1970-2013, applying the vector error correction model (VECM). The covariates considered are the GDP growth rate, lending rate, growth rate of money supply, fiscal deficit as per cent of GDP, degree of openness, the nominal exchange rate of rupee with respect to the US dollar, and crude oil price. The VECM estimates show that the inflation rate is associated with one period lagged interest rate and the previous period inflation rate is associated with the GDP and money supply growth rates. The error correction rate is 14%, implying the slow speed of adjustment towards the long-run equilibrium relationship.

Behera (2016) investigates the dynamic relationship between inflation, GDP, exchange rate, and money supply in India, for the period 1975-2012, applying the vector error correction method. The empirical results show the existence of a long-run equilibrium relationship among the variables. The results also suggest that money supply has a positive effect on GDP growth. The Granger causality test results exhibit a unidirectional causality from GDP to inflation and exchange rate to inflation, and the exchange rate Granger causes both GDP and money supply. The error correction mechanism shows a negative sign for the GDP and exchange rate. The impulse response results show that GDP has a positive response to money supply from the occurrence to the end of the period, whereas the response of the exchange rate to the money supply is negative during the whole lag period. The variance decomposition shows that no significant part of the variance is caused by money supply.

Kaur (2019) examines the macroeconomic determinants of inflation and the proposition of a positive effect of fiscal deficits on inflation in India using quarterly data from 1996-1997Q1 to 2016-2017Q1. The ARDL bounds approach to cointegration reveals the existence of a long-run relationship between inflation, gross fiscal deficit, money supply, exchange rate, crude oil prices, and the output gap. The long- and short-run dynamics indicate that gross fiscal deficit and money supply generate a negative impact on inflation in India. On the supply side, crude oil price and exchange rate play an important role in determining domestic prices. On the demand side, in the absence of a stronger output-inflation relationship, the flexible inflation targeting framework does get encumbered, as the case for the existence of the Phillips curve in India further weakens.

Data and Methodology

The study uses the time series of annual data of 30 years, from 1986 to 2016, for India. The study variables are wholesale price index, interest rate, exchange rate, broad money (M3), gross fiscal deficit, and gross domestic product at the current price. The data on variables interest rate, exchange rate, gross fiscal deficit, and broad money data are obtained from the RBI Handbook of Statistics on Indian Economy, and data on wholesale price index and GDP are derived from the World Development Indicators of the World Bank.

Vector Error Correction Model

The first step in the empirical analysis of a time series is to check for stationarity of series. Most time series are trended, and therefore, in most cases, are non-stationary. Hence, the standard OLS regression procedure yields biased coefficient estimates. Therefore, the series is to be made stationary.

ADF Unit Root Test of Stationarity: A variable is said to be stationary if it has a time-invariant mean, time-invariant variance, and the value of the covariance between the two time periods depends only on the distance or gap or lag between the two time periods and not the actual time at which the covariance is computed. The Augmented Dickey-Fuller (ADF) test is commonly used to test the stationarity of the variables. In this unit root test, the first difference of the variable (Δy_t) is regressed against a constant, a time trend (t = 1, 2, ..., T), and lags of Δy_t, along with the error term. The ADF regression is specified as:

$$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta y_{t-i} + \varepsilon_t \quad (1)$$

Where, the disturbance term ε_t is a white noise process and is assumed to be independently and identically distributed, with zero mean and constant variance. Sufficient lags of Δy_t are to be included to ensure no autocorrelation in the error term. The Schwarz Information Criterion (SIC) test is to be used to confirm that autocorrelation is not present.

The null hypothesis is that the series has a unit root ($\delta = 0$), meaning that the series is non-stationary, against the alternative hypothesis that the series is stationary. In the presence of a unit root, i.e., non-stationarity, δ would not be statistically different from zero. If the p-value of the coefficient of y_{t-1} is less than 0.05 at 5% level of significance, the null hypothesis is rejected, indicating that the series is stationary.

Phillips-Perron Test: The PP test is used to test the null hypothesis that a time series is integrated of order 1. The Phillips-Perron test considers the higher-order autocorrelation in errors and makes a non-parametric correction to the t-test statistic. The test is robust with respect to unspecified autocorrelation and heteroscedasticity in the disturbance process of the test equation. The PP regression is specified as:

$$y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \varepsilon_t \quad (2)$$

The null hypothesis restricts $\delta = 1$. Variants of the test, appropriate for series with different growth characteristics, restrict the drift and deterministic trend coefficients, β_1 and β_2, to be 0. If the p-value of the coefficient of y_{t-1} is less than 0.05 at 5% level of significance, the null hypothesis is rejected, indicating that the series is stationary.

VAR Lag Length Selection: The optimal lag for the variables are determined by certain model selection criteria like the Akaike's information criterion (AIC), Schwarz information criterion (SIC), and Hannan-Quinn information criterion (HQIC).

Akaike's Information Criterion: The AIC compares the quality of a set of statistical models and chooses the best model from that set. The AIC is defined by:

$$AIC = -2(log - likelihood) + 2k \quad (3)$$

Where, k is the number of model parameters and log-likelihood is a measure of model fit. The higher the number, the better the fit. However, the quality of the chosen model need not be absolute quality and absolutely the best. Therefore, once the best model is selected, a hypothesis test is to be performed to figure out the relationship between the variables in the model and the outcome of interest.

Schwarz Information Criterion: The SIC chooses the least complex probability model among multiple options using a likelihood function. The SIC is defined by:

$$SIC - kln(n) - 2In(\hat{L}) \quad (4)$$

Where, the likelihood $\hat{L} = Prob(x|\hat{\theta}M)$, where M is

the model, x are the data, and $\hat{\theta}$ are the parameters of the model.

Hannan-Quinn Information Criterion: The HQIC is a measure of the goodness of fit, not based on log-likelihood function, but related to the Akaike and Schwarz information criteria. The QC is defined by:

$$HQIC = -2L_{max} + 2kln[ln(n)] \quad (5)$$

where, L_{max} is the log-likelihood, k is the number of parameters, and n is the number of observations.

Cointegration Test: If the two-time series data are non-stationary, there exists a possibility for a linear combination of the two variables such that the error term is stationary. The two variables are cointegrated if they have a long-term or equilibrium relationship between them. The existence of the cointegration between the variables is tested by the trace and eigenvalue statistics, defined as:

Trace Statistic: $-T\sum \log(1-\lambda_t^1) \qquad t = r+1, \ldots, p$ (6)

Maximum Eigenvalue Statistic:

$$\lambda_{max}(r, r+1) = -Tlog(1-\lambda_{r+1}^1) \quad (7)$$

Where, $\lambda^1_{r+1},\ldots, \lambda^1_p$ are (p-r) number of estimated eigenvalues.

The test hypothesis is:

H_0: No cointegration (r = 0), against H_1: presence of cointegration (r > 0)

Where, 'r' implies cointegration relation. If the absolute value of the computed trace statistic and computed eigenvalue statistic are greater than their respective critical values, the null hypothesis is rejected, implying that there exists at least one cointegrating relation between the variables at 5% level of significance. Then, the hypothesis test is:

H_0: presence of one cointegrating relation (r = 1).

H_1: presence of more than one cointegrating relation among the variables (r > 1).

Based on the value of the computed trace statistic and the eigenvalue, the null hypothesis is either accepted or rejected. If the cointegration test indicates that the variables are cointegrated, the Vector Error Correction Mechanism (VECM) is to be used to obtain the rate of adjustment by the variables in the short run to achieve equilibrium in the long run. If the variables are not cointegrated, the Vector Autoregression (VAR) method is used to capture the contemporaneous effects among the variables.

Causality Test: When there is cointegration between the two variables, then the direction of the long-term causal relationship between them is to be ascertained. The causal relationship may be unidirectional or bidirectional. The Granger causality test identifies the direction of causality and the way the variables are built-in in their long-term relationship. The Granger causality test finds out which variable causes the other and allows determining the short-run or forecasting direction of the relations between the variables. Assuming two variables x and y, the following regression equations are to be estimated for the test:

$$y_t = \sum_{i=1}^{n} a_i x_{t-i} + \sum_{i=1}^{m} b_j y_{t-j} + \varepsilon_{1t}$$
$$x_t = \sum_{i=1}^{n} c_i x_{t-i} + \sum_{i=1}^{m} d_j y_{t-j} + \varepsilon_{2t} \quad (8)$$

Where, n is the maximum number of lagged observations included in the model. The significance of the coefficients a_i, b_j, c_i, and d_j determine the direction of causality and the coefficients are jointly tested for their significance. There are two null hypotheses in the system: the first examines the null hypothesis that x does not Granger cause y and the second examines the null hypothesis that y does not Granger cause x. If the test fails to reject the former null hypothesis and rejects the latter, then x changes are Grange caused by a change in y. If the computed p-values exceed 0.05 at 5% level of significance, the null hypothesis is rejected, indicating causality between the two variables and no causality otherwise. Unidirectional causality exists between the two variables if either null hypothesis is rejected, bidirectional causality exists if both null hypotheses are rejected, and no causality exists if neither null hypothesis are rejected.

Vector Error Correction Mechanism (VECM): The cointegration gives the long-run relationship between the variables. However, the cointegration equation does not say anything about the short-run dynamics of the relationship. It is intuitive that the existence of a long-term relationship itself indicates that there must be some short-term forces that are responsible for keeping the long-run relationship intact. Therefore, the short-run and long-run dynamics have to be built in a more comprehensive model,

i.e., equilibrium specification, whereby any short-term deviation from the long-term equilibrium is automatically corrected. Engle and Granger (1987) show that this is accomplished by an error correction mechanism (ECM) in a Vector Autoregression (VAR), which includes the lagged disequilibrium terms as explanatory variables that capture the short-run dynamics and adjust towards the long-run equilibrium. The VECM directly estimates the level to which a variable can be brought back to equilibrium condition after a shock on other variables. Thus, the VECM estimates the short-term effect for the variables and the long-run effect of the time series data, i.e., the speed of adjustment in short-run disequilibrium towards the long-run equilibrium.

The VECM(p) with the cointegration rank r ≤ k can be specified as:

$$\Delta y_t = \theta_0 + \theta_1 \Delta x_t + \tau(\hat{\varepsilon}_{t-1}) + v_t \qquad (9)$$

Where, τ is the coefficient of the error correction term, which should be theoretically negative and measures the speed of adjustment back to equilibrium following an exogenous shock. The coefficient θ_1 captures any immediate effect of short-run disturbances. The error correction term , which can be written as $(y_t - x_t)$, is the residual from the cointegrating relationship, which is non-zero (positive or negative) that captures long-run properties of the relationship. The short-run behaviour is partially captured by the equilibrium error term, which says that if y_t is out of equilibrium, it will be pulled towards it in the next period and further aspects of short-run behaviour are captured by the inclusion of ΔX_t.

Impulse Response Function: The IRF measures the response of the dependent variable in the VAR model to shocks in the error terms. The IRF detects the impact of a one-time shock in one of the innovations on the current and future values of the endogenous variables. The IRF can be specified as:

$$y_t = \mu + \omega_0 \varepsilon_t + \omega_1 \varepsilon_{t-1} + \omega_1 \varepsilon_{t-2} + \cdots + \omega_p \varepsilon_{t-p} \qquad (10)$$

Where, y_t is a vector of endogenous dependent variables, α is a vector of the constants, ε_i is a vector of innovations, and ω_i is a vector of parameters that measure the reaction of the dependent variable to innovations in all variables included in the VAR model.

Empirical Analysis

Table 1 presents the descriptive statistics of the variables used in this study. The natural logarithm of money supply, GDP, gross fiscal deficit, and WPI are used.

Table 1: Descriptive Statistics of Variables

Variable	*Description*	*Mean*	*Std. Dev.*
ln(WPI)	Wholesale price index (2010=100)	63.459	36.883
ln(GDP)	Gross domestic product (at 2010 price) (₹)	80.296	11.401
ln(GFD)	Gross fiscal deficit (₹)	16.76.2	16.663
ln(M3)	Broad money supply (₹ billions)	52.95	38.18
IR	Average lending rate of scheduled commercial banks (%)	12.617	2.963
ER	Exchange rate (₹ per US$)	39.685	13.803

ADF Unit Root Test: The variables are tested for stationarity at levels and at first difference using the ADF unit root test. The null hypothesis states the presence of unit root i.e., the series is non-stationary, against the alternative hypothesis that the series is stationary. The ADF test results presented in Table 2 show that the variables are not stationary at levels, but become stationary at first difference. The null hypothesis of unit root is rejected at first difference at 0.05 level of significance, as the computed values are greater than the critical value of 1.96. Thus, all variables are integrated of order one, i.e., I(1) process, and all these variables achieve stationarity at first differencing.

Table 2: Augmented Dickey-Fuller Unit Root Test of Stationarity

Variable	*At Level*	*At First Difference*
ln(WPI)	0.230 (0.2005)	4.308** (0.002)
ln(GDP)	0.819 (0.992)	4.774** (0.007)
ln(GFD)	0.595 (0.856)	4.77** (0.007)
ln(M3)	1.459 (0.538)	3.689** (0.046)
IR	0.909 (0.777)	5.451** (0.0001)
ER	0.748 (0.818)	4.920** (0.005)

Note: Figures are t-values. p-values in parentheses. *indicates rejection of null hypothesis at 5% significance level.

Lag Length Selection: The lag order selection helps in determining the optimal lag length of variables in the VAR estimation. The appropriate lag length is selected

using the selection criteria. The results presented in Table 3 identify the optimal lag length as 2 by AIC and HQ criteria.

Table 3: Optimal Lag Length Selection

Lag	*LR*	*HQ*	*AIC*	*SIC*
1	317.80*	−4.968	−5.57984	−3.581*
2	47.122	−5.015*	−6.14989*	−2.438

Note: *indicates lag order selected by the criteria at 5% significance level.

Johansen Cointegration Test: The Johansen cointegration test examines the presence of a long term relationship between variables that are integrated of order 1. The null hypothesis is that there is no cointegration, against the alternative hypothesis of cointegration, between the variables. The Johansen cointegration test results are presented in Table 4. The trace statistic and eigenvalue statistic indicate 1 cointegrating equation at 0.5% level of significance.

Table 4: Johansen Cointegration Test

No. of CE_s	*Trace Statistic*	*0.05 Critical Value*	*Prob.**	*Maximum Eigenvalue Statistic*	*0.05 Critical Value*	*Prob.**
None*	119.422	95.754	0.0005	43.551	34.077	0.001
Atmost1*	85.872	59.819	0.001	32.665	23.877	0.001

Note: *indicates rejection of null hypothesis at 5% significance level.

Pairwise Granger Causality Test: Given the cointegration between the variables, the direction of causation is ascertained by the Granger causality test. The null hypothesis under the test is that the variable under consideration does not granger cause the other variable, against the alternative hypothesis that the variable Granger causes the other variable. The Granger causality test results presented in Table 5 show that the null hypothesis that money supply does not Granger cause WPI is rejected, as the computed F-statistics is greater than the table value and the p-value is less than 0.05 at 5% level of significance. Hence, there is a unidirectional causality from money supply to inflation. In addition, the null hypothesis that WPI does not Granger cause gross fiscal deficit is rejected at 5% level, as the p-value is 0.007 and F-statistics is 6.172, which is greater than the critical value. The Granger causality tests also show that WPI has a unidirectional causality with the current GDP and the exchange rate. Thus, changes in money supply, GDP, and exchange rate have an impact on WPI and a change in WPI has an effect on gross fiscal deficit and interest rate.

Table 5: Pairwise Granger Causality Test

Null Hypothesis	*F-Statistic*	*Prob.*
lnM3 does not Granger cause lnWPI	5.132*	0.014
lnWPI does not Granger cause lnM3	1.824	0.184
lnGFD does not Granger cause lnWPI	1.826	0.183
lnWPI does not Granger cause lnGFD	6.172*	0.007
lnGDP does not Granger cause lnWPI	5.340*	0.012
lnWPI does not Granger cause lnGDP	2.331	0.120
IR does not Granger cause lnWPI	0.823	0.452
lnWPI does not Granger cause IR	8.666*	0.001
EX does not Granger cause lnWPI	12.267*	0.0002
lnWPI does not Granger cause EX	1.824	0.080

Note: *F-value significant at 5% level.

Vector Error Correction Estimates: The cointegration test results show that there exists a long-run relationship between inflation and its identified determinants. If there is any deviation from the long-run relation, the system has a tendency to come back to the original level within a short period of time, i.e., if there is a change in inflation as a result of these variables, inflation will adjust in the next period; the percentage of correction is called the error correction. The cointegration equation is:

$$ECT_{-1} = 1.000\ lnWPI_{-1} + 0.360lnGDP_{-1} - 0.195lnGFD_{-1} - 5.621lnM3_{-1} - 0.018IR_{-1} + 0.001EX_{-1} - 12.433 \quad (11)$$

The estimated VECM equation with WPI as a target variable is:

$$\Delta WPI = -0.199ECT + 0.205lnWPI_{-1} - 0.282lnGDP_{-1} + 0.108lnGFD_{-1} + 0.384lnM3_{-1} + 0.009IR_{-1} - 0.017EX_{-1} + 0.051 \quad (12)$$

Table 6 presents the VECM estimates. The VECM result shows that the previous period deviation from the long-run equilibrium is correlated with the current period at an adjustment rate of 19.9%. The error correction term is statistically significant. Thus, the short-run disequilibrium is corrected towards the long-run equilibrium at the speed of about 20%. This means that if the two series are out of equilibrium, growth rates will adjust to reduce the equilibrium error and vice versa. A 1% change in current period inflation is associated with about a 20% change in its previous period inflation rate. The current inflation is associated with a 3.8% increase in money supply and a 2.8% reduction in GDP. A 1% increase in inflation is associated with about a 1% increase in the gross fiscal deficit. A 1% increase in inflation is followed by a 1.7% reduction in the exchange rate, while a 1% change in WPI is associated with a 1% increase in interest rate.

Table 6: Vector Error Correction Estimates

Variable	*D(lnWPI)*	*D(lnGDP)*	*D(lnGFD)*	*D(lnM3)*	*D(IR)*	*D(EX)*
CointEq1	−0.199* (3.106)	−1.771* (4.336)	−3.865* (4.640)	−0.115 (1.177)	−4.998 (0.803)	61.894* (4.133)
D(lnWPI(-1))	0.205* (3.023)	1.231* (3.115)	−4.194* (5.203)	0.101 (1.068)	22.431* (3.729)	−25.866*** (1.785)
D(lnGDP(-1))	0.282* (2.782)	0.567 (1.501)	−1.306*** (1.694)	−0.131 (1.447)	4.532 (0.788)	−7.543 (0.544)
D(ln GFD (-1))	0.108** (2.329)	−0.221** (2.571)	0.369** (2.104)	0.025 (1.239)	−1.511 (1.155)	9.845* (3.124)
D(lnM3(-1))	0.384* (2.928)	0.799 (1.042)	4.147* (2.650)	0.517* (2.806)	−25.660** (2.197)	−54.653*** (1.942)
D(IR(-1))	0.009 (1.221)	−0.015 (1.081)	0.057** (2.023)	0.004 (1.212)	−0.290 (1.386)	0.562 (1.113)
D(EX(-1))	−0.017* (2.928)	0.012 (1.106)	−0.050** (2.333)	−0.005*** (1.831)	−0.062 (0.382)	−0.316 (0.813)
Constant	0.051 (0.739)	−0.184 (1.428)	−0.072 (0.275)	0.082* (2.646)	1.894 (0.966)	12.435* (2.634)
R-square	0.553	0.505	0.707	0.607	0.520	0.513
Adj. R-square	0.396	0.332	0.605	0.469	0.352	0.343
F-statistic	3.530	2.918	6.905	4.414	3.094	3.016
Log-likelihood	56.823	39.540	19.577	79.494	−36.697	−61.318
AIC	−3.487	−2.253	−0.827	−5.106	3.192	4.951
SIC	−3.107	−1.872	−0.446	−4.726	3.573	5.332

Note: Absolute t-values in parentheses. *, **, ***significant at 1, 5, 10 per cent levels.

Impulse Response Functions: The IRFs generate the effects of shocks to the errors (ε) on the entire time paths of the variables contained in the VAR system. The IRFs presented in Fig. 2 show the response time path of WPI to the one standard deviation innovation to the other variables in the VAR system for ten periods. A shock in GDP will lead to a sudden increase in inflation, which dissipates over time. There is a sharp increase in WPI from the 1st to 2nd period of gross fiscal deficit, after which the response of inflation shows a sudden fall. The impulse response of WPI to M3 shows a positive response over time horizons till the 9th period. An increase in the money supply will push inflation upwards. The impulse response of WPI to interest rate stocks is more or less stable; there is not much fluctuation in the response curve. An impulse of one standard deviation to the exchange rate is negatively reflected in the inflation rate.

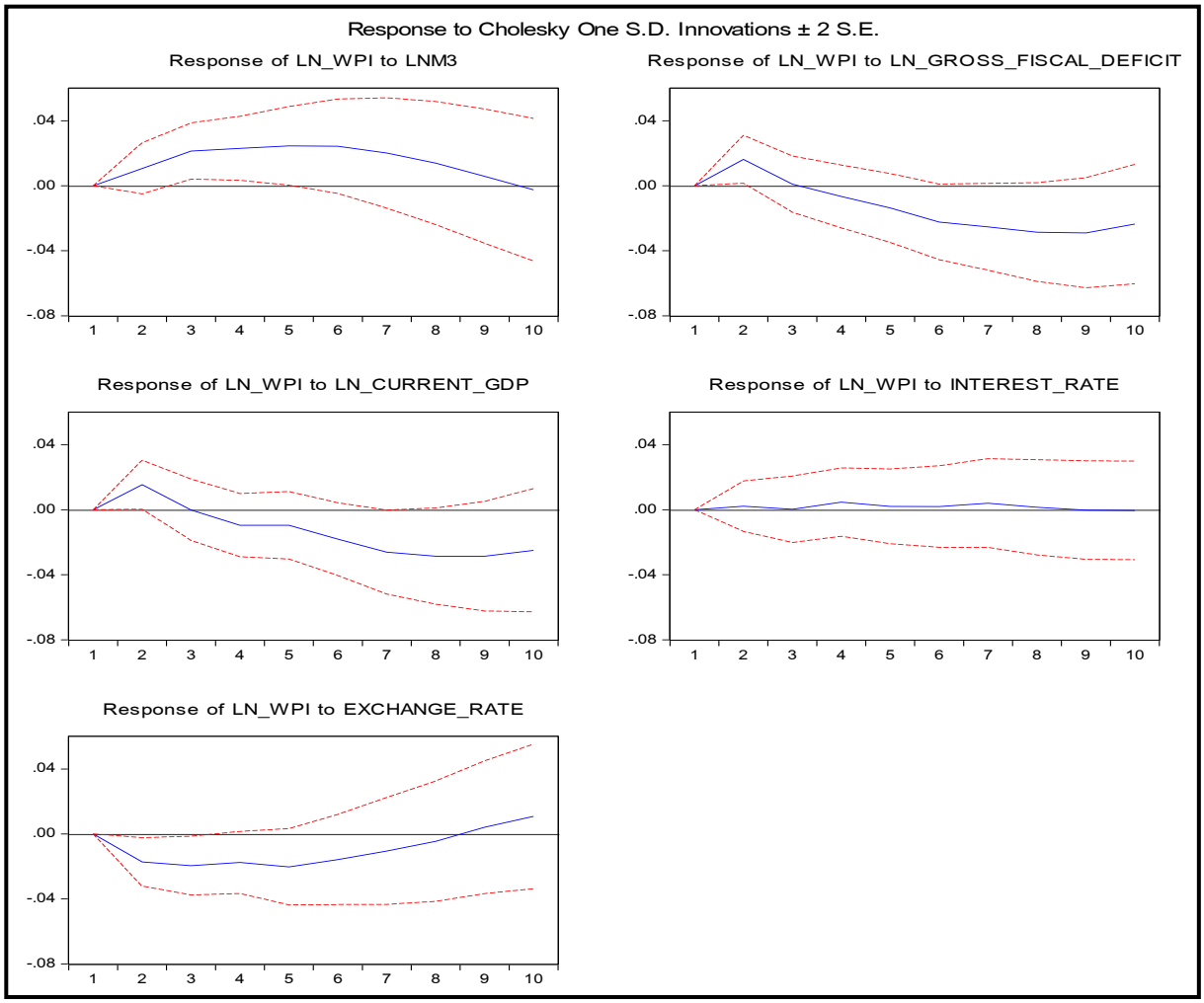


Fig. 2: Impulse Response of WPI to Other Variables

Stability of VAR Model: The stability condition of VAR requires that the characteristic roots of the polynomial lie outside the unit circle. The VAR model is stationary if all roots of the characteristic AR polynomial have an absolute value less than one and lie outside the unit circle. There should be (number of variables) * (number of model lags) roots visible on the graph. Therefore, in the inverse roots of the AR polynomial, all the roots should lie inside the unit root circle. The points in Fig. 3 are the inverse roots of the VAR model and all roots are inside the unit circle, suggesting that the model does not suffer from the problem of autocorrelation or heteroscedasticity. Therefore, the VAR model is stable and the sequences of WPI, GDP, gross fiscal deficit, interest rate, exchange rate, and money supply have a finite and time-invariant mean and variance.

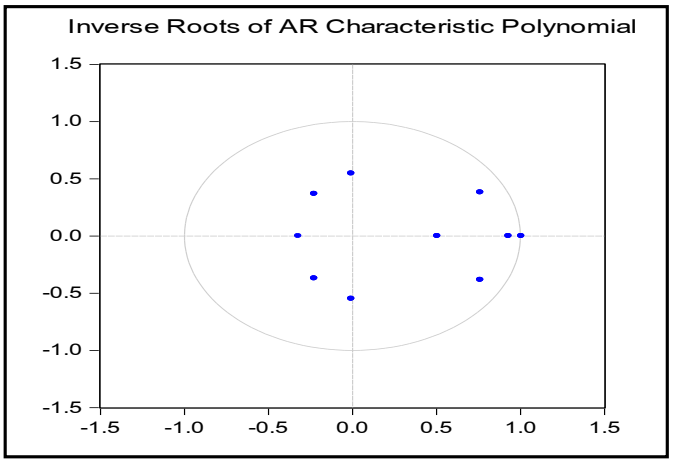


Fig. 3: Stability of VAR Model

Conclusion

Macroeconomic stability with low or moderate inflation is the necessary precondition for sustained economic growth. However, low inflation does not constitute a sufficient condition for growth. The relationship between inflation and macroeconomic variables like growth rate, money supply, fiscal deficit, interest rate, and the exchange rate remains a controversial one in both theory and empirical findings. Though theoretically there seems to be consensus on the negative effects of inflation on economic growth, the effects are not the same across developed and developing countries. Empirical studies also find threshold and non-linear effects of inflation on growth. Some studies even report positive effects of inflation on growth, often comparing inflation with deficit financing. Further, causality is not always one way. To understand the macroeconomic relationship between inflation and other variables in the Indian context in recent years, this study examines the causal relationship between inflation and some macroeconomic variables for the period 1986-2016. The variables considered in this study are wholesale price index, interest rate, exchange rate, GDP, broad money, and gross fiscal deficit. Data for the variables are sourced from the RBI Handbook of Statistics on Indian Economy and the World Bank. Empirically, considering all the variables as endogenous, the vector error correction mechanism (VECM) estimation method is followed. All the variables in the study are considered as a group and are endogenous. The usual diagnostics of time series data, viz. stationarity, cointegration, and causality tests, are performed. The tests show that the macro variables are stationary at first difference; there exists a cointegrating relationship between inflation and other macroeconomic variables; money supply, GDP, and exchange rate cause inflation; and a change in WPI has an effect on gross fiscal deficit and interest rate.

The VECM estimates show that money supply and GDP are the most important macro variables in explaining the variation in inflation. A 1% increase in inflation is due to a 3.8% increase in money supply and a 2.8% decrease in GDP. A 1% change in current period inflation is associated with about a 20% change in its previous period inflation rate. A 1% increase in inflation is associated with about a 1% increase in the gross fiscal deficit. The error correction term shows that any divergence from the long-run relation in the current period should be adjusted to around 20% in the following period. Thus, the short-run disequilibrium is corrected by about 20%, every period, towards the long-run equilibrium. The impulse response results show that inflation responds positively to money supply from the start to the 9th period. The response of WPI to exchange rate, GDP, and fiscal deficit are generally negative. The shock of the interest rate on inflation is more or less stable over the period. The results of this study suggest that to promote economic growth and keep inflation low, the government needs to rationalise money supply and budget deficits. The government should curtail unproductive expenditure, which is bad for both growth and inflation, in favour of investment, to provide macroeconomic stability for promoting growth.

References

Balakrishnan, P. (1991). Money, output and price level. *Economic and Political Weekly*, *26*(24), 1472-1474.

Behera, J. (2016). Dynamics of inflation, economic growth, money supply and exchange rate in India: Evidence from multivariate analysis. *Quarterly Journal of Econometrics Research*, *2*(2), 42-54.

Berument, H., Inamlik, A., & Olgun, H. (2008). Inflation and growth: Positive or negative relationship? *Journal of Applied Sciences*, *8*(2), 192-204.

Bhowmik, D. (2015). An econometric model of inflation in India. *International Journal of Scientific and Research Publications, 5*(2), 1-9.

Bishnoi, T. R., & Koirala, T. P. (2006). Stability and robustness of inflation model of Nepal: An econometric analysis. *Journal of Quantitative Economics*, *4*(2), 114-129.

Bozkurt, C. (2014). Money, inflation and growth relationship: The Turkish case. *International Journal of Economics and Financial Issues*, *4*(2), 309-322.

Bruno, M., & Easterly, W. (1998). Inflation crises and long-run growth. *Journal of Monetary Economics*, *41*(1), 3-26.

Burdekin, R. C. K., Denzau, A. T., Keil, M. W., Sitthiyot, T., & Willett, T. D. (2004). When does inflation hurt economic growth? Different nonlinearities for different economies. *Journal of Macroeconomics*, *26*(3), 519-532.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, *74*(366), 427-431.

Engle, R. F. (1982). Autoregressive conditional heteroskedasticity with estimates of the variance of UK Inflation. *Econometrica*, *50*(4), 987-1007.

Engle, R., & Granger. (1987). Co-integration and error correction: Representation, estimation, and testing. *Econometrica, 35*(2), 251-276.

Erbaykal, E., & Okuyan, H. A. (2008). Does inflation depress economic growth? Evidence from Turkey. *International Research Journal of Finance and Economics*, *17*(1), 40-48.

Faria, J., & Carneiro, F. (2001). Does high inflation affect growth in the long and short run? *Journal of Applied Economics*, *4*(1), 89-105.

Ghosh, A., & Phillips, S. (1998). Warning: Inflation may be harmful to your growth. *IMF Staff Papers, 45*(4), 672-710.

Gillman, M., Harris, M. N., & Matyas, L. (2004). Inflation and growth: Explaining a negative effect. *Empirical Economics*, *29*(1), 149-167.

Gokal, V., & Hanif, S. (2004). Relationship between inflation and economic growth. Working Paper No. 2004/04, Economics Department, Reserve Bank of Fiji, Suva, Fiji.

Gullapalli, S. (2013). Analysing the relationship between inflation and growth: Policy implications for Central Banks. Working Paper, Colgate University.

Jha, R., & Dang, T. (2012). Inflation variability and the relationship between inflation and growth. *Macroeconomics and Finance in Emerging Market Economies*, *5*(1), 3-17.

Johansen, S. (1988). Statistical analysis of cointegrating vectors. *Journal of Economic Dynamics and Control*, *12*(2-3), 231-254.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration - with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*, *52*(2), 169-210.

Kaur, G. (2019). Inflation and fiscal deficit in India: An ARDL approach. *Global Business Review*.

Krishna Veni, L., & Choudhury, P. K. (2007). Inflation and growth dilemma: An econometric analysis of the Indian economy. *IUP Journal of Financial Economics*, *5*(1), 80-87.

Kumar, R. (2013). A study of inflation dynamics in India: A cointegrated autoregressive approach. *Journal of Humanities and Social Science*, *8*(1), 65-72.

Mallik, G., & Chowdhury, A. (2001). Inflation and economic growth: Evidence from four South Asian countries. *Asia-Pacific Development Journal*, *8*(1), 123-135.

Patnaik, A. (2010). Study of inflation in India: A cointegrated vector autoregressive approach. *Journal of Quantitative Economics*, *8*(1), 118-129.

Pattanaik, S., & Nadhanael, G. V. (2013). Why persistent high inflation impedes growth? An empirical assessment of threshold level of inflation for India. *Macroeconomics and Finance in Emerging Market Economies*, *6*(2), 204-220.

Philips, P. C., & Perron, P. (1988). Testing for unit root in the time series regression. *Biometrika*, *75*(2), 335-346.

Sahadudheen, I. (2012). A cointegration and error correction approach to the determinants of inflation in India. *International Journal of Economic Research*, *3*(1), 105-112.

Tabi, H. N., & Ondoa, H. A. (2011). Inflation, money and economic growth in Cameroon. *International Journal of Financial Research*, *2*(1), 45-56.

Guidelines for Authors

International Journal of Business Analytics & Intelligence welcomes original manuscripts from academic researchers and business practitioners on the topics related to descriptive, predictive and prescriptive analytics in business. The authors are also encouraged to submit perspectives and commentaries on business analytics, cases on managerial applications of analytics, book reviews, published-research paper reviews and analytics software reviews based on below mentioned guidelines:

Journal follows online submission for peer review process. Authors are required to submit manuscript online at http://manuscript.publishingindia.com

Title: Title should not exceed more than 12 Words.

Abstract: The abstract should be limited to 150 to 250 words. It should state research objective(s), research methods used, findings, managerial implications and original contribution to the existing body of knowledge.

Keywords: Includes 4–8 primary keywords which represent the topic of the manuscript.

Main Text: Text should be within 4000-7000 words Authors' identifying information should not appear anywhere within the main document file. Please do not add any headers/footers on each page except page number. Headings should be text only (not numbered).

Primary Heading: Centered, capitalized, and italicized.

Seconday Heading: Left justified with title-style capitalization (first letter of each word) and italicized.

Tertiary Heading: Left justified and indented with sentence-style capitalization (first word only) in italics.

Equations: Equations should be centered on the page. If equations are numbered, type the number in parentheses flush with the left margin. Please avoid using Equation Editor for simple in-line mathematical copy, symbols, and equations. Type these in Word instead, using the "Symbol" function when necessary.

References: References begin on a separate page at the end of paper and arranged alphabetically by the first author's last name. Only references cited within the text are included. The list should include only work the author/s has cited. The authors should strictly follow APA style developed by American Psychological Association available at American Psychological Association. (2009). Publication manual of the American Psychological Association (6th Ed.). Washington, DC.

Style Check

To make the copyediting process more efficient, we ask that you please make sure your manuscript conforms to the following style points:

Make sure the text throughout the paper is 12-point font, double-spaced. This also applies to references.

Do not italicize equations, Greek characters, R-square, and so forth. Italics are only used on p-values.

Do not use Equation Editor for simple math functions, Greek characters, etc. Instead, use the Symbol font for special characters.

Place tables and figures within the text with titles above the tables and figures. Do not place them sequentially at the end of the text. Tables and figures must also be provided in their original format.

Use of footnotes is not allowed; please include all information in the body of the text.

Permissions

Prior to article submission, authors should obtain all permissions to use any content if it is not originally created by them.

When reproducing tables, figures or excerpts from another source, it is expected to obtain the necessary written permission in advance from any third party owners of copyright for the use in print and electronic formats. Authors should not assume that any content which is freely available on the web is free to use. Website should be checked for details of copyright holder(s) to seek permission for resuing the web content.

Review Process

Each submitted manuscript is reviewed first by the chief editor and, if it is found relevant to the scope of the journal, editor sends it two independent referees for double blind peer review process. After review, the manuscript will be sent back to authors for minor or major revisions. The final decision about publication of manuscript will be a collective decision based on the recommendations of reviewers and editorial board members.

Online Submission Process

Journal follows online submission for peer review process. Authors are required to register themselves at http://manuscript.publishingindia.com prior to submitting the manuscript. This will help authors in keeping track of their submitted research work. Steps for submission is as follows:

1. Log-on to above mentioned URL and register yourself with “International Journal of Business Analytics & Intelligence”
2. Do remember to select yourself as “Author” at the bottom of registration page before submitting.
3. Once registered, log on with your selected Username and Password.
4. Click “New submission” from your account and follow the 5 step submission process.

Main document will be uploaded at step 2. Author and Co-author(s) names and affiliation can be mentioned at step 3. Any other file can be uploaded at step 4 of submission process.

International Journal of Business Analytics & Intelligence

(Biannual Journal)

SUBSCRIPTION DETAILS

Dispatch Address:-

The Manager,

International Journal of Business Analytics & Intelligence

E-598, Ground Floor

Palam Extension, Sector-7, Dwarka (Near Ramphal Chowk)

New Delhi-110077

Office No. : 011-28082485; 011-47044510, 011-49075396

Mobile No.: +91-09899775880

Subscription Amount for Year 2022

	Print	Print + Online
Indian Region	Rs 2200	Rs 3500
International	USD 150	USD 180
Price mentioned is for Academic Institutions & Individual. Pricing for Corporate available on request. Price is Subject to change without prior notice.		

Payment can be made through D.D./at par cheque in favour of "Publishing India Group" payable at New Delhi and send to above mentioned address.

Disclaimer

The views expressed in the Journal are of authors. Publisher, Editor or Editorial Team cannot be held responsible for errors or any consequences arising from the use of Information contained herein. While care has been taken to ensure the authenticity of the published material, still publisher accepts no responsibility for their inaccuracy.

Journal Printed at Anvi Composers, Paschim Vihar.

Copyright

Printed and published by Publishing India Group, New Delhi. Any views, comments or suggestions can be addressed to – Coordinator, IJBAI, info@publishingindia.com

www.manuscript.publishingindia.com

PublishingIndia.com

Publishing India Group

E-598, Ground Floor, Palam Extension,
Sector-7, Dwarka (Near Ramphal Chowk)
New Delhi-110077
Tel.: 011-28082485, 011-47044510
Email: info@publishingindia.com
Website: www.publishingindia.com

ISSN 2321-1857

9 772321 185001