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What Does It Mean To Be A Professional New Zealand Farmer?

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Abstract: This article reprises the idea of 'professional farmer' as of central importance to the future of economic wellbeing and innovation for farmers, farming communities, New Zealand as a whole, and by implication any society. Using contemporary analysis of professionalism and how this continues to change, a mix of admiration and critique of current practices and encouragement for the sector to continue its professional development, will help engagement with today's changing political, environmental and economic climate. Common contrasts made between government versus farmers, science experts versus farmers, and urban residents as 'townies' versus farmers are unhelpful hangovers from last century and the one before. Embracing elements of each is necessary for a present-day professionalism that is sustainable as a career and way of life across generations, meets the needs of the land, water and local environment, and for meeting the global questions of sustainability facing farming and society today.

INTRODUCTION

Being professional, doing a professional job, acting like a professional, are all terms much bandied around today. Do these words help us to think about modern farming? The idea of a professional has changed over time, even though most people think of profession or professional as a fixed thing, role or quality. The modern idea of professional has been around for about two centuries, a little longer than when New Zealand Māori and Pakeha (white) partners signed the signed the Treaty of Waitangi in 1840. In the decades either side of the Treaty, a series of charters were accepted in Britain incorporating Royal Societies around different spheres of expert knowledge—from medicine in 1800 to veterinarians in 1844 several dozen occupations gained royal charters beginning the journey towards present-day professions (Reader, 1966, pp. 16ff). The history of professions has a particular resonance for New Zealand, since the country does not have an extensive aristocratic class or landed gentry, but professions developed in the era of colonisation and modernisation (King, 2004).

The focus in this article is not, however, the history of professions but the contemporary question of how the idea of professionalism that emerges from modern historical and economic developments can be identified in the New Zealand farming community today. Both *professions* themselves, and the idea of *professionalism* – what counts as being professional or doing a professional job – have continuously shifted over the last two centuries (Larson, 1977; Macdonald, 1995). There used to be features of class status

associated with professions, but this sits very differently today. At one stage, profession meant the *opposite* of business, whereas today in conventional professions and in activities like farming, the two words are often put together—professional manager, for instance. To be a professional is not only used to refer to some formal legal status and registration but is also used to say something about the approach to an activity in terms of quality, knowledge, competence, as well as factoring in the range of internal and external influences and resources in how that complex activity is performed.

Staying a moment longer on that historical development helps make the connection to the idea of contemporary professional farmers. Farming today with its high levels of business, technological and other requirements is very different from what the same word farmers meant centuries ago. The majority of farmers then were poor, uneducated, unskilled and in their rural environment largely cut off from the intellectual, social life and innovations of cities and elites. From that sort of world, it was part of the emergence of the colonising European modern world that the conjunction of scientific knowledge began to be applied to farming as well as other spheres of human need and concerns such as health and education. Land improvement, animal and crop breeding, agricultural and horticultural trading, developed alongside other more controversial developments like land enclosures, deforestation, decline in fallowing, and other sustainable practices.

FARMER PROFESSIONALISM AND THE GOODNESS-EXPERT BUNDLING

Professions have always offered in some variation or other the double claim that (1) they are experts and (2) they are good and oriented to serve the good of society. I argue in my recent book (Burns, 2019, p. 123) and a series of articles about professions and professionalism over some years, that this is a powerful claim, and has been substantially successful for professional groups in their occupational projects of winning social recognition and status as well as gaining economic rewards that are for the most part higher than the average earnings of members of society. In significant ways, however, there are powerful *unbundling* processes happening to each of these twin claims today. Farmers are positioned in such a way that they have actually experienced their own version of these unbundling processes, and so farmers are potentially, in key respects, better placed to deal with these shifts than many conventional professions are – if they take present opportunities to do so.

In New Zealand's history the settler-farmer has been economically a major force and until relatively recently the dominant political block of voting interests (Belich, 2001; Burns, 2007a). Even today the economic importance of dairy, sheep, cattle, horticulture and viticulture are basic to the country's wellbeing. Yet what sociologists call the normative position of farmers and farmers has changed. Just as professionals generally mounted a claim to be good and doing publicly good and useful things, farmers held a parallel position: they were contributing to the wealth of the nation, developing land into productive forms; producing food, all of which was regarded as inherently a good thing. Campbell has described how that farming normative umbrella has shifted, as the economic and political focus has changed, not only in New Zealand (Campbell & Le Heron, 2007; Campbell & Dixon, 2009). Non-farmer views about food quality, water quality, treatment of animals, environmental effects of farming, eating meat, alternative milks, and other issues have steadily grown to loom large in discussions of the value and 'goodness' of farmers and farming.

So like professions more broadly, the previous automatic normative positioning of farming as a good and honourable calling is not the same today. There are in my view, however, points of opportunity that can in ways that conventional professions may not have open to them, bring back that respect and social approval of the societal value and human worthwhileness of farmers and farming. First, the necessity for humans to have food and water, which is mostly within the care of farmers, is the central driver of recognition of farmers as the source from where quality and sufficiency of various foods come. In the century ahead, the importance of food production and water are likely to become once again primary signifiers of what distinguishes functioning societies around the world. Second, if rising best practices are applied by farmers to their farm management and food production and deployed consistently, then end-users, consumers and regulators can be assured of the quality of what they do and how they do it. Former standards and practices will in many instances not provide adequate justification, whether sincerely believed, argued in curmudgeonly style, or used to belittle urban folks. But a core professional approach will be able to provide the necessary justification. Cost and profit are necessarily part of this professional approach. The professional capacity to adapt can secure the future of different forms of farming and communities across New Zealand.

Having spoken about the *normative* place of New Zealand faming as an occupation and community, I want to name the expert dimension of New Zealand farming and argue for the expertise of New Zealand farming in conjunction with this positive normative space as forming the basis of high-level professional approaches in New Zealand's rural industries. This changing professionalism can potentially lift sectoral performance, social respect and acceptance in several ways within New Zealand and against international benchmarks since the bulk of produce is sent globally. As with other professional groupings, there is not just one category of farmers in terms of competence, expertise and doing the right thing.

CHANGING PROFESSIONALISM

Professions used to be thought of simple categories of occupation and expertise. Nowadays we are more knowledgeable (Burns, 2007b). Not only have professions been differentiated and new professions emerged, we know that any given professional group has poor practitioners, average practitioners who function appropriately, and some who are outstanding. I have spoken with professionals and they find this hard to credit since in their view they all have the same qualification and fulfil the same function, surely? Such credentials are, however, simply the minimum entry point. A little reflection reminds us this is the case: the reason we ask around friends and family when choosing a doctor, dentist or accountant is to increase the chances of avoiding less competent professionals and increasing our chances of getting a better and more capable one. The same logic applies to the range of professionalism and competence amongst farmers. Any categorisation is, of course, a simplification of complex factors, but it also highlights important net effects of applying knowledge and purpose to an intended professional outcome.

Here is a farm-focused example of this kind of contemporary professional analysis. On one occasion I attended a bank seminar at which the keynote speaker to the rural audience was a very experienced principal of a large accountancy firm with many agricultural clients in a major farming district. His farming clients, he said, could be divided into four groups, and only the top quarter of his clients—group one—fitted an ideal professional profile:

they did the right things at the right time. So what, he posed the question we should be asking him, was the difference between the group one farmers and group two farmers—the second quarter? His answer was that the second group similarly did the right things but often not at quite the right time, a little too soon or a little too late—planting, sowing, harvesting, shearing, calving, spraying, and so on. The third and fourth groups of farmers in his typology (third and fourth quarters of his client list respectively) sometimes made the wrong decision (group three); even then, some pursued the related poor decision/action outside the best time to do it (group four).

At an earlier point in history, altruism or service ethic as work goals were perceived as sharply contrasted with commitment to making money and were seen as opposites. The same was true decades ago in many sports codes, rugby football included. Today this opposition no longer holds true – yes, these may be opposites, but not necessarily so. Applying expertise and working for the good of the wider society in what is being produced may yield wins for multiple stakeholders. Farmers often see themselves as business enterprises, but re-framing identity as professional farmers offers new narratives for generating sustainable success.

LOOKING FORWARD: WHAT COUNTS AS PROFESSIONAL 'GOODNESS' AND WHAT COUNTS AS EXPERTISE?

From one perspective farmers have a real possibility of coming back to being seen as good for society in a way that might be harder for conventional professional groups because of the driver of client need – food and clean water. Mitchell (2019) reports a positive perspective, 'while dairy has been the story of farming for the past 25 years, there would be much greater diversity across the industry during the next 25 years':

> The outlook for the future of the farming sector is bright, so long as farmers can adjust to the changing nature of the industry. ASB Rural Banking general manager Richard Hegan said skyrocketing global food demands were the reason for the optimism in New Zealand's primary sector. 'To feed 10 billion people is going to require the world to produce as much food in the next 30 years as has been produced since mankind was first created'.

At the same time, however, this is not a simple winding of the clock back to the 'good old days'. Society, as clients, government requirements, internet-informed publics, re-assesses and changes its values about quality, creating a much more complex world we are entering. Good to have the strong positive potential, but the template of professionalism is not today a simplistic repetition of the unproblematised 'goodness' of the past, nor is it the assessment of expertise as simple trust—'the doctor knows best', 'teacher knows best', or 'leave it to farmers'.

A digital world is a more connected world and a more knowledgeable world, and issues of how outputs are achieved, at previous stages in history, such as the farmer externalising their costs onto water itself, and similarly to environment, to animal wellbeing and to soil health, are much more acutely focused upon than ever before. Fournier (1999) and others including myself in New Zealand have described how urging the idea of professionalism can be an issue of control rather than independence (Burns, 2006). However, rather than that being a reduction of farmer control over their work as it is for the subsidiary professional

workers that Fournier describes, farmers still have substantial autonomy in the practice and direction of their work. But there is a reframing that is necessary here to integrate this in today's economy and society and it runs as follows. Each of those constraints, or potential impacts on farmers' work, enterprise and profit at the same time indicate the scaffolding of expertise required in the twenty-first century. Not just the tractor, but dangers of the tractor, damage that mechanical farming can do. Not just water, but the dangers to water and the dangers that impacted water has downstream.

Not just the production of food but the selling of it, the social acceptance of it. New Zealand farmers have an excellent track record back into the nineteenth century of co-operative action that is more genuinely entrepreneurial and professional than the digital step-change of Silicon Valley. It was Beck (1992) who explained that in terms of contemporary risk theory, being conscious of 'bads' as well as 'goods' in decisions and practices is fundamental to how society and any subset such as farming is run. The amalgamation of diverse forms of knowledge and skills in farming meets the criteria of complex knowledge, or expertise, that ordinary people do not possess and hence rely on the skilled practitioner. We have seen conventional professions experience resistance from the ordinary population on prescriptions, vaccinations, surgery, alien environments and many more things. Farmers today need to recognise general policy and governmental scrutiny arises from a broader cultural opposition to being excluded, and hence vulnerable, by those who 'know better' or command a field of knowledge and expertise.

The same higher levels of farmer education are also matched by greater public and political awareness of the 'bads' or potential 'bads' that may adversely affect the wellbeing of clients or community by farmers and farming as well as more widely. This changes social and business discourses, creating new levels of attention and concern, but also a sense of barrier from farmers' expertise that citizens know they need but find hard to evaluate—who is benefiting most and what risks do they place themselves within in receiving them? Things that famers used to be able to expect to be largely invisible except to farmers, are now likely to become publicly available through social media, mobile cameras, drones, challenges in courts to quality and care. It cannot be repeated too often that this sense of 'nuisance' has to be met and it can become the very pivot point of embedding modern professional practices and standards that raise the quality and monetary value of what is produced.

More than simply information being 'out of the way' or unknown to the non-farming and urban public, there was simply not the attention by anyone to environmental soil and water impacts of farming. In fact, like business generally in the modern western era, farming was an externalising machine, passing the costs of land-clearing and intensification onto the environment. The land in its own time-frame pushes back and shows that it is not accepting that division of cost and profit. What requires necessary sympathy is that farmers now receive greater blame for this than the rest of society which has benefitted in multiple ways from this activity. But farmers are still doing it, comes the reply. But the further counter in this changing discourse is that society wants cheap milk, cheese, butter, vegetables, fruit, flour and other farmed crops. It does not matter how desirable more sustainable practices are, urban people want these commodities and many more. To farmers, embedded in the social and economic relationships of food production, such urban non-farming consumer attitudes appear as hypocrisy and feeds a sense of unfairness at what appears to be spurious concern about sustainable land-use: maybe noble values but unchanged behaviour.

RECONFIGURING NEW ZEALAND PROFESSIONALISM

Farmers, like all professionals, then, find themselves engaged in a contest about the value and identity of what their goods and services are. Yes, in one sense these products are highly desired, but it is more than urban consumerism that insists on having opinions about things, even though individuals are substantially ignorant in terms of detailed knowledge. Doctors, lawyers and accountants have client groups questioning their work today; from a farming position one might say of these professions: 'and rightly so'. The same, of course, applies to querying what farmers do and the feeling of less familiarity about what and how farmers produce their outputs does not diminish the claim, from the non-farmer viewpoint. Farmers' understanding that the populace need them for food and water, seems very simplistic if not defensive to an outsider to farming; it seems spurious insofar as wastes, inefficiencies, sprays, treatment of livestock and run-off, are all visible to these outsiders, and impacts are increasingly measurable. The professionalism of New Zealand farmers to date is what has made them competitive on the world stage. They key is not dismissal of critical, even uninformed views, but 'reading' what these views signal and turning these negatives into opportunities.

What are these characteristics of professional New Zealand farmers? What skills and abilities place them in the top group of farmers in the example cited above? That is, the timeliness and good decision-making seem clear, but what skills and combinations of skills give consistency and underlie these resulting virtues of the top farmers? It has always been the case that whatever is the major threat of the times—land degradation, water access and quality today, economic recession at other times, perhaps changing tastes and preferences in commodities—the problems are a greater threat to farmers with less-developed professional skills. They are pressured to exit the industry, and while excellent farmers are also pressured, the latter have skills and 'personal capital', to adapt Bourdieu's (1992) phrase. Bourdieu's (2008) depiction of French farmers in the 1960s and 1970s struggling to adapt to rural depopulation, aggregation of farming units and the need for acquiring modern skills and practices, conveys a feeling or pathos but eloquently described the inevitability of change affecting modern rural individuals and their communities.

Five traits of professional farmers are suggested below. Inevitably they overlap, intersecting with each other. None by itself achieves a professional approach to farming. It is the bundling of them that has greatest utility to meet difficult challenges and finding a way to be effective in adapting to viable and sustainable farming.

1. Multiple skill-sets

Farming requires multiple skill-sets that are used and understood in relation to one another. A professional farmer integrates these, recognises limits of their personal knowledge and seeks further specialised knowledge. Some of this is learned apprentice-style doing the task and learning the skills. In previous generations this was commonly the only way to gain the requisite skills. Gradually from agriculture colleges, short-term courses and university study, many new kinds of input of information can be added to on-the-ground activities of farming. Traditional infrastructure of farm agents and agencies, coupled with seminars and study groups, combine with the ubiquity of Google searches, to acquire further information. It is possible to lead with one skill-set—an engineering or building background, perhaps banking or accounting in previous employment. These can be great shapers of individual style of farming, but it is the combination with other practical or technical skills that make up broad professional competence.

2. Technological competence

Within this cluster of skills needed for professional farming practice, the 'new kid on the block' is competence with digital technologies of various sorts. Rural communities are not always able, however, to access the essential infrastructure to participate quickly enough in these developments. Online purchases and accounts payments are the start of gains. Replacing cheques and bank visits with staff payments online or by mobile phone save hours at a time. But receiving daily milk reports from collection, market intelligence for flock decisions, or ever-better weather forecasts, have become indispensable. But great gains beyond that are accumulating, some still seem like science-fiction, but gate-opening, trough-monitoring, water and nutrient monitoring are quickly becoming standard, with robotics and drones showing early promise. With control over a land area, farming is well placed to avoid some of the more contentious areas of negotiating these new tools and digital technologies. Computer spreadsheets and databases have already revolutionised accuracy and assessment of budgets, costing and strategic decision-making; they get better and simpler to use.

3. Inner sense of stewardship

This sounds like a 'soft' professional skill, but it relates to knowing the limits of one's capabilities, mentioned earlier. The shift from settler hyper-masculinity of previous generations shows that farmers are as vulnerable as the next group when careers and income are in jeopardy, and the sense of responsibility is coupled with the lack of ability to control events. Beyond the simple and sensible recognition of the need for managing this exposure and seeking advice, the point of personal enjoyment and interest in an individual's working day is the fulcrum for doing well. It is enhanced by a professional approach, at the same time, lowering the boom on expectations. One of the unspoken offences of the neoliberal regimes under which farmers and other groups are expected to 'perform' is the crushing pressure this brings to bear through narratives of hyper-success, making amazing incomes—bandied around as though these things can be pulled from the air if individuals just work hard enough.

The implicit message in such myths creates a sense of failure and blame when those unrealistic, supposed entrepreneurial stories, are not able to be met. Instead, I would invert that business model. New Zealand has an amazing professional narrative in the history of the dairy co-operative movement (Ward, 1975; Scrimgeour et al., 2006), first in dairying, but it can be seen in other places like the success of the 'Veterinary Club Movement' during and in the decades following World War Two (Burns, 2007a). Instead of manufacturing pseudo-success narratives, a grounded sense of being stewards of the land in one generation for future generations is stronger, many farmers already having this kind of perspective. It resonates well with Mäori traditions in New Zealand—stewardship, whaihua, or guardian of the land, kaitiaki o te whenua.

4. Business competence—knowledge for decision-making

Business competence is a different kind of expertise than important technical knowledge about equipment, varieties, breeds, fencing, drainage and transport, described earlier as multiple skill-sets. It overlaps, as do all these traits, but it is decisional capacity that is distinctive of professional farmers compared to others. This is not the gung-ho approach

of male-CEO decision-making that is sometimes seen as defining in organisational or other business contexts. Always, the competence is shown (or not) in processes of information-gathering, sorting and evaluating, leading up to decisions. Decisions themselves are simply the outcome of such processes. Several additional points extend this contention. First, the process is not a simple linear one; often decision-making follows a circular route or even a spiral one, rechecking or cross-checking relevant facts. For some farmers this comes apparently naturally, though it can be improved by training, for others there is a continual agony despite other good qualities. Second, only in academic analysis can a decision be isolated. In real-world farming multiple events and activities require decisions many times over, re-deciding or changing over time.

Third, again only in formal analysis that is set out on the page or presentation slides can the mistake be made that all decisions are created equal. There are pivotal decisions, season-ending or making decisions, five-year strategic decisions to spend or invest, daily decisions that have cumulative effects that can barely be identified. Fourth, a style of arriving at decisions, evolves slowly, just like the quality of All Black captains' on-paddock decision-making, maturing over time and better integrating multiple forms of farming knowledge: these were noted above as contributing sources of skill and knowledge for farmers. Previous background skills may inadvertently also create blocks to full competency in decision-making. For example, an engineer-turned-farmer whose training was to measure everything carefully and exactly, may miss the need is to make timely decisions. The necessary indeterminacy of many farming decisions will not allow indecision from informational exactitude that farming seasons, weather and markets never fully provide.

5. Renewed normative security

Farmer professionalism provides a practical and normative framing in the pursuit of commercial success and profitability as well as the aspiration of acceptance and recognition for doing a difficult job well and which benefits the country on several levels. Giddens (1991) and others used the phrase 'ontological security' to refer to a state of stability if not wellbeing that eludes many farmers. Coming after the certainty and self-confidence of settler society the goals of farm production as New Zealand were settled by Europeans self-evidently emulating Britain. More recently the feeling for many farmers is deficit, ontological insecurity, which is best addressed reframing the challenges of today. Those same farmers may feel an affinity for the land with tangata whenua but are conflicted by new understanding of the need for sustainable practices.

This helps explain why contemporary social values and points of respect do not uphold them today. It is unfair farmers bear primary blame for unsustainable ways of farming, yet the simple logic that they are still farming requires professional responses in following a process to a better way of earning a living from the land. Engaging with that covert, incomplete-understanding, even judgemental opinion can be utilised to galvanise entrepreneurship and innovation, ideally in the co-operative tradition of New Zealand's rural past to adapt to water, land and market demands. Both a social-community sense and an economic sense depend on it. What such major changes do not guarantee is the wellbeing or status quo for individual farms or farmers. Sometimes change is rushed not well-managed and individual farmers, sectors or ancillary stakeholders get hurt or frustrated unnecessarily. Even allowing those things to be the case, farming collectively, New Zealand economically and having a good society in which to live, depend on the

controlled expression of multiple skills and values to sustain both farming in the future and the transition to that sustainable future.

CONCLUSION

This discussion has avoided the listing of professional traits of occupational groups for farmers to be checked off to the degree they measure up to the ideals of professionalism. This check-list approach of defining professions has bedevilled studies of professions for decades (Macdonald, 1995). Instead, the idea of a profession being a special project (Larson, 1977) is more helpful and potentially more energising than the logic that performing some function in and of itself justifies and legitimates a role or occupational group. The range of farmers like other groups includes those who practice a model of professional farming, through to those who struggle to apply such an approach to the difficult times they face. Variability of markets, coming legislation on water plans, seem like impositions, but they are also the moments of opportunity in which famers take back responsibility and community recognition for sustainable use of land in this generation, between past and future ones.

Discerning readers will also have seen that climate and anthropogenic change have been avoided here. The several mentions of water, soil quality, the need for rain, and potable water for stock, crops and communities, all presuppose larger questions that are currently still politically or economically polarising. Instead, the mode of discussion here has embraced Deleuze's (Deleuze and Guattari, 1987) idea of assemblage. With different theoretical and regulatory questions facing farming today, simply bringing the pieces together can initiate new possibilities, rebundle existing ways of understanding and doing things, rather than applying top-down approaches. In this spirit, the idea of farming professionals and farmer professionalism offer an assemblage, a bringing-together, of key constituent elements of sustainable and viable farming in New Zealand. It is within this umbrella of professional farming that the large-scale philosophies of land, water and continuance can be found. It is thus not a question of denying that overall coherence of purpose and practice, but the necessity of local and specific things that can be done, working through personal or industry resistance, acquiring support for transitions and costs in the need to change

The world needs professional farmers more than ever. This is a quite different proposition than corporate farming or agribusiness—investments by private equity and Chinese interests around the world (Geisler & Makki, 2014). This article elaborated five aspects of farmer professionalism combining conventional conceptions of what professional means but in ways that are applicable to farming in New Zealand:

- Multiple skill-sets
- Technological competence
- Inner sense of stewardship
- Business competence – knowledge for decision-making
- Renewed normative security

Without these professional skills farms and farming will not last and change will be drastic. This framing combines suggestions from professions' history, the demands of business models of what it is to be professional, emerging digital technologies, and the recognition of global connectedness, including establishing the sustainability of farmed land and water.

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Forecasting Accuracy of Holt-Winters Exponential Smoothing: Evidence From New Zealand

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Abstract: Financial time series is volatile, dynamic, nonlinear, nonparametric, and chaotic. Accurate forecasting of stock market prices and indices is always challenging and complex endeavour in time series analysis. Accurate predictions of stock market price movements could bring benefits to different types of investors and other stakeholders to make the right trading strategies.

Adopting a technical analysis perspective, this study examines the predictive power of Holt-Winters Exponential Smoothing (HWES) methodology by testing the models on the New Zealand stock market (S&P/NZX50) Index. Daily time-series data ranging from January 2009 to December 2017 are used in this study. The forecasting performance of the investigated models is evaluated using the root mean square error (RMSE], mean absolute error (MAE) and mean absolute percentage error (MAPE).

Employing HWES on the undifferenced S&P/NZX50 Index (model 1) and HWES on the differenced S&P/NZX50 Index (model 2) we find that model 1 is the superior predictive algorithm for the experimental dataset. When the tested models are evaluated overtime of the sample period we find the supportive evidence to our original findings. The evaluated HWES models could be employed effectively to predict the time series of other stock markets or the same index for diverse periods (windows) if substantiate algorithm training is carried out.

1. INTRODUCTION

Financial markets are influenced by a variety of interdependent determinants. Adopting the fundamental perspective, Fama (1991), Chen, Roll, and Ross (1986), Chen (1991), Granger (1986), Engle and Granger (1987), Kwon and Shin (1999), Wongbangpo and Sharma (2002), Dassanayake and Jayawardena (2017) and so on evaluated the deterministic factors of the stock market price movements. They found the sources are multifaceted and originating from numerous sources ranging from domestic to international economic environments, motivation, and psychology of individual and institutional investors, local and international political situations, the degree of integration with international markets, and the impact of spontaneous events. These multidimensional forces consistently impacting on the stock market price movements in dissimilar scales thereby creating these time series to be dynamic, highly volatile, nonlinear, nonparametric, and turbulent.

Researchers and practitioners have been devoted to forecasting future trends in financial time series using different statistical, soft computing, and hybrid methods. These attempts could be broadly classified into technical analysis and fundamental analysis where these two schools of thought are at the opposite ends of the spectrum in devising forecasting models and taking different methodological, philosophical, and conceptual approaches. A time series can be defined as "*a set of regular time-ordered observations of a quantitative characteristic of an individual or collective phenomenon taken at successive, in most cases equidistant, periods of time*" (Statistics, O. E. C. D., 2013). Using this definition, a univariate time series is characterized by a vector of $y = [y_1, y_2,.., y_n]^T$, where y_t refers to the value of y in time step t and n refers to the total number of observations.

Fundamental analysts strive to determine the intrinsic value of an asset (company, industry, investment) based on the overall macroeconomic conditions, the management strategies of the company, industry environment, and its political atmosphere. Thus, the fundamentalists employ numerical information about macroeconomic, financial, and other related factors to predict the perceived value of the asset. The fundamental approach could be company-specific, industry-specific, or the economy as a whole. The technical analysis, on the other hand, has full reliance on the historical values of the time series to capture the past trends and cycles. Utilising charts, statistical and soft computing techniques, the technicians develop models to predict either high frequency or low-frequency financial time series. Schwager (1993, 1995); Covel (2004) uncovered that most brokerage companies hedge funds in practice have been heavily reliant on the technical analysis than the fundamental methodology.

The primary objective of this research is to evaluate the effectiveness and the performance of Holt-Winters Exponential Smoothing (HWES) for predicting the New Zealand stock market (S&P/NZX50) index. This paper contributes to the limited technical analysis based literature applied to the New Zealand stock market price/index prediction domain.

The remainder of the paper is organised as follows. Section 2 reviews the previous literature on stock market price-prediction models. In section 3 we review the Holt-Winters Exponential Smoothing (HWES) methodology applied in this study. Data and sample description is provided in section 4. Experimental results are reported in section 5. Section 6 contains the conclusions with some limitations and future research directions.

2. LITERATURE REVIEW

2.1 Preamble

The forecasting methodology of exponential smoothing (ES) appears to be originated from Robert G. Brown in 1944 when he was working as an operations research analyst in the US Navy during the second world war. Using a continuous set of data, he essentially applied an exponentially weighted moving average methodology to develop a model for tracking the velocity and angles of the enemy submarines. In the early 1950s, Brown extended the model from a continuous-time series to discrete data and improved it to deal with trends and seasonal fluctuations. Brown's application in predicting the demand for spare parts of the US Navy inventory system was vastly successful in terms of forecasting accuracy, thus, the methodology was implemented by the US Navy Inventory System (Gardner, 2006). In 1956, Brown presented the work of ES of inventory demands at a conference of Operations Research Society of America, and subsequently, this presentation established the basis of his first book, *Statistical forecasting for inventory control* (Brown, 1959). The general ES methodology was presented in Brown's second book, *Smoothing, Forecasting, and Prediction of Discrete Time Series* (Brown, 1963). Holt (1957) worked independently of Brown to formulate an alternative method for smoothing seasonal data whilst adopting a similar method for smoothing additive trends. Holt's original work was documented in the US Office of Naval Research (ONR) memorandum (Holt, 1957) but went unpublished until 2004 when it got published in the *International Journal of Forecasting* (Holt, 2004). Holt's additive and multiplicative seasonal exponential smoothing methodology gained wide publicity with the work of Winters (1960) where Winters empirically tested Holt's methods. Thus, Holt's seasonal versions are known as Holt-Winters' forecasting methods. Further development and collaborations to Holt's models were made by Muth (1960), Pegels (1969), Holt, Modigliani, Muth, & Simon (1960). Hyndman, Koehler, Snyder & Grose (2002) advocated a new approach for the categorization of ES methods. In a broader context, the popular ES methods are simple exponential smoothing (SES), Holt's linear method (additive trend, no seasonality), Holt-Winters' additive method (additive trend, additive seasonality), and Holt-Winters' multiplicative method (additive trend, multiplicative seasonality).

2.2 Variations

Many variations to the original ES have been projected. Rosas and Guerrero (1994) evaluated the incorporation of additional information through one or more constraints in exponential smoothing forecasts. They proposed to accommodate them as linear restrictions and suggested that appropriate use of such information improves prediction accuracy and precision. Carreno & Madinaveitia (1990) aimed at establishing the announced price increases through an adjustment to sales plus exponential smoothing, moving indices to normalize the original sales data, and modification of the forecast. Their rationale is useful for time series forecasting in an economy with high inflation. Williams & Miller (1999) proposed a methodology for letting the predictor incorporate the judgmental adjustments *within* the exponential smoothing model. This study demonstrated the proposed model is better than the alternative models tested. Lawton (1998) explored the precision of the Additive Holt-Winters methodology and argued for renormalization of the seasonal indices at each period, as it removes bias in estimates of the level and seasonal components. Roberts (1982) and McKenzie (1986) proposed marginally different

normalization schemes to Lawton (1998). Later, Archibald and Koehler (2003) developed innovative and much simpler renormalization equations arriving with similar forecasts. SES with drift is an important variation in between SES and Holt's method which is equivalent to Holt's method setting the trend parameter to be zero. Hyndman & Billah (2003) exhibited that Theta method proposed by Assimakopoulos & Nikolopoulos (2000) is simply a special case of SES with drift.

2.3 Application of ES to Financial market prediction

Exponential Smoothing (ES) is a simple yet robust methodology in time series prediction. ES can be applied to time series that exhibit homoscedastic as well as heteroscedastic patterns. Although the homoscedastic case is similar to the ARIMA process, the heteroscedastic case is different from the ARIMA process. Thus, Ord, Koehler & Snyder (1997) argued that ES could be expanded beyond the ARIMA class. Leung, Daouk & Chen (2000) tested the predictive power of two types of models on the S&P 500, FTSE 100, and Nikkei 225 indices. The tested classification models predict direction based on probability, include linear discriminant analysis, logit, probit, and probabilistic neural network. The tested level estimation counterparts are exponential smoothing, multivariate transfer function, vector autoregression with Kalman filter, and multilayered feedforward neural network. The empirical investigation finds that the classification models performed better than the level estimation models in terms of forecasting the direction of the stock market movement and maximising returns from investment trading. Maris, Pantou, Nikolopoulos, Pagourtzi & Assimakopoulos (2004) evaluated the forecasting performance of ES, random walk (RW), and four models of ARCH family employing MAPE and RMSE as the performance criteria. Applying the models to the Greek FTSE/ASE 20 stock index, they found RW outperformed the rest of the models tested. Taylor (2004) tested the forecasting capabilities of smooth transition exponential smoothing (STES) and a verity of GARCH models for the S&P500 index. Employing RMSE as the performance evaluation criteria and he found that STES was a better forecasting model for the tested sample. Pereira (2004) examined the forecasting performance of RW, ES, ARCH, and so on using MSE, RMSE, and MAPE as the evaluation criteria. Applying the analysis to the Portuguese stock market, he found that the superiority of the ARCH model. Poon, Hyung & Granger (2006) used ES, random walk, fractional integrated (FI) break, GARCH, and so on to test the forecast performance of the daily volatility of the S&P500 index. Using MAE as the evaluation criterion they found that FI was the superior forecasting model for 10 days or beyond. Using ES, exponentially weighted moving average (ESWA), ARCH/GARCH, and so on Balaban, Bayar & Faff (2006) tested the accuracy of the prediction models. Mean absolute error, root mean squared error and mean absolute percentage error were used as the performance criteria. Daily stock market indices of 15 countries were tested and the ES model performed better than the rest of the tested models. Bley & Olson (2008) used ES, single-factor, and multifactor volatility index models, GARCH, and so on to forecast the volatility of the S&P100, S&P500, and NASDAQ100 indices. Using RMSE, MAE, etc., they found that the single-factor and multifactor volatility index and ES are the best foresting models. Using traditional time series decomposition (TSD), Holt/Winters (H/W) models, Box-Jenkins (B/J) methodology, and neural network (NN) models, Tseng, Kwon & Tjing (2012) analysed daily closing stock prices of 50 randomly selected stocks during 1998 to 2010. MAPE was used to determine the foresting accuracy and they found B/J, H/W, and normalised NN models are superior in comparison to TSD

and non-normalised NN models. Awajan, Ismail & Wadi (2018) analysed stock market data of 6 countries to determine the forecasting performances of Holt-Winter method, ARIMA models, Structural Time Series, Theta method, Exponential smoothing state space method (ETS), Random Walk method (RW) and hybrid EMD-HW with (without) bagging methods. RMSE, MAE, MAPE, MASE TheilU performance criteria were used and they found that the EMD-HW bagging model is more accurate in comparison to the other tested models. Sharif and Hasan (2019) applied Holt's method on the time series of Dhaka Stock Exchange and found the suitability of different smoothing constants for prediction accuracies.

2.4 Application to New Zealand stock market

Application of the ES model to forecast the time series of New Zealand financial markets is limited. Yu (2002) evaluated the performance of nine alternative models [random walk, historical average, moving average, simple regression, exponential smoothing, exponentially-weighted moving average (EMA), autoregressive conditional heteroscedasticity (ARCH), generalized autoregressive conditional heteroskedasticity (GARCH) and stochastic volatility (SV)] for predicting the volatility in the New Zealand stock market. Using RMSE, MAE, and Theil-U evaluation measures, they analysed the daily data of the NZSE40 capital index for 1980 to 1998 to forecast the monthly stock market volatility. The exponential smoothing method was adjudged the best model based on the MAE whilst SV model outperformed the others based on both RMSE and Theil-U.

3. METHODOLOGY

3.1 Exponential Smoothing

The key characteristic of Exponential smoothing (ES) is that the predictions are weighted combinations of the past values of the time series, with more recent observations are assigned with relatively higher weight than the older observations. As the name reflects, the weights in the ES method decay exponentially as the observations get older. The smoothing scheme could be a single ES, double ES, and triple ES. The triple ES is also known as Holt-Winters ES (HWES).

The HWES method is a robust yet easy to use forecasting methodology which works quite well with real-world time series for short-term predictions. Thus, we use the HWES methodology in our study. The HWES methodology is summarised in equations 1- 4.

Let the overall smoothed level of the time series, the smoothed multiplicative trend, and the smoothed seasonal index at the time t are denoted by l_t, b_t, and s_t respectively. The formulae for updating l_t, b_t, and s_t, when a new observation y_t, becomes available, are given in equations 1- 4. Let α, β and γ denote the smoothing parameters for updating the level, trend, and seasonal index respectively whilst m denotes the number of observations per seasonal cycle.

$$l_t = \alpha \frac{y_t}{s_{t-m}} + (1-\alpha)\left(l_{t-1} + b_{t-1}\right) \qquad \textit{Overall Smoothing} \qquad (1)$$

$$b_t = \beta\left(l_t - l_{t-1}\right) + (1-\beta) b_{t-1} \qquad \textit{Trend Smoothing} \qquad (2)$$

$$s_t = \gamma \frac{y_t}{\left(l_{t-1} + b_{t-1}\right)} + (1-\gamma) s_{t-m} \qquad \textit{Seasonal Smoothing} \qquad (3)$$

$$\hat{y}_{t+h/t} = \left(l_t + hb_t\right) s_{t+h-m(k+1)} \qquad \textit{Forecast} \qquad (4)$$

Where y_t is the observed value of the time series in period t; l_t is the smoothed level of the series computed after y_t is observed; b_t is the smoothed multiplicative trend at the end of period t; s_t is the smoothed seasonal index at the end of period t; $\hat{Y}_{t+h/t}$ refers to forecast for h/t periods ahead from origin t. α, β and γ are the constants of Holt-Winters ES model. The smoothing parameters and initial estimates for the elements are estimated by minimising the associated errors through performance evaluation statistics. Also, for model identification, Akaike Information Criterion (AIC) will be used (Akaike, 1973; Faraway & Chatfield, 1998; Kihoro, Otieno & Wafula, 2004).

3.2 Performance Evaluation

Three error statistics are used to evaluate the performance of the models tested. They are mean absolute error (MAE), mean absolute percentage error (MAPE) and root mean square error (RMSE). These error statistics are given below:

$$MAE = \frac{1}{N} \sum_{i=1}^{N} \left| X_t - \hat{\mathrm{X}}_{\mathrm{t}} \right| \qquad (5)$$

$$MAPE = \frac{1}{N} \sum_{\mathrm{t}=1}^{N} \left| \frac{X_t - \hat{\mathrm{X}}_{\mathrm{t}}}{\hat{\mathrm{X}}_{\mathrm{t}}} \right| \qquad (6)$$

$$RMSE = \sqrt{\frac{1}{N} \sum_{\mathrm{i}=1}^{\mathrm{N}} \left(X_t - \hat{\mathrm{X}}_{\mathrm{t}} \right)^2} \qquad (7)$$

However, in an event where inconsistent conclusions transpire from these criteria, the MAPE, suggested by Makridakis (1993), is used as the benchmark as MAPE is relatively more stable than other criteria from a theoretical and practical viewpoint. For model identification, the AIC is used (Akaike [27]). AIC is outlined below.

$$AIC(p) = n\, Ln\left(\hat{\sigma}_e^2\right) + 2p \qquad (8)$$

4. DATA AND SAMPLE DESCRIPTION

S&P/NZX50 Index data are extracted from S&P Dow Jones Indices produced by S&P Global (S&P/NZX50 Index, 2018). The index is developed to capture the overall performance of the 50 largest stocks listed on the Main Board (NZSX) of New Zealand's Exchange (NZX). We use daily price series of S&P/NZX50 Index from 2009 to 2017 having a total number of 2173 observations. Continuously compounded daily returns are generated using the formula $R_t = l_n\ (P_t/P/_{t-1})$ where P_t and R_t refer to the price of the S&P/NZX50 Index and continuously compounded return on trading day t respectively. The data range was split into training and test sets. To evaluate the performance of each model configured, the first 1500 observations (approximately 70%) are used as the training sample and the rest of the observations are used for prediction purposes.

Figure 1 portrays the time plot of the S&P/NZX50 Index confirming the time series is nonstationary and exhibits an upward trend and some degree of seasonal, cyclical, and irregular variations.

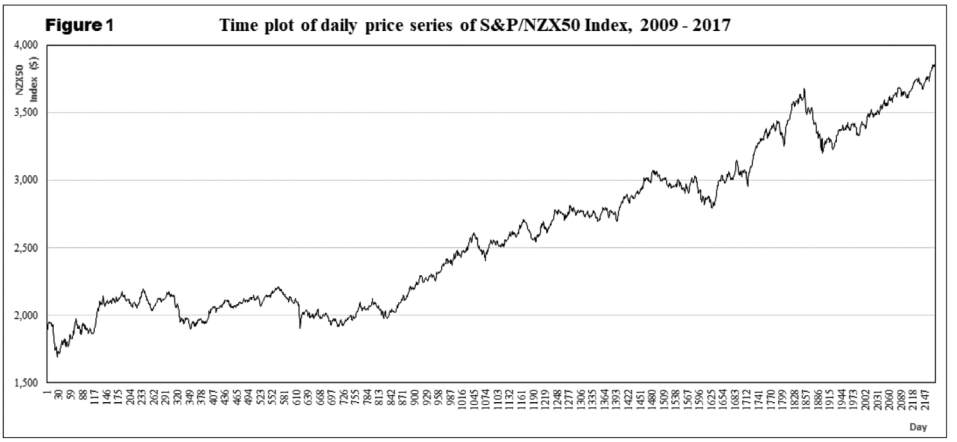
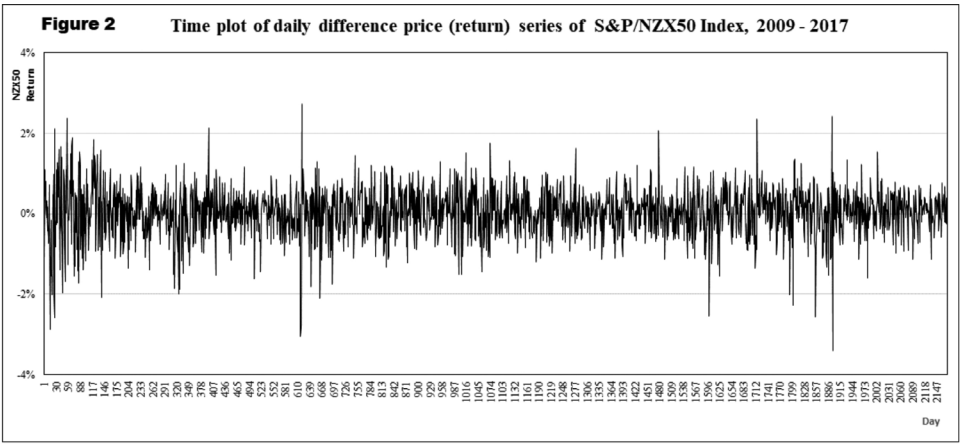


Figure 2 shows the time plot of the differenced S&P/NZX50 Index confirming the differenced series is stationary both in its mean and variance.



5. RESULTS

5.1 Tests for Stationarity

From a robustness perspective, two formal tests for stationarity are carried out. They are Augmented Dickey-Fuller (ADF) (Dickey and Fuller 1979, 1981) Phillips-Perron [Perron, 1987; Phillips & Perron (1988)] unit root tests. The Akaike Information Criteria (AIC) (Faraway & Chatfield 1998; Kihoro et al. 2004), is carried out to determine the optimum number of lags for ADF and Phillips-Perron tests. Both stationarity test results for S&P/NZX50 Index confirm that the price series is non-stationary at levels; however, the first difference of the price series (return) is stationary based on MacKinnon (1996) one-sided p-values at the 1% significance level (detailed results are available on request). These results confirm that the S&P/NZX50 Index is integrated of order 1. Also, the ADF and Phillips-Perron tests reinforce each other.

5.2 Comparison of Holt Winter's Exponential Smoothing (HWES) models

To determine the correct HWES model to forecast the S&P/NZX50 Index, the "HoltWinters()" function in R software is used. Technically HWES could have three components namely alpha (the smoothed level), beta (the smoothed time trend), and gamma (the smoothed seasonal component). Due to the non-trading days present in the index, the number of trading days per week (or month) is not going to be equal. If the seasonal smoother (gamma) is included when performing HWES in R software, the time series object it is applied to must have the frequency stated (with the frequency being at least 2). Due to the unequal numbers of trading days, we are unable to declare the frequency with accuracy and instead state a frequency of 1. To run the HWES, the seasonal smoothing component was omitted (leaving just the level and time trend). When the graphs of the data are examined carefully, we could not find a strong seasonal component which enables us to justify the decision of excluding the seasonal component. HWES was performed on the undifferenced NZX50 time series incorporating alpha and beta but excluding gamma (Model 1). HWES without beta or gamma was also performed on the differenced NZX50 time series. Each model was tested by comparing 1-ahead forecasts with the corresponding test data observations.

The performance comparisons of the tested HWES models are presented in Table 1.

Table 1

Table 1 Robustness evaluation of HWES models on S&P/NZX50 Index			
HWES Model	RMSE	MAE	MAPE
Model 1: HWES (alpha, beta) on NZX50 Index	18.4089	13.6894	0.0041781
Model 2: HWES (alpha) on difference of NZX50 Index	18.4091	13.6905	0.0041784

RMSE, MAE, and MAPE are used as performance evaluation criteria. Prediction performance results of model 1 [HWES (alpha, beta) on the NZX50 Index] shows its superiority over Model 2 tested [HWES (alpha) on the difference of NZX50 Index]. From an empirical perspective, the structure of model 1 makes more sense than the other model tested. Both models 1 and 2 refitted for each test predicted.

To determine the robustness of the investigation, we also evaluate how both HWES models perform over time. Approximately 70% of each year's data are used to train the models and the rest is used for prediction purposes. We apply the same performance evaluation criteria and the results are presented in Table 2.

Table 2

Table 2 Robustness evaluation of the tested HWES models on NZX50 Index over time										
Model 1: HWES (alpha, beta) on NZX50 Index										
	2009	2010	2011	2012	2013	2014	2015	2016	2017	**Average**
RMSE	12.2766	10.1173	12.8739	11.5958	13.4242	13.3414	15.3209	24.7211	13.3088	14.10890
MAE	10.1207	8.0740	10.1788	9.4989	10.6626	10.4930	12.8699	17.5289	10.3177	11.08272
MAPE	0.0048	0.0039	0.0051	0.0042	0.0041	0.0037	0.0044	0.0053	0.0028	0.00425
Model 2: HWES (alpha, beta) on NZX50 Index										
	2009	2010	2011	2012	2013	2014	2015	2016	2017	**Average**
RMSE	12.2753	10.0600	12.8741	11.5957	13.4129	13.3415	15.3108	24.8717	13.3079	14.11666
MAE	10.1192	8.1021	10.1795	9.4988	10.6452	10.4932	12.8576	17.6392	10.3110	11.09396
MAPE	0.0048	0.0039	0.0051	0.0042	0.0041	0.0037	0.0043	0.0053	0.0028	0.00426

Table two shows the annual performance evaluation statistics of the two HWES models. Although mixed results are observable when the two models are evaluated over time, the average of the annual results suggests the predictive superiority of the model 1 [HWES (alpha, beta) on NZX50 Index] over model 2 [HWES (alpha) on the difference of NZX50 Index] justifying our original finding.

5.3 Forecast based on the best HWES Model

The model 1 [HWES (alpha, beta) on NZX50 Index], which is adjudged as the superior model, is used for prediction purposes. From a total number of 2,173 observations, 1,500 are used to train the model and the remainder is used for prediction purposes. Predictions are made for the period 30/03/2015 to 29/12/2017, a total of 672. The actual S&P/NZX50 Index values, the predicted values, and the associated residuals are presented in Table 3.

Table 3

Table 3 Model 1: HWES (alpha, beta) on NZX50 Index Actual vs Prediction											
Observation	Actual (test)	Predicted	Residual	Observation	Actual (test)	Predicted	Residual	Observation	Actual (test)	Predicted	Residual
30/03/2015	2992.54	3009.61	-17.07	7/05/2015	2942.52	2959.01	-16.49	16/06/2015	2961.91	2964.2	-2.29
31/03/2015	2996.81	2991.59	5.22	8/05/2015	2944.8	2941.97	2.83	17/06/2015	2942.24	2962.86	-20.62
1/04/2015	2997.63	2997.96	-0.33	11/05/2015	2951.27	2943.4	7.87	18/06/2015	2927.19	2941.01	-13.82
2/04/2015	2995.48	2997.92	-2.44	12/05/2015	2950.39	2951.95	-1.56	19/06/2015	2943.51	2927.51	16.00
7/04/2015	3007.83	2996.67	11.16	13/05/2015	2952.01	2950.75	1.26	22/06/2015	2938.56	2941.48	-2.92
8/04/2015	3009.47	3009.06	0.41	14/05/2015	2944.84	2950.99	-6.15	23/06/2015	2938.61	2936.66	1.95
9/04/2015	3003.03	3010.78	-7.75	15/05/2015	2956.12	2945.28	10.84	24/06/2015	2940.31	2938.08	2.23
10/04/2015	3003.13	3003.99	-0.86	18/05/2015	2961.87	2955.11	6.76	25/06/2015	2918.83	2938.91	-20.08
13/04/2015	3006.7	3004.35	2.35	19/05/2015	2953.9	2962.35	-8.45	26/06/2015	2930.11	2919.53	10.58
14/04/2015	3020.98	3007.92	13.06	20/05/2015	2951.41	2953.5	-2.09	29/06/2015	2904.84	2930.6	-25.76
15/04/2015	3007.61	3022.02	-14.41	21/05/2015	2958.32	2950.11	8.21	30/06/2015	2915.61	2905.41	10.20
16/04/2015	3020.79	3008.05	12.74	22/05/2015	2959.95	2958.33	1.62	1/07/2015	2949.92	2915.6	34.32
17/04/2015	3010.38	3021.87	-11.49	26/05/2015	2970.12	2959.23	10.89	2/07/2015	2973.9	2949.54	24.36
20/04/2015	2991.27	3010.82	-19.55	27/05/2015	2950.03	2970.6	-20.57	6/07/2015	2940.89	2974.28	-33.39
21/04/2015	2987.8	2988.84	-1.04	28/05/2015	2960.12	2948.8	11.32	7/07/2015	2954.41	2940.05	14.36
22/04/2015	2975.53	2985.85	-10.32	29/05/2015	2994.61	2960.6	34.01	8/07/2015	2935.6	2954.13	-18.53
23/04/2015	2957.19	2976.52	-19.33	2/06/2015	3003.27	2995.23	8.04	9/07/2015	2920.2	2934.49	-14.29
24/04/2015	2961.01	2953.95	7.06	3/06/2015	2996.36	3004.61	-8.25	10/07/2015	2914.04	2918.03	-3.99
28/04/2015	2963.22	2958.28	4.94	4/06/2015	2999.8	2997.04	2.76	13/07/2015	2904.55	2913.57	-9.02
29/04/2015	2948.41	2960.3	-11.89	5/06/2015	3001.06	3002.06	-1.00	14/07/2015	2927.04	2902.95	24.09
30/04/2015	2974.36	2948.66	25.70	9/06/2015	2989.85	3001.88	-12.03	15/07/2015	2955.07	2926.37	28.70
1/05/2015	2977.47	2975.37	2.10	10/06/2015	2956.78	2990.36	-33.58	16/07/2015	2964.1	2955.79	8.31
4/05/2015	2961.9	2977.23	-15.33	11/06/2015	2984.57	2956	28.57	17/07/2015	2979.17	2964.27	14.90
5/05/2015	2972.53	2959.6	12.93	12/06/2015	2978.74	2984.93	-6.19	20/07/2015	2983.32	2980.02	3.30
6/05/2015	2960.97	2971.32	-10.35	15/06/2015	2964.98	2978.75	-13.77	21/07/2015	2990.95	2985.16	5.79
22/07/2015	3016.82	2991.61	25.21	26/08/2015	2838.21	2852.52	-14.31	1/10/2015	2793.15	2796.91	-3.76
23/07/2015	3003.36	3018.04	-14.68	27/08/2015	2867.3	2833.9	33.40	2/10/2015	2797.19	2790.01	7.18
24/07/2015	2999.74	3004.18	-4.44	28/08/2015	2885.38	2867.85	17.53	5/10/2015	2815.71	2793.68	22.03
27/07/2015	2988.48	3000.49	-12.01	31/08/2015	2872.65	2885.47	-12.82	6/10/2015	2833.8	2812.93	20.87
28/07/2015	2976.43	2989.48	-13.05	1/09/2015	2872.01	2870.67	1.34	7/10/2015	2824.76	2832.93	-8.17
29/07/2015	2987.82	2976.74	11.08	2/09/2015	2836.56	2870.13	-33.57	8/10/2015	2812.64	2822.71	-10.07
30/07/2015	2998.55	2989.2	9.35	3/09/2015	2826.15	2834.43	-8.28	9/10/2015	2819.14	2810.98	8.16
31/07/2015	3013.36	3000.02	13.34	4/09/2015	2814.58	2821.77	-7.19	12/10/2015	2844.66	2817.7	26.96
3/08/2015	3032.14	3016.46	15.68	8/09/2015	2844.69	2814.52	30.17	13/10/2015	2851.15	2843.51	7.64
4/08/2015	3019.88	3035.53	-15.65	9/09/2015	2871.63	2844.49	27.14	14/10/2015	2863.31	2850.21	13.10

Table 3 continued

Table 3 *Continue* Model 1: HWES (alpha, beta) on NZX50 Index Actual vs Prediction											
Observation	**Actual (test)**	**Predicted**	**Residual**	**Observation**	**Actual (test)**	**Predicted**	**Residual**	**Observation**	**Actual (test)**	**Predicted**	**Residual**
5/08/2015	3022.3	3022.38	-0.08	10/09/2015	2868.22	2870.81	-2.59	15/10/2015	2887.59	2864.26	23.33
6/08/2015	3017.3	3024.32	-7.02	11/09/2015	2856.71	2868.34	-11.63	16/10/2015	2909.74	2887.71	22.03
7/08/2015	2986.75	3019.02	-32.27	14/09/2015	2865.64	2857.13	8.51	19/10/2015	2917.15	2915.6	1.55
10/08/2015	2984.9	2987.12	-2.22	15/09/2015	2858.65	2864.53	-5.88	20/10/2015	2947.48	2917.44	30.04
11/08/2015	2963.18	2985.21	-22.03	16/09/2015	2861.37	2857.12	4.25	21/10/2015	2958.86	2947.97	10.89
12/08/2015	2930.03	2963.7	-33.67	17/09/2015	2874.63	2859.39	15.24	22/10/2015	2961.53	2962.08	-0.55
13/08/2015	2920.1	2927.51	-7.41	18/09/2015	2883.62	2874.26	9.36	23/10/2015	2985.06	2963.12	21.94
14/08/2015	2899.1	2919.41	-20.31	21/09/2015	2869.22	2882.86	-13.64	27/10/2015	3000.24	2989.91	10.33
17/08/2015	2914.87	2898.01	16.86	22/09/2015	2875.92	2868.09	7.83	28/10/2015	2999.22	3001.88	-2.66
18/08/2015	2906.39	2911.34	-4.95	23/09/2015	2839.8	2874.73	-34.93	29/10/2015	3001.22	3000.45	0.77
19/08/2015	2927.01	2905.89	21.12	24/09/2015	2849.65	2837.86	11.79	30/10/2015	2992.92	3002.97	-10.05
20/08/2015	2922.52	2926.08	-3.56	25/09/2015	2854.94	2847.53	7.41	2/11/2015	2991.65	2997.09	-5.44
21/08/2015	2926.45	2921.6	4.85	28/09/2015	2856.54	2853.18	3.36	3/11/2015	3010.72	2993.99	16.73
24/08/2015	2853.24	2926.43	-73.19	29/09/2015	2812.74	2855.05	-42.31	4/11/2015	3035.33	3012.37	22.96
25/08/2015	2856.28	2847.42	8.86	30/09/2015	2797.12	2809.57	-12.45	5/11/2015	3036.19	3036.86	-0.67
6/11/2015	3033.38	3039.11	-5.73	14/12/2015	3003.41	3021.45	-18.04	25/01/2016	3072.29	3046.51	25.78
9/11/2015	3022.46	3034.4	-11.94	15/12/2015	3006.04	3004.3	1.74	27/01/2016	3055.72	3073.61	-17.89
10/11/2015	2999.93	3023.53	-23.60	16/12/2015	3021.16	3006.74	14.42	28/01/2016	3059.58	3056.54	3.04
11/11/2015	3003.74	3000.7	3.04	17/12/2015	3029.82	3022.45	7.37	29/01/2016	3069.79	3060.66	9.13
12/11/2015	3008.6	3004.83	3.77	18/12/2015	3039.53	3030.62	8.91	1/02/2016	3071.92	3071.07	0.85
13/11/2015	2991.15	3009.76	-18.61	21/12/2015	3045.99	3041.12	4.87	2/02/2016	3074.7	3073.03	1.67
16/11/2015	2977.49	2991.96	-14.47	22/12/2015	3059.5	3047.15	12.35	3/02/2016	3051.46	3075.63	-24.17
17/11/2015	2980.45	2978.99	1.46	23/12/2015	3083.07	3062.22	20.85	4/02/2016	3053.61	3052.25	1.36
18/11/2015	2985.06	2981.62	3.44	24/12/2015	3098.1	3086.79	11.31	5/02/2016	3061.62	3054.4	7.22
19/11/2015	2992.77	2986.77	6.00	29/12/2015	3131.39	3100.77	30.62	9/02/2016	3020.58	3062.35	-41.77
20/11/2015	2999.4	2993.49	5.91	30/12/2015	3144.8	3134.42	10.38	10/02/2016	2994.8	3020.53	-25.73
23/11/2015	3033.89	3000.11	33.78	31/12/2015	3147.23	3149.39	-2.16	11/02/2016	2978.65	2995.51	-16.86
24/11/2015	3045.7	3035.5	10.20	5/01/2016	3124.26	3149.89	-25.63	12/02/2016	2952.25	2979.04	-26.79
25/11/2015	3027.54	3046.68	-19.14	6/01/2016	3116.28	3125.87	-9.59	16/02/2016	3022.6	2951.98	70.62
27/11/2015	3043.44	3029.48	13.96	7/01/2016	3091.83	3119.42	-27.59	17/02/2016	3027.67	3023.01	4.66
30/11/2015	3043.01	3045.9	-2.89	8/01/2016	3064.32	3094.41	-30.09	18/02/2016	3040.37	3028.37	12.00
1/12/2015	3064.57	3044.65	19.92	11/01/2016	3036.81	3065.84	-29.03	19/02/2016	3055.61	3041.02	14.59
2/12/2015	3059.35	3068.16	-8.81	12/01/2016	3041.55	3037.59	3.96	22/02/2016	3054.49	3056.48	-1.99
3/12/2015	3050.56	3060.45	-9.89	13/01/2016	3061.22	3042.38	18.84	23/02/2016	3072.5	3055.24	17.26
4/12/2015	3035.2	3053.33	-18.13	14/01/2016	3040.03	3062.57	-22.54	24/02/2016	3099.72	3073.91	25.81

Table 3 continued

Table 3 *Continue* Model 1: HWES (alpha, beta) on NZX50 Index Actual vs Prediction											
Observation	**Actual (test)**	**Predicted**	**Residual**	**Observation**	**Actual (test)**	**Predicted**	**Residual**	**Observation**	**Actual (test)**	**Predicted**	**Residual**
7/12/2015	3020.06	3037.61	-17.55	15/01/2016	3069.79	3040.88	28.91	25/02/2016	3096.79	3101.62	-4.83
8/12/2015	3005.41	3021.12	-15.71	19/01/2016	3046.9	3070.7	-23.80	26/02/2016	3096.65	3098.42	-1.77
9/12/2015	3012.51	3006.33	6.18	20/01/2016	3041.68	3047.7	-6.02	29/02/2016	3096.11	3097.85	-1.74
10/12/2015	3006.05	3013.36	-7.31	21/01/2016	3025.35	3042.49	-17.14	1/03/2016	3119.65	3098.23	21.42
11/12/2015	3020.67	3007.09	13.58	22/01/2016	3045.61	3025.91	19.70	2/03/2016	3132.93	3120.74	12.19
3/03/2016	3166.57	3136.28	30.29	11/04/2016	3295.29	3301.13	-5.84	17/05/2016	3415.36	3387.92	27.44
4/03/2016	3185.06	3171.3	13.76	12/04/2016	3295.74	3298.75	-3.01	18/05/2016	3419.17	3416.47	2.70
7/03/2016	3185.46	3186.5	-1.04	13/04/2016	3321.17	3299.58	21.59	19/05/2016	3380.48	3420.15	-39.67
8/03/2016	3198.93	3189.31	9.62	14/04/2016	3343.66	3324.55	19.11	20/05/2016	3383.53	3383.67	-0.14
9/03/2016	3202.4	3200.42	1.98	15/04/2016	3353.91	3348.11	5.80	23/05/2016	3382.51	3386.01	-3.50
10/03/2016	3217.93	3204.81	13.12	18/04/2016	3357.08	3357.39	-0.31	24/05/2016	3365.31	3385.62	-20.31
11/03/2016	3221.46	3224.8	-3.34	19/04/2016	3367.78	3361.98	5.80	25/05/2016	3382.06	3367.69	14.37
14/03/2016	3246.88	3222.76	24.12	20/04/2016	3381.61	3372.5	9.11	26/05/2016	3397.82	3383.65	14.17
15/03/2016	3251.45	3250.76	0.69	21/04/2016	3383.98	3384.87	-0.89	27/05/2016	3419.21	3400.05	19.16
16/03/2016	3243.12	3257.34	-14.22	22/04/2016	3364.38	3389.7	-25.32	31/05/2016	3440.32	3421.25	19.07
17/03/2016	3237.63	3245.26	-7.63	26/04/2016	3329.89	3367.68	-37.79	1/06/2016	3429.82	3442.17	-12.35
18/03/2016	3262.28	3240.85	21.43	27/04/2016	3307.69	3331.67	-23.98	2/06/2016	3420.2	3431.24	-11.04
21/03/2016	3269.99	3266.01	3.98	28/04/2016	3327.08	3310.46	16.62	3/06/2016	3430.58	3423.24	7.34
22/03/2016	3280.98	3271.09	9.89	29/04/2016	3342.08	3328.86	13.22	7/06/2016	3436.89	3432.33	4.56
23/03/2016	3274.19	3285.94	-11.75	2/05/2016	3327.98	3343.97	-15.99	8/06/2016	3413.78	3440.59	-26.81
24/03/2016	3271.09	3277.64	-6.55	3/05/2016	3353.07	3331.12	21.95	9/06/2016	3400.46	3415.21	-14.75
29/03/2016	3277.86	3275.44	2.42	4/05/2016	3343.99	3354.97	-10.98	10/06/2016	3401.06	3402.19	-1.13
30/03/2016	3292.95	3279.36	13.59	5/05/2016	3369.47	3345.58	23.89	14/06/2016	3333.35	3403.71	-70.36
31/03/2016	3310.02	3299.14	10.88	6/05/2016	3380.06	3373.44	6.62	15/06/2016	3350.23	3334.55	15.68
1/04/2016	3287.81	3311.6	-23.79	9/05/2016	3372.89	3383.99	-11.10	16/06/2016	3356.92	3351.54	5.38
4/04/2016	3305.25	3289.72	15.53	10/05/2016	3384.82	3376.58	8.24	17/06/2016	3336.7	3358.39	-21.69
5/04/2016	3291.63	3308.48	-16.85	11/05/2016	3401.59	3386.22	15.37	20/06/2016	3347.65	3338.25	9.40
6/04/2016	3300.68	3295.72	4.96	12/05/2016	3390.05	3404.12	-14.07	21/06/2016	3332.96	3347.78	-14.82
7/04/2016	3310.05	3304.29	5.76	13/05/2016	3386.82	3393.25	-6.43	22/06/2016	3304.86	3334.23	-29.37
8/04/2016	3297.83	3311.86	-14.03	16/05/2016	3385.62	3389.41	-3.79	23/06/2016	3324.17	3306.06	18.11
24/06/2016	3249.33	3323.73	-74.40	1/08/2016	3583.9	3588.47	-4.57	6/09/2016	3646.47	3615.59	30.88
27/06/2016	3258.66	3249.67	8.99	2/08/2016	3570.53	3587.14	-16.61	7/09/2016	3677.5	3650.24	27.26
28/06/2016	3273.11	3258.96	14.15	3/08/2016	3545.3	3575.3	-30.00	8/09/2016	3652.94	3681.2	-28.26
29/06/2016	3315.81	3272.68	43.13	4/08/2016	3555.38	3548.7	6.68	9/09/2016	3620.88	3657.01	-36.13
30/06/2016	3361.29	3316.78	44.51	5/08/2016	3560.41	3558.03	2.38	12/09/2016	3528.9	3624.13	-95.23
1/07/2016	3375.28	3363.13	12.15	8/08/2016	3579.84	3565.16	14.68	13/09/2016	3511.15	3530.88	-19.73
5/07/2016	3397.09	3377.28	19.81	9/08/2016	3587.08	3582.42	4.66	14/09/2016	3491.91	3512.87	-20.96
6/07/2016	3400.13	3398.21	1.92	10/08/2016	3580.48	3589.91	-9.43	15/09/2016	3483.36	3492.53	-9.17
7/07/2016	3414.64	3401.64	13.00	11/08/2016	3582.53	3585.6	-3.07	16/09/2016	3509.63	3481.79	27.84

Table 3 continued

Table 3 *Continue* Model 1: HWES (alpha, beta) on NZX50 Index Actual vs Prediction											
Observation	**Actual (test)**	**Predicted**	**Residual**	**Observation**	**Actual (test)**	**Predicted**	**Residual**	**Observation**	**Actual (test)**	**Predicted**	**Residual**
8/07/2016	3411.03	3416.72	-5.69	12/08/2016	3587.05	3585.99	1.06	19/09/2016	3522.99	3510.43	12.56
11/07/2016	3441.41	3413.45	27.96	15/08/2016	3599.35	3588.49	10.86	20/09/2016	3537.67	3523.39	14.28
12/07/2016	3449.7	3446.04	3.66	16/08/2016	3561.51	3604.46	-42.95	21/09/2016	3524.47	3538.06	-13.59
13/07/2016	3442.32	3453.37	-11.05	17/08/2016	3583.11	3563.42	19.69	22/09/2016	3520.78	3526.34	-5.56
14/07/2016	3449.29	3447.04	2.25	18/08/2016	3597.78	3586.92	10.86	23/09/2016	3513.57	3521.05	-7.48
15/07/2016	3445.67	3451.92	-6.25	19/08/2016	3607.59	3601.95	5.64	26/09/2016	3498.22	3514.97	-16.75
18/07/2016	3461.78	3447.59	14.19	22/08/2016	3634.97	3609.19	25.78	27/09/2016	3492.47	3497.81	-5.34
19/07/2016	3485.59	3464.63	20.96	23/08/2016	3637.49	3639.58	-2.09	28/09/2016	3506.94	3493.35	13.59
20/07/2016	3494.28	3490.72	3.56	24/08/2016	3609.71	3641.85	-32.14	29/09/2016	3525.23	3508.17	17.06
21/07/2016	3514.44	3496.7	17.74	25/08/2016	3617.98	3611.39	6.59	30/09/2016	3533.7	3526.91	6.79
22/07/2016	3520.29	3518.75	1.54	26/08/2016	3600.21	3620.8	-20.59	3/10/2016	3539.17	3534.74	4.43
25/07/2016	3564.74	3524.55	40.19	29/08/2016	3588.5	3603.7	-15.20	4/10/2016	3529.56	3541.02	-11.46
26/07/2016	3561.37	3571.41	-10.04	30/08/2016	3598.58	3591.41	7.17	5/10/2016	3490.53	3531.33	-40.80
27/07/2016	3557.24	3565.33	-8.09	31/08/2016	3603.39	3601.92	1.47	6/10/2016	3455.07	3491.35	-36.28
28/07/2016	3559.4	3565.75	-6.35	1/09/2016	3611.98	3606.76	5.22	7/10/2016	3440.92	3456.33	-15.41
29/07/2016	3579.76	3561.25	18.51	2/09/2016	3613.4	3615.22	-1.82	10/10/2016	3416.49	3442.01	-25.52
11/10/2016	3420	3416.84	3.16	16/11/2016	3272.8	3243.21	29.59	22/12/2016	3273.33	3249.82	23.51
12/10/2016	3411.94	3420.27	-8.33	17/11/2016	3268.04	3272.52	-4.48	23/12/2016	3285.33	3271.77	13.56
13/10/2016	3417.99	3412.14	5.85	18/11/2016	3288.76	3268.64	20.12	28/12/2016	3284.75	3283.85	0.90
14/10/2016	3424.33	3414.26	10.07	21/11/2016	3284.49	3286.52	-2.03	29/12/2016	3292.63	3283.32	9.31
17/10/2016	3392.22	3425.04	-32.82	22/11/2016	3268.88	3285.06	-16.18	30/12/2016	3287.35	3292.9	-5.55
18/10/2016	3347.44	3392.53	-45.09	23/11/2016	3285.09	3265.92	19.17	4/01/2017	3331.82	3287.45	44.37
19/10/2016	3349.09	3343.87	5.22	25/11/2016	3304.38	3285.84	18.54	5/01/2017	3332.03	3331.7	0.33
20/10/2016	3347.77	3348.17	-0.40	28/11/2016	3305.98	3303.94	2.04	6/01/2017	3329.38	3331.67	-2.29
21/10/2016	3340.39	3346.56	-6.17	29/11/2016	3305.4	3304.22	1.18	9/01/2017	3349.48	3329.76	19.72
25/10/2016	3361.73	3334.56	27.17	30/11/2016	3302.26	3303.28	-1.02	10/01/2017	3361.35	3350	11.35
26/10/2016	3310.53	3359.77	-49.24	1/12/2016	3317.32	3301.68	15.64	11/01/2017	3376.64	3361.8	14.84
27/10/2016	3332.49	3309.86	22.63	2/12/2016	3303.68	3316.19	-12.51	12/01/2017	3373.49	3377.2	-3.71
28/10/2016	3333.14	3328.95	4.19	5/12/2016	3277.82	3302.66	-24.84	13/01/2017	3365.55	3374.01	-8.46
31/10/2016	3341.48	3331.6	9.88	6/12/2016	3301.89	3275.05	26.84	17/01/2017	3373.19	3366.23	6.96
1/11/2016	3326.99	3340.23	-13.24	7/12/2016	3292.05	3300.63	-8.58	18/01/2017	3371.43	3373.97	-2.54
2/11/2016	3289.68	3322.5	-32.82	8/12/2016	3303.97	3290.94	13.03	19/01/2017	3372.9	3371.88	1.02
3/11/2016	3253.77	3290.47	-36.70	9/12/2016	3293.12	3303.01	-9.89	20/01/2017	3366.27	3373.71	-7.44
4/11/2016	3219.95	3248.68	-28.73	12/12/2016	3284.87	3293.78	-8.91	23/01/2017	3375.52	3366.81	8.71
7/11/2016	3298.57	3219.02	79.55	13/12/2016	3272.53	3285.25	-12.72	24/01/2017	3373.76	3375.99	-2.23
8/11/2016	3309.17	3294.59	14.58	14/12/2016	3247.53	3273.86	-26.33	25/01/2017	3386.54	3374.05	12.49
9/11/2016	3198.71	3304.84	-106.13	15/12/2016	3224	3247.56	-23.56	27/01/2017	3407.24	3388.66	18.58
10/11/2016	3232.07	3192.23	39.84	16/12/2016	3229.56	3224.62	4.94	30/01/2017	3383.98	3407.95	-23.97
11/11/2016	3213.92	3229.72	-15.80	19/12/2016	3241.98	3225.94	16.04	31/01/2017	3367.36	3384.38	-17.02

Table 3 continued

Table 3 *Continue* Model 1: HWES (alpha, beta) on NZX50 Index Actual vs Prediction											
Observation	**Actual (test)**	**Predicted**	**Residual**	**Observation**	**Actual (test)**	**Predicted**	**Residual**	**Observation**	**Actual (test)**	**Predicted**	**Residual**
14/11/2016	3231.17	3211.4	19.77	20/12/2016	3243.61	3241.28	2.33	1/02/2017	3369.63	3368.13	1.50
15/11/2016	3246.83	3227.08	19.75	21/12/2016	3249.86	3243.11	6.75	2/02/2017	3368.69	3370.98	-2.29
3/02/2017	3388.2	3368.97	19.23	14/03/2017	3409.22	3420.32	-11.10	20/04/2017	3383.74	3398.47	-14.73
7/02/2017	3375.14	3388.72	-13.58	15/03/2017	3386.57	3409.8	-23.23	21/04/2017	3388.05	3384.22	3.83
8/02/2017	3374.77	3375.79	-1.02	16/03/2017	3385.74	3387.2	-1.46	24/04/2017	3400.16	3388.58	11.58
9/02/2017	3401.21	3375.24	25.97	17/03/2017	3388.66	3386.43	2.23	26/04/2017	3452.98	3400.53	52.45
10/02/2017	3393	3402	-9.00	20/03/2017	3335.37	3389.59	-54.22	27/04/2017	3462.15	3454.45	7.70
13/02/2017	3407.83	3393.86	13.97	21/03/2017	3348.84	3333.29	15.55	28/04/2017	3473.51	3466.25	7.26
14/02/2017	3412.69	3408.73	3.96	22/03/2017	3337.16	3349.3	-12.14	1/05/2017	3475.14	3474.54	0.60
15/02/2017	3426.59	3413.4	13.19	23/03/2017	3331.38	3336.05	-4.67	2/05/2017	3494.1	3476.15	17.95
16/02/2017	3388.39	3427.48	-39.09	24/03/2017	3336.7	3332.72	3.98	3/05/2017	3486.26	3495.21	-8.95
17/02/2017	3385.31	3388.78	-3.47	27/03/2017	3331.46	3336.77	-5.31	4/05/2017	3473.35	3487.33	-13.98
21/02/2017	3395.89	3385.66	10.23	28/03/2017	3332.64	3330.85	1.79	5/05/2017	3467.27	3474.78	-7.51
22/02/2017	3370.49	3396.47	-25.98	29/03/2017	3362.35	3333.34	29.01	8/05/2017	3495.19	3468.5	26.69
23/02/2017	3383.4	3370.63	12.77	30/03/2017	3376.38	3362.77	13.61	9/05/2017	3488.44	3497.04	-8.60
24/02/2017	3368.24	3384.21	-15.97	31/03/2017	3388.9	3376.68	12.22	10/05/2017	3494.12	3490.56	3.56
27/02/2017	3374.71	3368.46	6.25	3/04/2017	3402.2	3389.97	12.23	11/05/2017	3524.96	3495.39	29.57
28/02/2017	3416.79	3375.35	41.44	4/04/2017	3410.33	3402.7	7.63	12/05/2017	3507.39	3526.79	-19.40
1/03/2017	3407.28	3417.61	-10.33	5/04/2017	3419.99	3410.89	9.10	15/05/2017	3496.83	3509.15	-12.32
2/03/2017	3417.35	3407.94	9.41	6/04/2017	3431.51	3420.99	10.52	16/05/2017	3486.32	3497.99	-11.67
3/03/2017	3410.22	3418.47	-8.25	7/04/2017	3409.96	3432.4	-22.44	17/05/2017	3492.99	3488.17	4.82
6/03/2017	3418.73	3411.27	7.46	10/04/2017	3407.66	3410.71	-3.05	18/05/2017	3467.96	3494.86	-26.90
7/03/2017	3413.45	3419.46	-6.01	11/04/2017	3414.96	3408.4	6.56	19/05/2017	3477.53	3469.05	8.48
8/03/2017	3417	3414.12	2.88	12/04/2017	3413.63	3415.7	-2.07	22/05/2017	3485.71	3478.91	6.80
9/03/2017	3394.4	3417.68	-23.28	13/04/2017	3403.39	3414.66	-11.27	23/05/2017	3474.05	3486.87	-12.82
10/03/2017	3411.25	3395.05	16.20	18/04/2017	3405.18	3403.97	1.21	24/05/2017	3490.89	3475	15.89
13/03/2017	3419.24	3411.98	7.26	19/04/2017	3398.08	3406.17	-8.09	25/05/2017	3492.98	3491.95	1.03
26/05/2017	3496.31	3494.54	1.77	6/07/2017	3571.44	3557.71	13.73	10/08/2017	3645.51	3652.23	-6.72
30/05/2017	3482.4	3497.5	-15.10	7/07/2017	3567.94	3573.66	-5.72	11/08/2017	3612.47	3648.03	-35.56
31/05/2017	3485.66	3483.43	2.23	10/07/2017	3550.07	3569.13	-19.06	14/08/2017	3632.51	3614.18	18.33
1/06/2017	3498.05	3486.51	11.54	11/07/2017	3570.96	3550.98	19.98	15/08/2017	3656.76	3633.29	23.47
2/06/2017	3521.09	3499.7	21.39	12/07/2017	3551.04	3572.15	-21.11	16/08/2017	3675.29	3658.1	17.19
6/06/2017	3516.89	3522.65	-5.76	13/07/2017	3561.83	3552.2	9.63	17/08/2017	3683.11	3678.19	4.92
7/06/2017	3503.02	3518.39	-15.37	14/07/2017	3580.02	3563.43	16.59	18/08/2017	3684.74	3686.42	-1.68
8/06/2017	3495.98	3504.05	-8.07	17/07/2017	3603.32	3581.5	21.82	21/08/2017	3682.05	3687.19	-5.14
9/06/2017	3485.4	3497.16	-11.76	18/07/2017	3606.96	3606.56	0.40	22/08/2017	3681.39	3683.5	-2.11
13/06/2017	3486.72	3486.3	0.42	19/07/2017	3618.85	3609.41	9.44	23/08/2017	3687.18	3683.38	3.80
14/06/2017	3506.77	3487.64	19.13	20/07/2017	3590.63	3620.36	-29.73	24/08/2017	3682.01	3688.95	-6.94
15/06/2017	3519.23	3508.32	10.91	21/07/2017	3589.89	3591.93	-2.04	25/08/2017	3677.05	3683.36	-6.31

Table 3 continued

Table 3 *Continue* Model 1: HWES (alpha, beta) on NZX50 Index Actual vs Prediction											
Observation	**Actual (test)**	**Predicted**	**Residual**	**Observation**	**Actual (test)**	**Predicted**	**Residual**	**Observation**	**Actual (test)**	**Predicted**	**Residual**
16/06/2017	3536.27	3520.07	16.20	24/07/2017	3595.24	3591.83	3.41	28/08/2017	3662.2	3678.81	-16.61
19/06/2017	3554.66	3537.46	17.20	25/07/2017	3609.64	3596.69	12.95	29/08/2017	3620.78	3664.38	-43.60
20/06/2017	3552.09	3556.98	-4.89	26/07/2017	3608.48	3611.35	-2.87	30/08/2017	3633.51	3622.03	11.48
21/06/2017	3524.26	3553.64	-29.38	27/07/2017	3609.01	3610.04	-1.03	31/08/2017	3649.94	3634.99	14.95
22/06/2017	3541.39	3525.34	16.05	28/07/2017	3575.22	3611.39	-36.17	1/09/2017	3652.06	3651.55	0.51
23/06/2017	3536.69	3542.53	-5.84	31/07/2017	3600.71	3576.37	24.34	5/09/2017	3629.2	3653.86	-24.66
26/06/2017	3556.28	3537.77	18.51	1/08/2017	3617.31	3602.14	15.17	6/09/2017	3633.08	3630.36	2.72
27/06/2017	3570.23	3558.13	12.10	2/08/2017	3626.14	3619.83	6.31	7/09/2017	3634.6	3634.56	0.04
28/06/2017	3569.36	3572.98	-3.62	3/08/2017	3628.68	3627.13	1.55	8/09/2017	3656.37	3635.65	20.72
29/06/2017	3597.89	3572.52	25.37	4/08/2017	3625.11	3631.09	-5.98	11/09/2017	3656.48	3657.78	-1.30
30/06/2017	3563.25	3601.11	-37.86	7/08/2017	3637.02	3626.2	10.82	12/09/2017	3651.2	3658.29	-7.09
3/07/2017	3552.48	3564.3	-11.82	8/08/2017	3642.24	3639.75	2.49	13/09/2017	3641.77	3652.53	-10.76
5/07/2017	3555.86	3554.06	1.80	9/08/2017	3650.16	3644.31	5.85	14/09/2017	3635.98	3643.15	-7.17
15/09/2017	3609.67	3637.36	-27.69	20/10/2017	3748.92	3748.09	0.83	28/11/2017	3746.72	3765.03	-18.31
18/09/2017	3607.84	3610.77	-2.93	24/10/2017	3749.18	3751.59	-2.41	29/11/2017	3745.85	3748.54	-2.69
19/09/2017	3610.54	3608.5	2.04	25/10/2017	3745.75	3750.72	-4.97	30/11/2017	3764.64	3747.61	17.03
20/09/2017	3635.6	3611.65	23.95	26/10/2017	3729.18	3747.52	-18.34	1/12/2017	3765.27	3766.54	-1.27
21/09/2017	3609.69	3636.89	-27.20	27/10/2017	3728.37	3731.28	-2.91	4/12/2017	3761.42	3766.14	-4.72
22/09/2017	3618.66	3610.68	7.98	30/10/2017	3755.58	3730.31	25.27	5/12/2017	3754.65	3763.61	-8.96
25/09/2017	3641.96	3619.03	22.93	31/10/2017	3756.66	3757.44	-0.78	6/12/2017	3733.25	3756.41	-23.16
26/09/2017	3650.02	3643.23	6.79	1/11/2017	3713.99	3758.6	-44.61	7/12/2017	3751.74	3734.54	17.20
27/09/2017	3662.33	3651.47	10.86	2/11/2017	3727.48	3715.59	11.89	8/12/2017	3780.42	3752.84	27.58
28/09/2017	3655.03	3663.68	-8.65	3/11/2017	3719.21	3729.26	-10.05	11/12/2017	3799.9	3782.54	17.36
29/09/2017	3662.77	3656.53	6.24	6/11/2017	3713.91	3720.55	-6.64	12/12/2017	3801.41	3803.18	-1.77
2/10/2017	3661.52	3663.93	-2.41	7/11/2017	3712.09	3715.21	-3.12	13/12/2017	3803.14	3803.61	-0.47
3/10/2017	3663.61	3663.07	0.54	8/11/2017	3707.82	3713.12	-5.30	14/12/2017	3821.13	3805.75	15.38
4/10/2017	3671.13	3665.17	5.96	9/11/2017	3698.44	3709.28	-10.84	15/12/2017	3838.16	3826.32	11.84
5/10/2017	3678.57	3672.79	5.78	10/11/2017	3675.94	3699.7	-23.76	18/12/2017	3830.49	3841.28	-10.79
6/10/2017	3678.73	3679.96	-1.23	13/11/2017	3674.92	3676.86	-1.94	19/12/2017	3856.68	3832.34	24.34
9/10/2017	3693.92	3681.55	12.37	14/11/2017	3689.47	3673.01	16.46	20/12/2017	3848.58	3859.46	-10.88
10/10/2017	3706.62	3697.74	8.88	15/11/2017	3685.75	3690.3	-4.55	21/12/2017	3839.81	3852.75	-12.94
11/10/2017	3717.3	3711.15	6.15	16/11/2017	3701.77	3686.31	15.46	22/12/2017	3854.49	3842.71	11.78
12/10/2017	3720.59	3722.32	-1.73	17/11/2017	3713.74	3703.05	10.69	27/12/2017	3845.31	3857.09	-11.78
13/10/2017	3730.37	3723.23	7.14	20/11/2017	3726.56	3715.07	11.49	28/12/2017	3860.05	3847.72	12.33
16/10/2017	3731.02	3731.99	-0.97	21/11/2017	3725.95	3727.97	-2.02	29/12/2017	3855.25	3862.75	-7.50
17/10/2017	3740.85	3734.23	6.62	22/11/2017	3733.55	3727.35	6.20				
18/10/2017	3742.22	3743.64	-1.42	24/11/2017	3742.96	3735.2	7.76				
19/10/2017	3746.4	3744.68	1.72	27/11/2017	3762.65	3744.32	18.33				

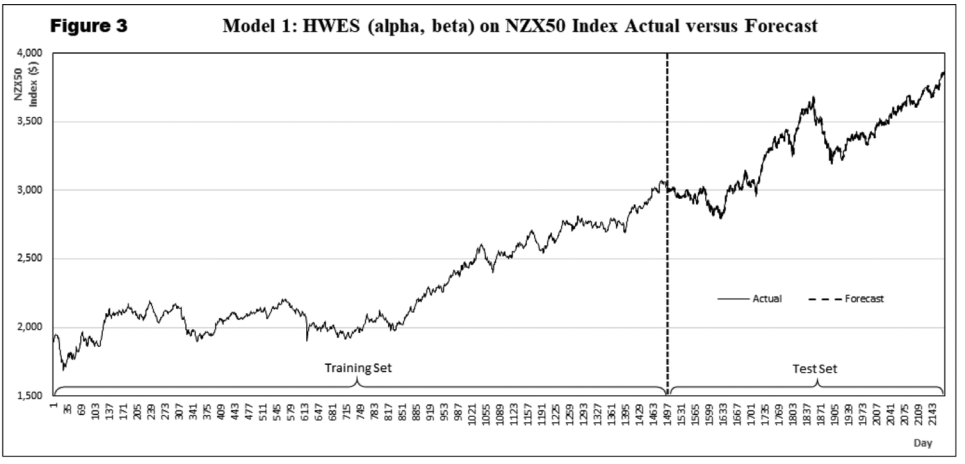
One sample hypothesis testing on the residuals are statistically insignificant and these results are presented in Table 4.

Table 4

Table 4 t-Test: One Sample	
	Residual
Mean	0.1760
Variance	339.3597
Observations	672
Hypothesized Mean	0
df	671
t Stat	0.2476
P(T<=t) one-tail	0.4022
t Critical one-tail	1.6471
P(T<=t) two-tail	0.8045
t Critical two-tail	1.9635

Predicted values generated from Model 1 and the actual S&P/NZX50 Index values are presented in the "Test Set" section of Figure 3. The "dashed-line" in Figure 3 shows the predicted values from Model 1 whilst the "solid-line" shows the actual values. The figure represents quite a strong forecasting accuracy of the S&P/NZX50 Index based on Model 1 [HWES (alpha, beta) on the NZX50 Index].

Figure 3



The predictive model 1 [HWES (alpha, beta) on NZX50 Index] suggests that, on average, S&P/NZX50 Index increases each day (much like a random walk with drift). Further, the change in index price is affected by the previous day's change. If the previous day's price change was positive (negative), this effect will be positive (negative) but smaller in magnitude than that change.

6. CONCLUSIONS

Taking a technical analysis perspective, this study employs the Holt-Winters Exponential Smoothing (HWES) methodology to predict the New Zealand stock market (S&P/NZX50) Index. Multiple performance evaluation measures, namely MAE, MAPE, and RMSE are used with AIC, ADF, and Phillips-Perron unit root tests. The results of the performance evaluation measures reinforce that model 1 [HWES (alpha, beta) on NZX50 Index] outperforms model 2 [HWES (alpha) on the difference of NZX50 Index].

Applying model 1 [HWES (alpha, beta) on NZX50 Index] for prediction purposes we find that the predictions are very accurate of forecasting the next lags of the S&P/NZX50 Index. We find that the S&P/NZX50 Index follows more or less a pattern of a random walk with drift. An increase (decrease) of the index would usually be followed by a marginally smaller impact [smaller increase (decrease)].

The HWES models evaluated in this paper were specifically trained to capture the smoothed level, trend, and seasonal components inherent with the NZX 50 index for the period of 2009 to 2015 (having 1,500 observations for training, 70%). The trained HWES models were then used to forecast the NZX 50 index from 2016 to 2017 (673 observations in total for prediction, 30%). The forecasting results of model 1 [HWES (alpha, beta) on the NZX50 Index] demonstrates its predictive efficiency and effectiveness.

The proposed model could be successfully implemented in forecasting other stock market time series or same index for different periods (windows) if effective and substantiate algorithm training is carried out. A potential future research endeavour could be to compare and contrast the predictive effectiveness of HWES with a deep-learning model such as long short term memory (LSTM) which has the calibre to remember and efficiently learn the long-term dependencies.

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Impact of Internal Migration on Poverty: Evidence from Bangladesh

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Abstract: Internal migration has a pivotal contribution to mitigate household income risk, particularly for those in lower socio-economic groups. This research applies the theory of New Economies of Labour Migration to analyse three years of household-level panel data collected by BRAC for evaluating the outcome of internal migration on household welfare. Welfare is analysed using three key outcome variables, namely household income, capability for asset building, and poverty gap. Remittances significantly enhance household-level welfare and vice versa. The study observes that migrant households earn higher, build more assets, and reduce the poverty gap than non-migrant households.

INTRODUCTION

Internal migration as a livelihood strategy for better employment opportunities and improved earning has been rapidly increasing in both developed and underdeveloped countries, including Bangladesh (Alam and Islam, 2014). Migration allows the migrant households to enhance their resource base which plays a significant role in poverty reduction. Internal migration as income risk-avoidance is a useful strategy that reduces the severity of poverty (Adams and Page, 2003; De and Ratha, 2012) and also reduces the probability of poverty by 0.18 points (Kauser et al., 2016). Skeldon (2006) postulates a hypothesis on the relationship between migration and poverty and finds that migration widens the horizon of poverty-stricken households' access to resources which helps to reduce poverty. In line with Skeldon's findings, Yang et al. (2007) also estimated that the aggregate poverty in China would rise from 14.4% to 15.4% without migration. Poverty reduction in countries like Bangladesh, Ghana, and Uganda can be attributed to the effects of the inflow of remittances (Adams and Page, 2003). However, some other studies, e.g. Finan (2004), argue that migration is a regular livelihood strategy and its ability to reduce

poverty is limited. Similarly, Campbell and Kandala (2011), in their analysis of the impact of remittance on poverty, find that remittance inflow in the migrant households cannot create a positive effect on poverty reduction.

This study undertakes an in-depth analysis of the impact of internal migration through the lens of New Economies of Labour Migration theory (NELM) and a livelihood strategy framework. NELM is a neoclassical migration approach and deals with a household strategy to avoid income risk (Massey et al., 1993; Stark,1991). This paper endeavours to explain the consequences of internal migration on household well-being.

Research Gap and Research Question

While there is an abundance of research on internal migration, attention to the poverty-stricken, in particular, longitudinal empirical studies is insufficient. This study focuses on the impact of internal migration on poverty reduction. Since remittance inflow from internal migration changes the households' income structure, we intend to investigate:

Does internal migration result in a reduction in households' levels of poverty?

This study considers income, accumulation of assets and reduction of poverty gap as indicators of poverty reduction. The research question is addressed through an in-depth modelling and analysis of the panel data collected by BRAC in rural Bangladesh over three periods: 2007, 2009 and 2011.

METHODOLOGY

This study analyses three outcome variables: income movement, overall capability of asset accumulation, and poverty gap in the households. The migration status, i.e., whether or not a household has at least one migrant member, is the treatment binary variable. This study considers two treatment variables, (i) migrant household (MigHH) and (ii) migrant household new (MigHH New). A MigHH is a household that has at least one migrant member during one or more studied years. A MigHH New is a household that has a migrant member for a period of at least one year during the study period. These two variables are considered for cross-validation of the impact of internal migration on poverty reduction.

The impact assessment of internal migration however, faces methodological challenges due to the fact that the migration decision dummy variable is endogenous. We consider a simple regression model:

$$Y_{it} = \alpha X_{it} + \beta MigHH_{it} + \Phi_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (i)$$

Here, in equation (i), the dependent variable, Y_{it}, is the log of income of i^{th} household over t^{th} period. *MigHH* is a dummy variable; X_{it} is the vector of explanatory variables of the households, and Φ_{it} is the error term. However, the binary variable *MigHH* is endogenous as in most of the cases it is correlated with the error term, Φ_{it}. Therefore, to confirm the issue of endogeneity, the study conducts the Hausman endogeneity test. Without endogeneity, the OLS model is appropriate, but with endogeneity, an Instrumental Variable (IV) model using the two-stage least squares (2SLS) method is applied for analysis. The traditional IV model in the first stage estimates OLS regression of $MigHH_{it}$ on X_{it} and Z_{it} to obtain the predicted value of $MigHH_{it}$. The regression equation for predicting $MigHH_{it}$ is as follows:

$$MigHH_{it} = \beta_i X_{it} + \gamma_i Z_{it} + \eta_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (ii)$$

Here, in equation (ii), $MigHH_{it}$ refers to the migration status dummy variable which is equal to 1 for internal migration of at least one member and 0 for none; X_{it} is a vector of the explanatory variable, and Z_{it} is the instrumental variable. The instrument Z should be highly correlated with migrant household, but uncorrelated with unobserved characteristics that affect log of income or poverty status of the household. Hence, to check the validity of the instrument, the study has undertaken two tests: (i) F-test of the excluded instrument, and (ii) over-identification test for models with at least two instruments. Meanwhile, considering the log of income on X_{it} vector of explanatory variable and the predicted value of $MigHH_{it}$, second stage equation of the IV model is estimated by running another OLS. Thus, the following equation is used for estimation at the second stage:

$$Y_{it} = \alpha X_{it} + \beta \widehat{MigHH_{it}} + \Phi_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (iii)$$

Instrumental variable as a way out

Based on the availability of data, this study uses the different instrumental variable to resolve the endogeneity problem. While it is challenging to find a good instrument, particularly in the case of internal migration, similar studies have successfully applied these instruments. For example, Edouard and Michael (2016) in their study in Uganda, consider the interaction between the log of the distance between origin and destination, and young adult at baseline (aged 15 to 24 years) as an instrument to address the endogeneity problem. Similarly, to solve the endogeneity problem, Chukwuone et al. (2008) use sources of remittance as a tool to analyse the impact of remittances on levels of poverty in Bangladesh, and Shahana (2017) considers the intensity of district-level remitter as an instrumental variable for analysing the impact of remittances on human capital. Other instruments, e.g. predicted value of migration and asset ownership (Hagen-Zanker and Azzarri, 2010), or the highest educational status (Mendola, 2006) have also been used in similar studies. This study analyses households having children below ten years, a member of more than 65 years, marriage dummy, and a mobile phone as instruments. Different regression models have been constructed replacing Y_{it} by overall asset building and poverty-gap to evaluate the impact of internal migration on the households.

DATA ANALYSIS AND DISCUSSION

The study uses secondary data on impoverished communities from 13 districts in Bangladesh. BRAC collected the data through a longitudinal survey of 31477 households over three periods, 2007, 2009 and 2011. Initially, a 'mini census' comprising160,000 households in the underprivileged areas were conducted. Geographical targeting method was used for the detection of the underprivileged areas. A total of 32000 households were randomly selected from this mini-census, but the total sample size turned into 31477 as unavailable households were dropped from the list during data collection. However, a total of 26,720 households were found in the spot during the study. The dataset is statistically significant for this research.

Mean difference t-test

An overview of the characteristics of the migrant and non-migrant households has been provided in Table 1 containing three different periods, 2007, 2009 and 2011. The head of the migrant households are male-dominated and younger than that of the non-

migrant households implies that the internal migration is more favourable to male-headed households. The average size of the migrant households is significantly larger than that of the non-migrant households. Table 1 also delineates that the mean dependency ratio of the non-migrant household is greater than that of migrant household, which is statistically significant at 1% level of significance. This high dependency is the reason for non-migrant households to avoid internal migration as an income risk-avoiding strategy. In 2007, total consumption expenditure, including food and non-food was higher for non-migrant households than that of migrant households. The mean ownership of the land asset, excluding homestead is also larger for non-migrant households than that of migrant households. Therefore, internal migration is taken place among the poor households in search of earning to minimise income risk as a livelihood strategy. The mean difference test on food security bears testimony of the earlier statement.

Food security increases from pre- to post-migration. The food consumption expenditure of the migrant households was lesser than that of the non-migrant households in 2007, but the scenario reversed in 2009 and 2011, i.e. the migrant households outperformed the non-migrant households in terms of the mean of total expenses. The consumption behaviour of migrant households improves as they earn more and become stable.

The mean difference t-test also reveals that the migrant households have a higher burden of the loan compared to the non-migrant households. Sometimes, the migrant households borrow money for their migration as an initial startup cost, and in some cases, they migrate for increased earning to repay the existing loan. The gaps between migrant and non-migrant households for per capita protein-intake and calorie-intake gradually reduce over the study period.

The mean participation of NGOs is larger for non-migrant households than that of the migrant households. The non-migrant households avoid migration as an income risk aversive strategy as they can run different economic activities locally with the help and supports of NGOs and become financially sound.

Table 1: Mean difference t-test of migrant and non-migrant households

	2007			2009			2011		
	Non-mig.	Mig.	Diff.	Non-mig	Mig.	diff	Non-mig.	Mig.	Diff.
Age of HH head	44.98	42.01	2.96***	46.73	43.96	2.77***	48.28	45.66	2.62***
Sex of HH head	0.75	0.9	-0.15***	0.75	0.88	-0.13***	0.74	0.86	-0.12***
HH size	3.78	4.52	-0.74***	3.84	4.65	-0.81***	4.36	5.10	-0.74***
Last class passed	1.98	1.76	0.22***	2.03	1.77	0.26***	2.12	1.72	0.4***
Can read and write	0.25	0.23	0.02***	0.24	0.22	0.02***	0.24	0.21	0.03***
Can keep account	0.967	0.975	-0.008***	0.973	0.982	-0.009***	0.98	0.987	-0.007***
Dependency ratio	0.31	0.3	0.01***	0.3	0.28	0.02***	0.26	0.24	0.02***
Food consumption	32447	31796	651**	33876	34187	-311	44390	45812	-1422***
Non-food consumption	14105	13183	922**	11446	11295	151	23861	23708	153
Total consumption expenditure	46553	44979	1574**	43439	43496	-57	65076	66252	-1176
House ownership	0.61	0.6	0.01	0.64	0.65	-0.01	0.72	0.72	0
Land asset	57.62	19.46	38.16***	36.12	16.71	19.41***	47.86	23.23	24.63***
Food security	0.73	0.8	-0.07***	0.78	0.83	-0.05***	0.63	0.77	-0.14***
Loan taken by household	0.36	0.44	-0.08***	0.52	0.6	-0.08***	0.39	0.45	-0.06***
House damage	0.052	0.056	-0.0041	0.038	0.0467	-0.0077***	0.0337	0.0382	-0.0045*
Per cap calorie	2270	1900	370***	2090	1768	322***	2019	1788	231***
Per capita Protein	60.59	50.12	10.47***	56	47.23	8.77***	52.34	46.35	5.99***
Ngo participation	0.05	0.03	0.02***	0.12	0.07	0.05***	0.11	0.07	0.04***

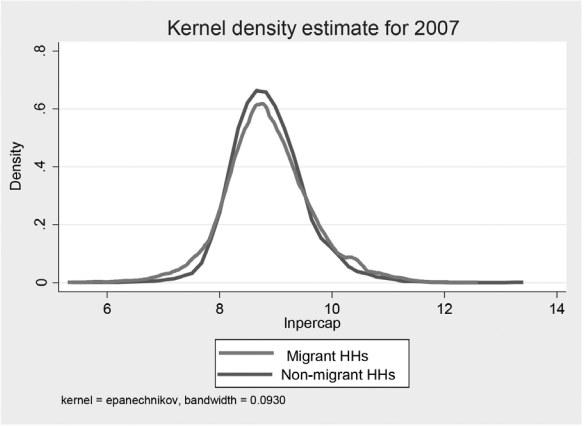
Note: ***P<0.01, **P<0.05 and *<0.1

Income density and Household poverty status

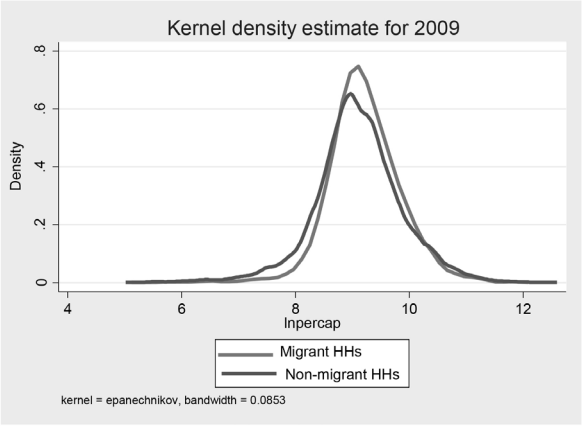
The Kernel density compares the income density of migrant and non-migrant households in Figure 1. It reveals that at the beginning of the study, migrant households earn less, but in the end, they earn more compared to non-migrant households.

Figure 1: Income density of migrant and non-migrant HHs

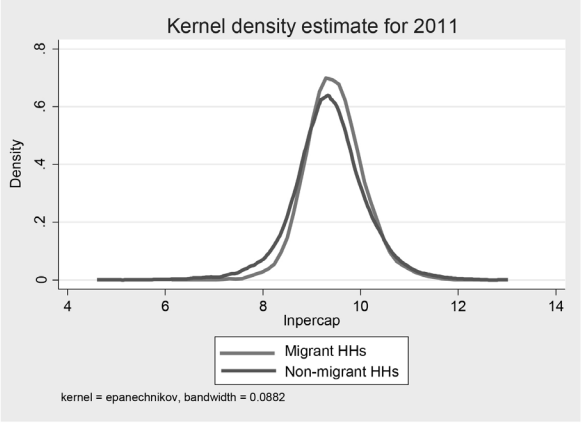
2007



2009



2011



The income and poverty status of households by migration status is provided in Table 2. Based on the income and poverty indicators, migrant households appeared to be poorer in 2007, but their per capita income in 2009 and 2011 outperform the non-migrants. On the other hand, per capita income of the migrant households falls drastically if remittance inflow is deducted from the total income, which suggests that mostly the poor people choose internal migration as a livelihood strategy. In other words, internal migration is an important livelihood strategy for the migrant household.

Table 2: Income and poverty status of households, by migration status

	2007			
	All HHs	mig	Non-migHHs	Mean diff.
No. of Households	26,720	6,204	20,516	
Annual Per capita income (in BDT)	9602	8990	9788	-798 ***
Annual per capita non-remittance income (in BDT)	9581	8901	9788	-887***
Annual per capita remittance	20	89	--------	--------
Annual remittance inflow in HHs (in BDT)	87	374	--------	--------
Income poor (%)	69.95	66.55	70.98	-4.4***
Income poor non-remittance income (%)	70.02	66.86	70.98	-4.11***
	2009			
	All HHs	mig HHs	Non-migHHs	Mean diff.
No. of Households	26,718	6,914	19,804	
Annual Per capita income (in BDT)	12176	12396	12099	297*
Annual per capita non-remittance income (in BDT)	12121	12180	12099	-81*
Annual per capita remittance	56	216	--------	--------
Annual remittance inflow in HHs (in BDT)	256	991	--------	--------
Income poor (%)	53.79	41.46	58.09	-16.32**
Income poor non-remittance income (%)	53.98	42.21	58.09	-15.88***
	2011			
	All HHs	mig HHs	Non-migHHs	Mean diff.
No. of Households	26,720	6,084	20,636	
Annual Per capita income (in BDT)	15464	15631	15415	216*
Annual per capita non-remittance income (in BDT)	15433	15496	15415	81
Annual per capita remittance	31	134	--------	--------
Annual remittance inflow in HHs (in BDT)	146	642	--------	--------
Income poor (%)	32.62	18.26	36.86	-18.60***
Income poor non-remittance income (%)	32.71	18.65	36.86	-18.21***

Poverty rate decomposition for the migrant households

Table 3 shows the poverty decomposition with and without remittance of the migrant households. Here, P_o, P_1 and P_2 stand for poverty headcount index, poverty gap index, and poverty severity index. The study estimates P_o, P_1 and P_2 on the poverty line of $1.25 per person per day (UNICEF, 2013). The poverty status of migrant households reduces drastically over the study period. The study observes internal migration drastically reduces the poverty status of migrant households, which is consistent with Chowdhury et al., (2012). The migrant households become poorer when the remittance is excluded from their income, which is consistent with Gustafsson and Makonnen (1993).

Table 3: Poverty decomposition

	Year-2007			Year-2009			Year-2011		
	P_o	P_1	P_2	P_o	P_1	P_2	P_o	P_1	P_2
All HHs	70.40	33.69	20.18	54.02	22.26	13.03	32.74	13.35	7.62
Migrant HHs	66.61	26.72	13.25	41.49	11.41	4.77	18.26	4.54	1.75
Migrant HHs (excluding remittance)	66.92	27.04	13.49	42.24	11.89	5.09	18.65	4.68	1.83

IMPACT ANALYSIS OF MIGRATION ON POVERTY

The study uses three indicators, i.e. (i) income (ii) asset-building capacity and (iii) poverty gap to evaluate the impact of internal migration on the households' poverty reduction. Impact on household income is assessed under the assumption that poverty is reduced when income increases. The asset-building capacity is used to evaluate how remittance helps the households to build overall asset (business and non-business assets). It is also assumed that that poverty reduces when the asset-building capacity increases. The study then measures poverty gap to evaluate the impact of internal migration.

Impact of Internal Migration on Household Income

The panel data has gone through numerous statistical tests to assess the impact of internal migration on household income. The test results are added in Table 4. Since Model 1 and Model 2 have the problem of endogeneity, the analysis moves towards an IV method. Marriage dummy and children below ten years of age are considered as an IV for migrant HH dummy and migrant HH new dummy. The F-statistics bear justification that the instruments used in Mode1 and Model 2 are powerful instruments. Meanwhile, both of the models are tested for random effect vs fixed effect. The result rejects accept fixed-effect model over the random effect model.

This study captures two different dimensions of internal migration, i.e. migration in any specific year (Mig HH) and migration at least once in three years (Mig HH new). For the first dimension, migration dummy takes value 1 if the household has at least one migrant in any specific year and if there is no migrant from the same household in the following year, then migration dummy takes value zero for that specific year. Therefore, the number of migrant households varies throughout the study period. For the other dimension, migration dummy takes value 1if the household migrated any time during the study period. It is true if the following condition is satisfied (1-1-1, 1-0-0, 0-1-0, 0-0-1, 1-1-0,0-1-1=1 and 000=0). Here, the number of migrant households remains the same for all three years (2007, 2009 and 2011).

In table 4, the instrumental variable model reveals that migrant households have 4.13% higher income than non-migrant household, ceteris paribas, and the result is significant at 1% level. The increase of household heads age by one year increase the income of the household by 0.9%, ceteris paribas. Male headed households, increase of educational qualification of the household head, NGO participation, and land asset (excluding homestead) increase the percentage of income.

Table 4 shows that migrant households with land assets decrease the percentage of income than non-migrant households. It indicates that sending migrant is not a good strategy for those households that have income-generating land assets. However, it is better to keep the household member at home and use their skill to boost income generation from the land. House damage and crop-loss are dummy variables take value one if the household experiences house damage or crops loss by natural calamity. Experience of house damage and crop-loss decreases the percentage of income. The study includes a migrant household new variable in model 2 to cross-check the result derived from Model 1. The result shows that all of the variables come with the same sign and the patterns of the variable being significant are also similar. Therefore, from Model 1 and Model 2, it can be concluded that internal migration is a good livelihood strategy that increases the percentage of household income.

Table 4 Impact of internal migration on household income and expenditure

	Model 1		Model 2	
	First Stage	2SLS	First Stage	2SLS
VARIABLES	Mig. HH	Log of income	Mig. HH New	Log of income
Migrant HH		4.125***		
		(0.648)		
Migrant HH New				2.495***
				(0.327)
Age of the HH head	-0.002***	0.009***	-0.002***	0.008***
	(0.000)	(0.001)	(0.000)	(0.001)
Sex of the HH head	0.108***	0.235**	0.146***	0.293***
	(0.009)	(0.096)	(0.010)	(0.072)
HH head canread and write	-0.003	0.033	-0.013**	0.064***
	(0.005)	(0.023)	(0.006)	(0.019)
HH head cankeepaccount	0.025**	0.187***	0.026**	0.205***
	(0.010)	(0.046)	(0.012)	(0.037)
HH head last class passed	-0.002***	0.022***	-0.004***	0.023***
	(0.001)	(0.003)	(0.001)	(0.002)
NGO participation	-0.002	0.173***	-0.001	0.160***
	(0.006)	(0.027)	(0.007)	(0.022)
ln Land Asset	-0.060***	0.363***	-0.061***	0.273***
	(0.001)	(0.036)	(0.001)	(0.018)
Land*migrant HH	0.230***	-0.843***	0.186***	-0.367***
	(0.002)	(0.142)	(0.002)	(0.057)
Loan taken by HH	0.025***	-0.021	0.033***	0.026*
	(0.003)	(0.024)	(0.004)	(0.015)

	Model 1		Model 2	
	First Stage	2SLS	First Stage	2SLS
VARIABLES	Mig. HH	Log of income	Mig. HH New	Log of income
Seasonality	-0.020***	-0.013	-0.011***	-0.075***
	(0.003)	(0.020)	(0.004)	(0.012)
House damage	0.006	-0.166***	0.013	-0.147***
	(0.007)	(0.034)	(0.008)	(0.027)
Crop loss	-0.005	-0.099***	-0.010	-0.077***
	(0.005)	(0.022)	(0.006)	(0.018)
Marriage dummy	0.041***		0.076***	
	(0.008)		(0.010)	
Num of child below ten years	0.009***		0.014***	
	(0.002)		(0.002)	
Constant	0.189***	8.354***	0.327***	8.331***
	(0.012)	(0.154)	(0.015)	(0.131)
Observations	72,199	72,199	72,199	72,199
R-squared	0.223		0.150	
Test	**Statistics**	**p-value**	**Statistics**	**p-value**
F-Test of excluded instruments	34.33	0.0000	68.91	0.0000
Hausman test *(Random effect vs fixed effect) (Chi2 &Pvalue)*	27.25	0.0115	24.22	0.0292
Hausman test *(IV model vs OLS) (Chi2 &Pvalue)*	109	0.0000	102.44	0.0000
Over identification test for all instruments				
(Sargan Statistic & Chi2 P-value)	0.0675	0.7976	0.9339	0.3338

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Impact of Migration on Asset Building Capacity

This study considers overall asset-building capacity (business asset and non-business asset) as a proxy of poverty reduction to explore the impact of internal migration on households' poverty. Higher the asset-building capacity lowers the chance of the households suffering from poverty. For the formulation of asset index, the paper applies Principle Component Analysis (PCA) following Filmer and Pritche (2001). Here, PCA is applied to extract weight from the first principle component of those business and non-business asset. A total of 21 assets of the households from two dimensions (business and non-business asset) are used to conduct PCA. X_1 to X_{21} represents 21 assets of the household. The formula applied for asset index calculation is depicted below:

$$\alpha_1\left(\frac{x_1 - x_1^*}{Z_1}\right) + \alpha_2\left(\frac{x_2 - x_2^*}{Z_2}\right) + \alpha_3\left(\frac{x_3 - x_3^*}{Z_3}\right) + \cdots \ldots \ldots \ldots \ldots + \alpha_n\left(\frac{x_n - x_n^*}{Z_n}\right)$$

Here,x_n^* and Z_n are the mean and standard deviation of the indicator x_n. For the asset index calculation,α_n represents the weight of each indicator of x and α_1 α_2 ……α_n are vector coefficient, where the scoring factor taken from the first principle component. Table 6 reports the scoring factor extracted from PCA considering 21 assets (business and non-business asset) of the households (see Table A2 in the Appendix for PCA). The mean of the overall asset index for 21 assets of the households is zero, and the standard deviation is 1.97. Each of the assets used for PCA is dummy variable comprising 0 and 1. Therefore, a move from 0 to 1 changes the index value by the difference factor $\frac{\alpha_n}{Z_n}$. For example, a household that owns a cow has an asset index higher by 0.22 units than the household who does not have a cow. In table 6 the mean difference test confirms that the non-migrant households are wealthier than migrant households. It implies that the poor households choose the decision of internal migration as an income risk reduction livelihood strategy. This result is consistent with Chowdhury et al. (2012) in which the study reveals that people in Bangladesh pushed to other cities because of their poor socio-economic conditions. However, the mean difference test of having a mobile phone is significantly larger for migrant households than that of non-migrant households. It indicates that migrant households use the mobile phone at a greater extent to maintain communication with the migrant members.

In Table 6, by applying IV method, we explore the impact of internal migration on household asset building capacity as a proxy of poverty reduction. Two IV models are used to evaluate the impact of internal migration. In the first IV model, variable "Migration HH" is used, and for the second IV model "Migrant HH new" variable is considered. This is done to check the robustness of the result of the impact of internal migration on asset accumulation capacity. Hausman test is conducted for each model to decide which model is more appropriate. Here, the test statistics prefers a random-effects model over the fixed effects model.

In this analysis, the test result shows rejection of null hypothesis for model 1 (Test statistics 208.71 and p-value 0.00) and model 2 (Test statistics 192.61 and p-value 0.00); it indicates that fixed effect model is preferred over random effect model. The two models are estimated by applying IV method. Children below ten years and senior household members over 65 years are considered as an instrument for migration HH and migration HHnew, since these two dependent groups are negatively correlated with migration decision of the households but not with the error term. The test statistics and p-values of Sargan test justify the validity of the instruments used in both of the models. The endogeneity test statistics justify the validity and relevance of using IV. The f-test of excluded instruments provides strong evidence that the used instruments are sufficiently robust.

Meanwhile, the preference of fixed effect model over the random effect model implies that something within the households may affect the outcome variables, and it is important to control them to trace the right impact of internal migration. The fixed-effect model removes the effect of time-invariant and unobserved characteristics to examine the net impact on the outcome variable.

The two estimated fixed effects models Table 6 shows that the coefficient for the migration status variable (migrant HH), which is the variable of interest, is positive and statistically significant. This confirms that holding other factors constant, households with migrant member have significantly higher asset accumulation capacity compared to their counterpart.

Age of the household head, educational qualification of household head (able to read write, can keep the account, passed last-class), NGO participation, the log of land assets (having income-generating land excluding homestead) have a positive and statistically significant impact on asset accumulation. It implies that an increase in the percentage of land increases the asset accumulation of the households. However, the interaction term of the log of land assets and migration dummy is negative and significant. It implies households that have income-generating land asset can lose their asset accumulation if the household member migrates because there are fewer people to earn money from the land asset. Also, the households having seasonal variation in the food supply, and vulnerable to the natural calamity are less capable to accumulate assets. Maccini and Yang (2009) also find that natural disaster destroys productive asset and pushes the poor into deep poverty.

Table 5: Scoring factor and summary statistics of variables used for computation of the first principal component

	Overall Household						Migrant HH	Non-migrant HH	
	(a)	(b)	(c)	(d)	(e)		(f)	(g)	(h)
	Scoring Factor (overall asset)	Mean	Std. dev	DF*	Scoring Factor (sub-indices)		Mean	Mean	Difference (f)-(g)
					Business Asset	Non-Business Asset			
Business Asset									
Cow	0.220	0.354	0.478	0.463	0.577		0.315	0.377	-0.061***
Chicken and Ducks	0.145	0.208	0.406	0.358	0.518		0.177	0.221	-0.044***
Goat/sheep	0.193	0.607	0.488	0.399	0.504		0.638	0.603	0.035***
Boat	0.035	0.009	0.094	0.535	0.141		0.008	0.009	-0.001
Fish-net	0.125	0.057	0.231	0.376	0.339		0.057	0.056	0.001
Rickshaw	0.0129	0.055	0.227	0.059	0.089		0.046	0.057	-0.011***
Non-Business Asset									
Radio	0.169	0.060	0.238	0.723		0.178	0.050	0.062	-0 .011***
Television	0.308	0.082	0.274	1.119		0.341	0.069	0.088	-0.019***
Electric Fan	0.298	0.098	0.297	0.995		0.332	0.085	0.102	-0.017***
Refrigerator	0.116	0.005	0.071	1.661		0.137	0.003	0.005	-00148***
Mobile Phone	0.324	0.203	0.403	0.804		0.351	0.223	0.205	0.0178***
Cycle	0.274	0.179	0.384	0.711		0.278	0.141	0.197	-0 .0558***
Motor Cycle	0.178	0.015	0.122	1.465		0.196	0.007	0.017	-0.0094***
Sewing Machine	0.091	0.014	0.117	2.915		0.103	0.010	0.014	-0.0039***
Chair	0.342	0.479	0.499	0.683		0.359	0.515	0.478	-0.0363***
Table	0.344	0.474	0.499	0.687		0.362	0.509	0.473	0.0355***
Cot	0.181	0.870	0.335	0.545		0.191	0.918	0.861	0.056
Sofa	0.124	0.011	0.105	1.202		0.142	0.008	0.011	-0.002***
Mosquito net	0.167	0.896	0.304	0.554		0.172	0.935	0.889	0.045**
Jewellery	0.203	0.685	0.464	0.441		0.205	0.735	0.675	0.06
No. of good Sharee	0.277	0.559	0.496	0.557		0.290	0.555	0.567	0.011
Index value of overall asset		0.00	1.97				-0.0039	0.0012	

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

Note: DF (Factor for Difference) = Scoring factor/Standard Deviation. Each of the variables takes value 1 if yes and zero otherwise, here weight assigned for each of the variable (normalised by their corresponding mean and standard deviation) are extracted from the first principle component. The first and second eigenvalues are 3.93 and 1.70, respectively; 18.75% of the covariates are explained by the first principle component.

Table 6: Impact of migration on overall asset-building capacity (2SLS -Fixed effect model)

VARIABLES	2SLS Model 1 First Stage Migrant HH	2SLS Model 2 Second Stage Overall Asset index	First Stage Migrant HH new	Overall Asset index
Migrant HH		3.155***		
		(0.729)		
Migrant HH New				1.935***
				(0.405)
Age of the HH head	-0.001***	0.003**	-0.001***	0.002*
	(0.000)	(0.001)	(0.000)	(0.001)
Sex of the HH head	0.100***	-0.019	0.100***	0.035
	(0.010)	(0.084)	(0.010)	(0.068)
HH Head can read write	-0.002	0.391***	-0.002	0.418***
	(0.005)	(0.027)	(0.005)	(0.025)
HH Headcan keep account	0.025**	0.137***	0.025**	0.143***
	(0.010)	(0.052)	(0.010)	(0.047)
Last class passed by HH Head	-0.002***	0.102***	-0.002***	0.102***
	(0.001)	(0.003)	(0.001)	(0.003)
Per capita calorie intake	-0.000***	0.000***	-0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
NGO participation	0.004	0.389***	0.004	0.379***
	(0.006)	(0.030)	(0.006)	(0.028)
Seasonality	-0.017***	-0.304***	-0.017***	-0.350***
	(0.003)	(0.022)	(0.003)	(0.015)
Log oflandasset	-0.056***	0.568***	-0.056***	0.502***
	(0.001)	(0.038)	(0.001)	(0.021)
Divorced	-0.098***	0.199	-0.098***	0.189
	(0.024)	(0.141)	(0.024)	(0.127)
Married	-0.006	0.686***	-0.006	0.649***
	(0.014)	(0.069)	(0.014)	(0.063)
Separated	-0.102***	0.352***	-0.102***	0.257**
	(0.020)	(0.124)	(0.020)	(0.102)
Widowed	-0.052***	0.238**	-0.052***	0.236***
	(0.017)	(0.095)	(0.017)	(0.086)
Land *migrant HH	0.226***	-0.690***	0.226***	-0.331***
	(0.002)	(0.159)	(0.002)	(0.069)
Loan taken by HH (Dummy)	0.025***	0.256***	0.025***	0.292***
	(0.003)	(0.027)	(0.003)	(0.019)
House damage (Dummy)	0.008	-0.230***	0.008	-0.216***
	(0.007)	(0.038)	(0.007)	(0.034)
Crop loss (Dummy)	-0.004	-0.117***	-0.004	-0.094***
	(0.005)	(0.025)	(0.005)	(0.023)
Children below 10 years	-0.000		-0.000*	
	(0.000)		(0.000)	
Senior member above 65 years	-0.032***		-0.032***	
	(0.004)		(0.004)	
Constant	0.324***	-2.688***	0.324***	-2.673***
	(0.020)	(0.264)	(0.020)	(0.237)
Observations	69,900	69,900	69,900	69,900
R-squared	0.231		0.231	
Number of bocd		90		90
Tests	**Statistics**	**p-value**	**Statistics**	**p-value**
F-Test of excluded instruments	35.42	0.00	55.26	0.00
Hausman test *(Random effect vs fixed effect) (Chi2 &Pvalue)*	208.71	0.00	192.61	0.00
Hausman test *(IV model vs OLS) (Chi2 &Pvalue)*	22.59	0.00	22.38	0.00
Over identification test for all instruments				
(Sargan Statistic & Chi2 P-value)	1.28261			
	0.2574	2.39413	0.1217	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Impact of Migration on Household Poverty Status

In this section, the paper evaluates the impact of internal migration from the lens of household poverty gap. Internal migration has a higher potential of remittance inflow (Afsar, 2003) for reducing the severity of poverty in low-income families. This study uses the poverty line as defined by UNICEF for Bangladesh for the period of 2007 to 2011 (UNICEF, 2013) as an income of $1.25 per person per day. The annual per capita household income is deducted from the newly constructed annual poverty line, and then it is divided by the newly constructed annual poverty threshold. The study proceeds further to evaluate the impact of internal migration on poverty reduction using the poverty gap as the dependent variable.

Table7considers the result of 2SLS model, where model 1 considers migrant HH and model 2 to check the robustness of the result considers migrant HH new variable. Since both the models' migration dummies are used as an explanatory variable, the model might have been suffered from endogeneity. The test statistics (Hausman) justifies the issue of endogeneity, and the number of children below ten years and use of the mobile phone is considered as an instrument for migrant HH and migrant HH new variable. The use of a mobile phone is considered as a proxy of the migration network that is correlated with migration dummy. The test statistics received from Sargan test is also satisfactory. The f-test for excluded instrument also gives evidence of the robustness of the instrument. The Hausman test of fixed effect vs random effect justifies the application of fixed effect estimation for both of the models.

Model 1 of Table 7 depicts strong evidence that migration reduces the poverty gap of the households, ceteris paribas. It implies that internal migration is a useful household strategy to avoid income risk. Study of Tandoh-Offin and Awuse (2013) also find in their analysis that there is a positive relationship between internal migration and poverty reduction. With the increase of the age and educational qualification (last class passed) of the household head, the poverty gap reduces. Male headed household reduces poverty gap more than a female-headed household. A household head, who is having knowledge of keeping the account only, increase the poverty gap because they are mainly involved in a job of less salary. This intense poverty pushes the households to send family members for internal migration, the coefficient of the first stage bears testimony to the statement, and it is significant at 5% level.

Loan burden, seasonality and house damage increase household poverty gap. On the other hand, land asset decreases poverty gap. However, the interaction dummy of land asset and migration dummy increases poverty gap. This result is also consistent with the earlier result of asset building where the coefficient for the interaction term depicts the decrease of asset accumulation of the households. In Table 7, migration HH New is consistent with model 1 with the same sign and same variable are significant.

Table 7: Impact of migration on household poverty gap (2SLS-Fixed effect model)

	Model 1		Model 2	
VARIABLES	**First Stage Mig HH**	**Second Stage Poverty gap**	**First Stage Mig HH New**	**Second Stage Poverty gap**
Migrant HH		-33.056***		
		(3.036)		
Migrant HH New				-25.263***
				(2.120)
Age of HH Head	-0.002***	-0.076***	-0.002***	-0.077***
	(0.000)	(0.007)	(0.000)	(0.006)
Sex of HH Head	0.142***	-4.010***	0.142***	-4.744***
	(0.005)	(0.459)	(0.005)	(0.477)
HH Head can read write	-0.004	-0.028	-0.004	-0.363**
	(0.005)	(0.173)	(0.005)	(0.158)
HH Head can keep account	0.026**	0.470	0.026**	0.616**
	(0.010)	(0.331)	(0.010)	(0.303)
Last class passed by HH Head	-0.003***	-0.104***	-0.003***	-0.121***
	(0.001)	(0.021)	(0.001)	(0.020)
Per capita calorie	-0.000***	-0.001***	-0.000***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
NGO participation	0.001	-0.326*	0.001	-0.195
	(0.006)	(0.198)	(0.006)	(0.179)
Log of Land Asset	-0.058***	-2.082***	-0.058***	-1.653***
	(0.001)	(0.162)	(0.001)	(0.112)
Land*migration	0.226***	7.066***	0.226***	4.158***
	(0.002)	(0.662)	(0.002)	(0.362)
Loan taken by HH (Dummy)	0.024***	0.967***	0.024***	0.754***
	(0.003)	(0.137)	(0.003)	(0.113)
Seasonality	0.013***	0.489***	0.013***	0.069
	(0.003)	(0.121)	(0.003)	(0.095)
Crop loss	-0.003	0.177	-0.003	-0.091
	(0.005)	(0.161)	(0.005)	(0.147)
House damage	0.010	0.799***	0.010	0.786***
	(0.007)	(0.239)	(0.007)	(0.217)
Children below 10 years	0.000		0.000	
	(0.002)		(0.002)	
Mobile phone	0.034***		0.034***	
	(0.004)		(0.004)	
Constant	0.287***	10.516***	0.287***	12.765***
	(0.013)	(0.946)	(0.013)	(1.038)
Observations	69,682	69,682	69,682	69,682
R-squared	0.230		0.230	
Number of bocd		90		90
Tests	**Statistics**	**p-value**	**Statistics**	**p-value**
F-Test of excluded instruments	37.85	0.00	54.22	0.00
Hausman test *(random effect vs fixed effect) (Chi2 &Pvalue)*	22.18	0.07	21.14	0.09
Hausman test *(IV model vs OLS) (Chi2 &Pvalue)*	5082.73	0.00	5166.48	0.00
Overidentification test for all instruments *(Sargan Statistic & Chi2 P-value)*	1.5242	0.2170	0.4327	0.5107

Standard errors in parentheses

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

CONCLUDING REMARKS

Internal migration as a livelihood strategy for the poor community in Bangladesh has a positive contribution to boost the household earning, asset accumulation and minimisation of the poverty gap. Withdrawal of remittance from the migrant household income intensifies poverty. Therefore, this paper can help the policymaker to adopt decentralisation of economic activities. That ultimately causes an upward shift of internal migration frontier and reduction of household poverty. Besides, empirical work on internal migration is quite a few. When it is about panel data analysis, then it is very limited in internal migration research. Since this internal migration study is on panel data, it can contribute to bridge the research gap in the ground of existing literature.

This study of internal migration from the perspective of Bangladesh has some limitations. Firstly, some qualitative factors are not incorporated in this study. Secondly, the panel data does not cover the pre-migration characteristics of migrant households. It becomes challenging to evaluate the impact of migration on poverty reduction. Incorporation of before-after data on migrant households and the collection of qualitative data from the field by KII and focus group discussions can be a further research option for experts on internal migration studies.

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Appendix A1: List of variables to address the two research questions

List of Variables	Explanation
Migrant HH(Dummy)	Household sent at least one migrant, and there is an oscillation in the migrant household over the year (2007, 2009 and 2011) and 0 for the non-migrant household
Migrant HH New(Dummy)	Household sent at least one migrant in any of the year (2007, 2009 and 2011) and 0 for non-migrant household
Income	Amount of total income including remittance for the migrant household
HH Expenditure	Food and non-food expenditure of the household
Overall Asset Building	An index includes business asset and non-business asset
Poverty gap	Per capita household income per year - per person poverty line per year/ per person poverty line per year
Destination preference	Destination preference of the migrant household,i.e.,1= Nearby villages in the same district, 2= Different Districts, 3=Dhaka and Chittagong
Age of household head (HHH)	Age of HHH in years
Sex of HHH	1= Male HHH and 0=Female HHH
HHH read write	HHH can read and write
HHH keep account	HHH can keep account
HHH last class pass	Last class passed by the HHH
Marital Status of HHH	Unmarried, Divorced, Married, Separated and widow (Unmarried dummy is considered as a reference dummy to avoid the dummy variable trap)
Occupational status of HHH	Labour, Farmer, Service, Small business, Large business, Skilled labour and others(Labour dummy is considered as a reference dummy to avoid the dummy variable trap)
HH size	Total household member
Dependency ratio	The ratio between below 10 years and above 65 years household member by the working-age members of the household due to a lot of child labour in Bangladesh.
Land ownership	Amount of income-generating land household possess excluding homestead (in decimal)
Loan burden (Dummy)	Loan taken by household (1=Yes, 0= No)
NGO part (Dummy)	1=Household involve in NGO activities and 0= Otherwise
Seasonality (Dummy)	A household faces seasonal variation in the food supply. (1=Yes, 0= No)
House Damage(Dummy)	A household experiences damage to the house due to a natural disaster. (1=Yes, 0= No)
Crop Loss (Dummy)	A household experiences loss of crops due to a natural disaster. (1=Yes, 0= No)

Author's compilation

Appendix A2

Migration over three years (2007, 2009, 2011)	Freq.	Percent	Cum.
Never migrate	15,636	58.52	58.52
At least once among three year	5,311	19.88	78.39
At least two times over three years	3,428	12.83	91.22
Migrate each of the year	2,345	8.78	100
Total	26,720	100	

Measuring Elasticity of Substitution: Poultry Broiler Sector of Bangladesh

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Abstract: The present paper is mainly concerned with finding the employment potential in different sizesof poultry broiler farmsi.e. small, medium and large farms in Bangladesh. This study makes the first attempt to estimate the Constant Elasticity of Substitution (CES) model for Bangladesh poultry production. Estimated results of CES suggests that the value of elasticity of substitution between labor and farm capital machineries is comparatively high in case of broiler medium and very particularly of large farms which indicate that there is great potential for employment in large broiler farms provided there are no factor price distortions. And small farms exhibits lower substitution value. The weak elasticity of substitution value suggests that production is not easy to have the substitutability between its inputs. In this regard, there occurs urgency of doing something for the small farms from the govt. at a large scale.

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I. INTRODUCTION

An important purpose of thestudy of production function is to analyze the range to which factor substitution is possible in the organization of any production process and it is obvious that across firms or industries substitutability may vary. The current study is concerned with the empirical estimation of factor substitutiongrounded on the Constant Elasticity of Substitution (CES).Arrow et al. (1961) introduced the CES production function having the advantage to be a generalization of three key functions namely: the Leontief function (in case of perfect complements), the linear function (in case of perfect substitutes), and the Cobb-Douglas function, which assume respectively an infinite, a zero and a unit elasticity of substitution (ES) between production factors.

In a growing developing country like Bangladesh, the growth rate in capital input is well over the growth rate in labour input, and for this reason, diminishing returns to capital input may pretense a challenge to the sustainability of growth. How solemn this trouble will turn out to be, depends crucially on the elasticity of substitution between capital and labour. If the elasticity of substitution between capital and labour is high, it may be easier to sustain a

relatively high rate of economic growth. This makes the elasticity of substitution between capital and labour vital to study.

The elasticity of capital labour substitution is a crucial parameter in measuring the welfare effects of policy shocks (Balestreri et al., 2003).The likelihood of efficient capital-labour substitution is vital for the achievement of most fiscal, financial and technological policies that are intended to surge employment in developing countries through the implementation of labour-intensive techniques of production (Battese and Malik, 1986). The elasticity of substitution is relevant to a number of other problems as well, in both developed and developing countries (Morawetz, 1976). If the possibilities occur for efficient capital-labour substitution, then labour can be substituted for capital without unavoidably resulting in deterioration in output. This issue remarkably relies on whether the elasticity of substitution is positive. If the possibilities exist for efficient capital-labour substitution, then labour can be substituted for capital without necessarily resulting in a decline in output (Battese and Malik, 1986). This issue remarkably relies on whether the elasticity of substitution is positive. A higher elasticity of substitution between labor and capital may result in a higher level of labor productivity in steady-state (Klump and De La Grandville, 2000).

Numerous classes of production functions are offered in the economic literature(for details see Walter, 1963, 1968; Hildebrand and Liu, 1965; Nerlove, 1967; and Ferguson, 1969) but for empirical estimates of the elasticity ofsubstitution the most extensively used production functions are the Cobb-Douglas (CD), and the Constant Elasticity of Substitution (CES).

The Cobb-Douglas tactic has often been criticized for its inflexibility. Motivated by strong empirical proof that the substitution between capital and labour is often not equal to unity in US manufacturing firms, Arrow, Chenery, Minhas, and Solow (1961) offered the constant elasticity of substitution (CES) function, where capital and labour can be substituted at a constant rate but at a value other than unity (the elasticity of substitution can take any value from zero to infinity). The CES function made a major advance in factor substitution study by allowing factor substitution of different magnitudes (0 to + ∞).

We know in Cobb-Douglas production function, elasticity of substitution is unity everywhere. But here we are discussing a production function, which has a constant elasticity of substitution (not necessary equal to unity).

The constant elasticity of substitution (CES) production function is an enhancement over the Cobb-Douglas production function as long as it recognizes the possibility of varying degrees of substitutability between capital and labor in different types of production. Such a function assumes that the basic measure of the degree of substitution (i.e. the elasticity of substitution) is constant but is no longer restricted to any prior value. Needless to say, the Cobb- Douglas and Leontief production functions are special cases of the CES manipulation. Despite the significance of estimating the CES models in poultry production, there are as yet no studies on this topic.

The present paper attempts to hit this gap. Estimating broiler CES production function has an important motivation. An estimate of constant elasticity of substitution (which is not present in current literature) for broiler meat production is necessary tocontribute to Bangladesh livestock development policy in designing appropriate policies in meat production toimprove its effectiveness towards a sustainable development.Given the

fact that Bangladesh is faced with different challenges as far as the livestock subsector is concerned, it then becomes crucial to measure the elasticity of substitution. It is an important determinant of sustainability of growth rate as well as movements in factor income shares over time. Besides, in generating employment it has important implication. If elasticity of substitution is high, it indicates high employment

elasticity of production. If elasticity of substitution is low, it indicates low employment elasticity of production. In addition to this, differences in elasticity of substitution between different sectors may be related with the difference in the growth rates of these sectors. For example an industry with high elasticity of substitution usually will have a higher output rate compared to an industry with low elasticity of substitution.

The above discussion has brought out clearly the significance of the capital-labour substitution elasticity. Thus estimating CES function would help us the way taking care of the poultry broiler industry. Besides, if weakness or strengthens varies across different categories of farms i.e. small, medium and large broiler farms respectively.

Nevertheless, this issue has received no attention in the literature of agriculture economy in Bangladesh. As discussed in the coming section, there has been no study of elasticity of substitution between capital and labour for poultry industry in Bangladesh. In the absence of any work the present paper may shed some light in this regard which makes the paper special.

II. LITERATURE REVIEW

The first application of flexible form to the agricultural sector was made by H. P. Binswanger (Binswanger, 1973). He found both substitutability and complementarity relationship among different inputs and found clear evidence of biased technical change in the US agriculture. In the econometric analysis of factor substitution, *R. S.* Brown (Brown, 1978) found capital-labour and labour-material pairs to be substitutes while capital and material were found to be complements in the US agriculture. Wyzan (1981) used the translog production functions to the Soviet agricultural sector. Wyzan found substitution possibilities between land and labour. Kazi et al. (1976) estimated CES function while G. E. Battese and S. J. Malik (Battese and Malik, 1988) estimated both the CES and VES function to determine the elasticity of substituion between labour and capital for different manufacturing industries in Pakistan.

Earlier, some attempts have been made to estimate the elasticity ofsubstitution between capital and labour in Bangladesh. For instance, Raihana Bilkis (Bilkis, 2012) estimated factor substitution and technical change in Bangladesh agricultural sector for the first two decades after independence by using the trans log cost function. The elasticity estimates (0.76) were statistically significant at the 5 per cent level.

It's true that a good number of studies have been undertaken on different aspects of poultry and poultry farm in Bangladesh. The studies include production performance of poultry and demand for poultry (Ukil, 1994; Islam K.M. Nabiul, 2001, Khan et. al., 2006, Rahman et al., 2009, Shah et al, 2011), measuring relative costs, returns and economic analyses (Miah, 1990, Ahmed et al., 1985, Bhuiyan, 2003; Alam, 2004), benefit and profitability analysis of contract farming (Begum I. A. et al., 2000,Bairagi, 2004 and Jabbar et. al., 2007), effectiveness of trained farmers (Ershad et al., 2004), marketing and value chain analysis (USAID-ATDP, 2005), role of NGO in poultry (Ahmed, 2001, Shamsuddoha M.,

2009), role of poultry in biogas and electricity generation (Zaman, 2007, Sajib et. al., 2015), environmental impact of the poultry sector in Bangladesh (Akter et al. 2004) etc.

There have been some studies that have examined the efficiency of agricultural production in Bangladesh based on stochastic frontier (SFA) and data envelopment analysis (DEA) (Wadud and White, 2000, Kamruzzaman et al, 2006, Haider et al. 2011, Uddin et al., 2017) aiming on major food crops like rice, wheat, fish, maize etc. and no studies have dealt with the poultry.Hassan Md. M., (Hassan, 2018) analyzed the technical efficiency of poultry broiler production in Bangladesh from a sample of 100 poultry farmers selected from Savar and Dhamrai Upazilla under Dhaka and Bajitpur and Kuliarchar Upazilla under Kishorganje district using stochastic parametric technique.

However no effort has yet been made to take into account the elasticity of substitution for poultry industries in Bangladesh.The present study tries to tackle the issue. The current work differs from previous studies in Bangladesh by introducing the concept of elasticity of substitution i.e. constant elasticity of substitution in case of poultry industry. In this study, the elasticity of substitution for small, medium and large poultry broiler farms was estimated separately. In order to avoid difficulties in time-series data cross-section analysis was made.

The rest of the paper is structured as follows. Section III describes the methodology of the study highlighting the theoretical model of the CES production function, data sources, data collection procedure and other necessary information while section IV is dedicated for analyzing results of the work stating results of CES production function as aggregate as well as categories of farms. And finally section V concludes with some policy suggestions.

III. METHODOLOGY OF THE STUDY

3.1 The Theoretical Model (Formalization of the CES Model):

The Constant Elasticity of Substitution (CES) production function was first empirically used by **Arrow, Chenery, Minhas, and Solow (ACMS) in 1961**, who estimated, assuming profit maximization, perfect competition and constant returns to scale, that the production function is of the form **as (Kmenta, J., p-514, 1971)**.

$$Q = \gamma [\delta K^{-\theta} + (1-\delta) L^{-\theta}]^{-1/\theta} \text{ ---------- (1)}$$

Where Q, K, and L are respectively the value of output at constant prices, the services of actual capital inputs measured at constant prices and the actual labor inputs measured in physical units of labor. Equation (1) is reportedly homogenous of degree one. The technology embodied in it is depicted by three different parameters that are also assumed to be constant:

γ: Scale or efficiency parameter; $\gamma>0$

δ: Distribution parameter; also indicates the degree to which technology is capital intensive.

$1-\delta$: It indicates the degree to which technology is labor intensive.

θ: Substitution parameter.

The elasticity of factor substitution, a simple function of θ is given by the following expression:

$$\sigma = \frac{1}{1+\theta}$$

Equation (1) stated above, has been further generalized by Cani and Brown with the introduction of a fourth parameter h that measures the degree of homogeneity of the function in question or putting it differently the degree of returns to scale. The version of the CES relation introduced by them takes the form:

$$Q = \gamma [\delta K^{-\theta} + (1-\delta) L^{-\theta}] - h/\theta \text{---------- (2)}$$

In the original ACMS formulation h was treated to be one, thereby imposing the restriction of constant returns to scale. Taking the logarithmic transformation of the equation no (2) yields the expression:

$$\ln Q = \ln\gamma(- h/\theta)\ln [\delta K^{-\theta} + (1-\delta) L^{-\theta}] \text{---------- (3)}$$

Equation no (3) contains four parameters that summarize the feature of the prevailing technology integrate in the production function.

Usually the values of θ, the substitution parameter, range from -1 to ∞, which allows σ to range +∞ to 0. However, for $0< \theta <\infty$, we will have $\sigma < 1$ (ACMS, 1961, p.230).

However, due to the problems related to the capital stock variable e.g., adjustment of book value figures, lack of capital price deflators, adjustments for capacity utilization etc. we adhered to a specification where no capital input variable is directly required for estimation of the elasticity parameter (ibid.), **ACMS (1961, p.225)** demonstrate that the value added per unit of labor used within a given industry varies across countries with the wage rate. Their analysis is based on 19 different countries (ibid.).

Under the assumption of perfect competition in factor and product markets and constant returns to scale, the elasticity parameter can be indirectly estimated from the derived form of the CES production by using profit maximization condition of equating wages to marginal revenue product (ACMS, 1961). We attempt to choose a functional form which necessarily has the properties of (i) homogeneity, (ii) constant elasticity of substitution between capital and labor, and (iii) the possibility of having different elasticities for different industries (ACMS, 1961, pp.225-26).(Samad, Q.A. Jan.2003, p.3).

The mathematical procedure of obtaining the estimation form of the CES production function is based on the marginal productivity of labor relation derived from the equation. The estimated form of the function is:

$$\text{Ln } (Q/L) = a + b\text{LnW} + u\text{------- (4)}$$

Alternatively,

$$\text{Ln } (Q/L) = \text{Constant} + \sigma\ \text{LnW} + u\text{-------(5)}$$

Where,

b = σ = Elasticity of substitution

W = Real wage per employee

Q/L = Real value added per employee.

The coefficient of LnW in the above regression of Ln (Q/L) on LnW yields an estimate of σ. The possible values of ρ ranges from infinity to -1, when σ = 1 leads to Cobb- Douglas production function. It can be inferred from the partial elasticity of labor productivity that if σ is greater than 1, then there will be higher substitution possibilities and if σ is less than one, then there will be lower substitution possibilities.

The above equation will be estimated underlying the assumption of constant returns to scale. In most empirical cases relating to industry or agriculture, the CES production function is used to know the extent of substation possibilities between labor and capital. If the elasticity of substitution estimated from the CES production function is more than unity, then it can be concluded that the substitution possibilities will be more in favor of the labor input. If it is less than unity, then there will be low substitution possibilities in favor of labor input.

Yet we should keep in mind that the estimation of the above function by OLS method is subject to one way causation implying that labor productivity depends on real wage rate only. The variable real wage can be obtained by deflating the nominal wage rate or money wage rate (Money Wage / Price). Money wage in the present study is defined as wage divided by labor (Wage / Labor) and price equals price of product.

The above indirect specification of the CES production function (equation 4) has been widely used in empirical studies for the estimation of the elasticity of substitution in developing countries. An important advantage of this formulation is that, despite its restrictive assumption is that it does not require capital stock data, the estimation of which involves many problems especially in developing countries.

3.2 Estimation of CES Production Function:

By assuming two factors of production, capital (K) and labour (L), the CES production function in its general form may be written as:

$$\mathbf{Ln\ (Q.P\ /\ L) = Constant + \sigma\ Ln\ (Money\ Wage\ /\ P) + u}\text{-------}(6)$$

Where,

b = σ = Elasticity of substitution as before,

Money Wage / P = Real Wage perEmployee,

W/L = Money Wage,

P = Price of Output Charged by Each Farm (Poultry Broiler or Layer)

Q = Physical Output i.e. Output of Poultry Meat or Egg by Each Farm

Q.P = Value of Outputby Each Farm (Poultry Broiler or Layer)

Q.P / L = Average Revenue Product of Labor i.e. ARPL by Farm wise

Q/L = Real value added per employee.

From the equation 6 we can have the Model for our poultry broiler and layer farm.Thus using data on output per farm and average monthly wage rates per employee, we may fit the model by applying the usual technique of Ordinary Least Squares regression (OLSR).

3.3 Materials and Methods

For the present study Savar and Dhamrai Upazilla under Dhaka district and Bajitpur and KuliarcharUpazilla under Kishorganje district were selected. The data was collected through random selection of poultry farmers which gave the opportunity for fifty poultry farmers from each district making a total of 100 poultry farmers i.e. fifty farmers located in Dhaka and the rest fifty from Kisharganj. Data collection was done by means of structured questionnaireandas for statistical package Stata 14 was applied.

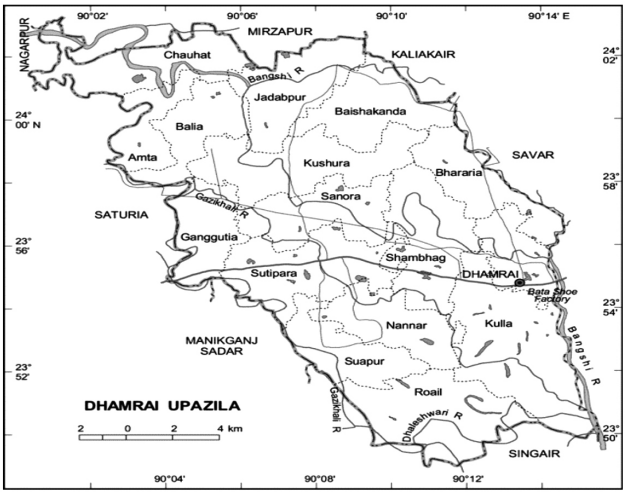

Figure 1: Site Map of Dhamrai Upazila

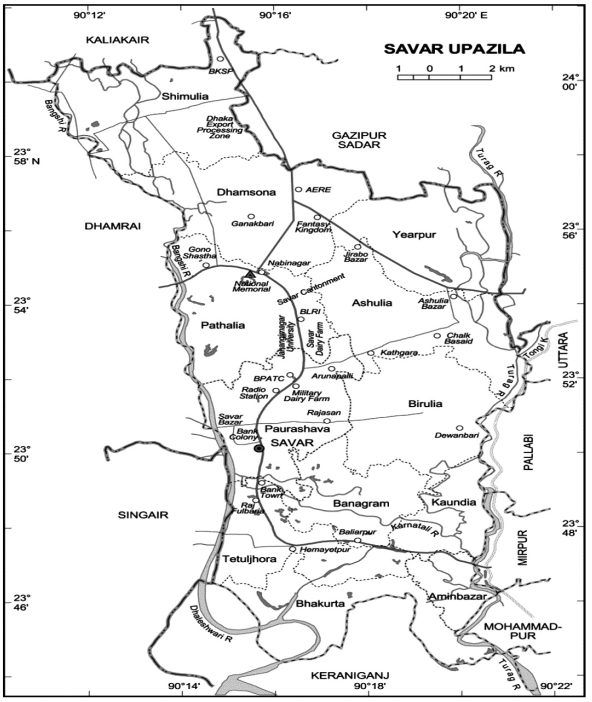

Figure 1.1: Site Map of Savar Upazila

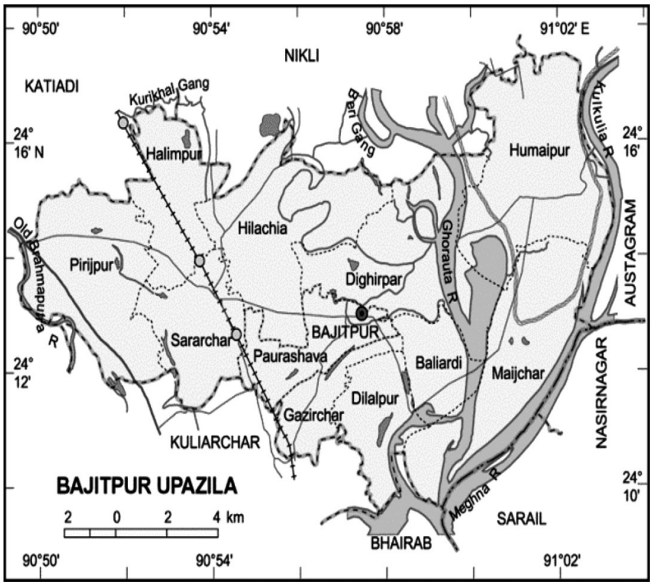

Figure 2: Site Map of Bajitpur Upazila

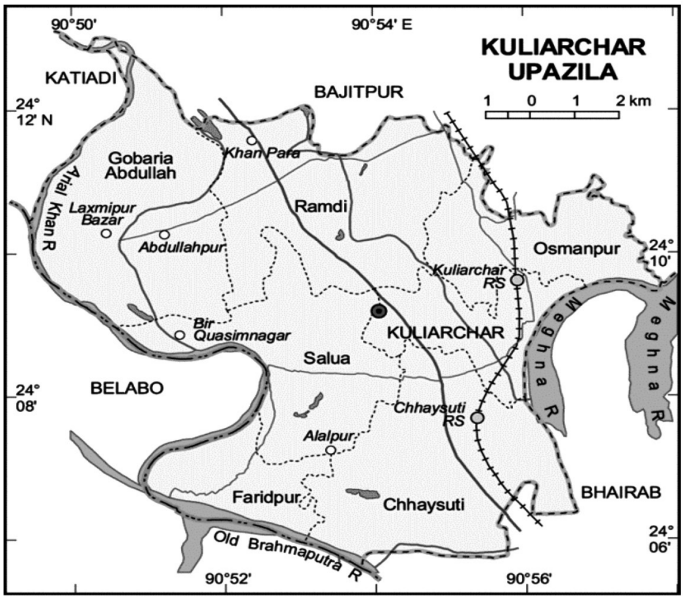

Figure 2.1: Site Map of Kuliarchar Upazila

3.4 Sources of Data

Poultry broiler rearers were the respondent of the study. So the primary data was collected from farmers involved in the production of poultry broiler meat. The data was collected from December 05, 2015 to March 20,2016. About 115 poultry farmers were selected and after necessary correction 100 poultry farmers were finalized for our research study.The collected data were studied by analyzinng mean, median, mode, outliers etc. Besides data were fitted for our study after taking necessary diagonestic treatment such as

multicollinearity (VIF), hetroskedasticity etc. Finally the farms were categorized according to the number of birds reared in the farm followed by The Bangladesh Bureau of Statistics (BBS). As per as BBS the definition of different farms is as follows:

TABLE 1: CATEGORIZATION OF FARMS

No. of Birds	Categories of Farms
Up to1000 birds:	Small
1001-5000 birds:	Medium
Above 5000:	Large

Sources: Farm Poultry and Livestock Survey 2007-08" by BBS

The above definition of poultry farms was used during the study.

IV. ESTIMATES OF CES PRODUCTION FUNCTION

The section starts with the descriptive statistics of the study.

4.1 Descriptive Statistics of Broiler Farmers

Table 2 below shows the summary descriptive statistics of the broiler farms. The table shows that in the study area the mean flock size was 2,567 birds. The average year of experience of farmers was 5.4 years and the mean age of farmers was 40. The poultry farmer's average family size was 5.

TABLE 2: BROILER DESCRIPTIVE STATISTICS

Variable	Obs	Mean	Mean	Min	Max
Flock size	100	2567.1	2559.238	100	1000
Experience	100	5.423	3.260286	1	15
Age	100	40.13	7.34662	18	54
Family members	100	5.03	1.714201	0	9

Source: **Field survey, 2015-16**

4.2 CES Function for Broiler Farmers (Aggregate)

In this segment, we have estimated the constant elasticity of substitution production function empirically, for the production of broiler farm as aggregate, broiler small farm, broiler medium farm and broiler large farm based on our sample data by taking the **natural logarithm of the value of output per worker** (Average Revenue Product of Labor i.e. ARPL) as the dependent variable and that of average **real wage** (real wage was calculated considering the base year 2010-2011) per employee **as the explanatory variable**. We can get the log linear form of the estimated CES function from equation 6 as follows:

$$\mathbf{Ln\ (Q.P\ /L) = Constant + \sigma\ Ln\ (Money\ Wage/P) + u}\text{-------}(7)$$

Where Money Wage/P = Real Wage for Broiler Laborer,

Money Wage =W/L;

P= Price of Product for Meat

Q.P / L = Average Revenue Product of Labor (ARPL) for Broiler Farm

It has already been discussed (in earlier discussions) that the Cobb-Douglas production function is an exceptional case of the CES production function with elasticity of substitution equal to unity. On the other hand, the CES production function can be viewed as an oversimplification of the C-D production function to the case of non-unity, but constant elasticity of substitution.

Having estimated the C-D production function based on composed data of a special sample of leather manufacturing, we made a drive to calculate approximately, following comprehensively the procedure cited above, the CES production function and to find out the corresponding elasticity of substitution for different stage of leather manufacturing industries.

We have prepared a wide use of multiple regression analysis contained by the framework of the method of Ordinary Least Squares (OLS) for our present study. Regressing average annual wage per employee rates on output per employee in each category of poultry farms for both broiler and layer production. We receive the asking CES production functions and the corresponding elasticity of substitution (as shown by coefficients of wage rate) for each case in the model.

4.3 CES Function for All Broiler Farms (Aggregate CES Function)

First of all we have estimated CES function for all broiler farms in the study area as a whole i.e. aggregate CES function. For this purpose we have used the following regression equation:

$$\textbf{Ln (Q.P /L)}_{\textbf{Aggregate}} = \textbf{Constant} + \sigma\ \textbf{Ln (Money Wage/P)}_{\textbf{Aggregate}} \ldots\ldots\ldots(8)$$

Table 3 below shows the estimated CES production function for all broiler farms. The coefficient of the real wage rate (0.918) that indicates a direct estimate of the elasticity of substitution (б) approaches to unity. Where we see that for broiler aggregate, the elasticity of substitution with respect to real wage rate significantly differs from zero at 1 percent level of significance confirming substitutability between capital and labor. The value of elasticity 0.918 which is near about unity indicates a near proportional relationship between real wage rate and labor productivity changes. The substitution value is near unity implying that the substitution (of capital for labor) has become easier in this case of broiler meat production. This shows that a one percent increase in money wage rate leads to increase the labor productivity by 0.918 percent. The R^2 shows that labor productivity changes are also explained by measured factors in the model.

TABLE 3: CES FUNCTION FOR BROILER AGGREGATE FARM

Ln (Q.P / L) Aggregate = Constant + σ Ln (Money Wage / P) Aggregate

Number of Observation = 100

F (1, 98) = 139.86

Prob> F =0.0

R-squared = 0.622

Adj R-Squared =0.608

ln(Q.P / L)	Coef.	Std. Err.	t	P>t
Ln (Money Wage / P)	0.918328	0.2223038	4.130959525	0.00007637
_cons	2.0084	0.2226249	9.021452677	0.00

Source: Author's Calculation

Now then we have estimated CES function based on category of farms i.e. small, medium and large farms respectively to see whether value of elasticity differs across categories.

4.4 CES Function for Broiler Small Farm

The regression results of the CES production function (table 4 below) shows that the regression coefficient of log wage rate 0.78, which is constant elasticity of substitution, is significantly different from unity confirming that the choice of the CES production function is correct. But the lower value of the elasticity of substitution (0.78) implies that it seems to be really tough to substitute capital for labor i.e. the extent of possibility of factor substitution is lesser in case of broiler small farm production.The value of coefficient shows that a one percent increase in money wage rate leads to increase the labor productivity by 0.78 percent. The R^2 shows that 61 percent of the changes of the dependent variable are explained by the independent variables in the model.

TABLE 4: CES FUNCTIONFOR BROILERSMALLFARM

Ln (Q.P / L) Small = Constant + σ Ln (Money Wage / P) Small

Number of Observation = 42

F (1, 40) = 62.56

Prob> F =0.0

R-squared = 0.61

Adj R-Squared =0.590

ln(Q.P /L)	Coef.	Std. Err.	t	P>t
Ln (Money Wage / P)	0.780	0.222	3.512	0.001
_cons	2.000	0.266	7.507	0.0

Source: Author's Calculation

4.5 CES Function for Broiler Medium Farm

The regression results of the CES production function (table 5 below) shows that the regression coefficient of log wage rate 0.886, which is constant elasticity of substitution, is significantly different from unity confirming that the choice of the CES production function is correct. But the lower value of the elasticity of substitution (0.886) implies that it seems that the extent of possibility of factor substitution is lesser in this case. The R^2 shows that 61 percent of the changes of the dependent variable are explained by the independent variables in the model.

TABLE 5: CES FUNCTIONFOR BROILERMEDIUMFARM

Ln (Q.P / L) Medium = Constant + σ Ln (Money Wage / P) Medium

Number of Observation = 32

F (1, 30) = 51.08

Prob> F =0.0

R-squared = 0.602

Adj R-Squared =0.588

ln(Q.P / L)	Coef.	Std. Err.	t	P>t
Ln (Money Wage / P)	0.886	0.298	2.970	0.005
_cons	1.880	0.127	14.775	0

Source: Author's Calculation

4.6 CES Function for Broiler Large Farm

The regression results of the CES production function (table 6 below) shows that the regression coefficient of log wage rate 1.21, which is significantly different from unity confirming that the choice of the CES production function is correct. The value of substitution is positive and larger than unity emphasizing the fact that the substitution possibilities are more in favor of labor than capital.The higher value of the elasticity of substitution in this case, in turn, implies that it has become relatively easier to substitute capital for labor i.e. possibility of factor substitution tends to be higher in case of large farm in comparison with the earlier two categories of farm (small and medium farm). The value of coefficient 1.21 shows that a one percent increases in money wage rate leads to increase the labor productivity by 1.21 percent.We can also say that labor productivity in this case is relatively more elastic to the changes in money wage rate.

TABLE 6: CES FUNCTION FOR BROILER LARGE FARM

Ln (Q.P / L) Large = Constant + σ Ln (Money Wage / P) Large

Number of Observation =26

F (1, 24) = 31.81

Prob> F =0.0

R-squared = 0.597

Adj R-Squared =0.569

ln(Q.P / L)	Coef.	Std. Err.	t	P>t
Ln (Money Wage / P)	1.212	0.488	2.483	0.020
_cons	3.003	0.199	15.075	0.0

Source: Author's Calculation

V. CONCLUSION AND POLICY IMPLICATIONS

For the case of Bangladesh broiler meat production, this paper makes the first attempt to estimate the CES production function with the objective of finding out the elasticity of substitution for capital and labor.From our study we have found that the magnitude of the elasticity is significantly less than unity in case of broiler aggregate i.e. 0.91 and broiler small and medium farms i.e. 0.78 and 0.886 respectively (table 2 and 3 correspondingly). This implies inelasticity for farm inputs which in turn leads to conclusion that it seems to be really tough to substitute capital for labor i.e. the extent of possibility of factor substitution is lesser in case of broiler small and medium farms. On the other hand,in case of large farms the elasticity magnitudewas positive (1.212 mentioned in table 4) and significantly larger than unity meaning high flexibility with respect to relative factor price i.e. emphasizing the fact that possibility of factor substitution tends to be higher in case of large farm in comparison with the earlier two categories of farm (small and medium farm). All these suggest that there is high output rate in case of broiler large farms specially compared to medium and then small farms.

As the wage to rental rate ratio changes, the sector with a higher elasticity of substitution between capital and labor – is in a better position to take advantage of these changes than the less flexible one. Due to the least per unit cost, reduced managerial cost in long run large farms face more efficiency than do medium and small farms. The smallholder broiler farmers are characterized by poor production process, low production quantities thus slow growth. That's why small farms (and medium farms also) demand special nurture and policy support from the govt..We need to keep in mind that small scale poultry enterprise play pivotal role for rural people especially illiterate, women and youth through generating employment opportunity. And small farm in this sector can reduce the rate of poverty enormously. If small farms were provided capital or capital machineries, equipment, modern technologies they could also do better and can survive in the market in long run. Our findings indicate the urgency of doing something particularly for the small farms from the govt. at a large scale. In this regard govt. can nurse the small poultry farms across the country through providing budgetary allocation as for poultry subsidy.Poultry Insurance can also be considered and may be introduced in this regard mainly underlining on small farmers.

The long-term position of Bangladesh as a prominent producer of poultry products leftovers bright even after the bird flu epidemic that has held off its prospect. The swelling demand for poultry meat and eggs has improved poultry activity into a full-grownindustry from a mere household activity until recently.This is the high time for govt. to take all necessary policy steps regarding poultry sector particularly emphasizing on the availability of quality chicks and feed, vaccination service by dept. of livestock, tax exemption and providing subsidy, introducing poultry insurance and finally creating a poultry friendly environment. The findings would contribute toproject the Bangladesh's effective policies on poultry broiler production with the appropriate allocation of inputs factors in order to achieve the optimal output. All categories of All categories of stakeholders should partake in policy formulation for the development of the poultry industry. stakeholders should partake in policy formulation for the development of the poultry industry. The sector will contribute more than it is expected to be if proper policy is taken and will contribute to the country's GDP leading a strong domestic economy of the country.

However, in the present paper we have studied 100 broiler farms and conducted our research work based on only two regions (such that Dhaka and Kishorganj). One can carry the same study more vigorously by incorporating more farms and raising the number of research region. If that one is possible we would have better result. Besides, in the current work we have studied only broiler not layer farms. Researchers interested in this industry can go for studying poultry layer farms to see the magnitude of the elasticity in that case. So then we can have an overall picture of the poultry industry in Bangladesh.

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