(RESEARCH ARTICLE)

Budgetary trade-offs in minimum wage adjustments: A Nigerian Case Study through the Lens of Cooperative Game Theory and Shapley Allocation

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Abstract

This study examines the budgetary trade-offs inherent in minimum wage adjustments in Nigeria and their implications for human capital development, fiscal sustainability, and macroeconomic stability. Employing a cooperative game theory framework, with the Shapley value as the solution concept, the research models the strategic interaction between labour unions and the government during wage negotiations. The analysis demonstrates that cooperative bargaining yields Pareto-superior outcomes for both parties and the broader economy, in contrast to prolonged non-cooperation, which aggravates fiscal strain, fuels inflationary pressures, and undermines human capital. Findings indicate that Nigeria's current fiscal constraints and limited revenue capacity are insufficient to sustain an unrestricted living wage without inducing significant macroeconomic distortions. Consequently, the study advocates for institutionalizing a permanent tripartite negotiation mechanism, conducting rigorous ex-ante fiscal impact assessments, and enhancing domestic revenue mobilization. These measures are proposed to facilitate sustainable minimum wage adjustments that equitably balance worker welfare with fiscal affordability and economic stability.

1. Introduction

The minimum wage, defined as the statutory minimum remuneration an employer must pay for work performed within a given period, is a globally recognized policy instrument aimed at protecting workers from exploitation and improving the socioeconomic conditions of low-wage earners (ILO, 2011; Addison & Blackburn, 1998). While its purpose is redistributive and protective, the economic and fiscal outcomes of minimum wage adjustments remain deeply contested, with effects varying significantly based on labour market structures and institutional contexts (Gindling, 2018).

Conventional economic analysis suggests that setting a wage floor above the market equilibrium may lead to unemployment and inflationary pressures, potentially undermining human capital formation (Antonova, 2018; Dakuku, 2024). However, empirical and theoretical counterpoints exist. Seminal work by Card & Krueger (1994; 1995) challenged the presumption of adverse employment effects, while models of monopsonistic labour markets illustrate how judicious minimum wage increases can enhance both employment and living standards (Stigler, 1946). More recently, research has shifted toward understanding the interaction between wage policy and human capital including the skills, knowledge, and competencies that drive individual and national economic growth (OECD, 2018; Wang & Chen,

2006). For instance, Alessandrini & Milla (2024) demonstrate that minimum wage levels influence educational pathways, stimulating enrolment in occupation-specific programs while discouraging traditional academic pursuits, thereby shaping the composition of a nation's future workforce.

In Nigeria, the negotiation over minimum wage levels embodies a critical budgetary trade-off. On one hand, increasing the wage to a "living" standard could boost disposable income, alleviate poverty, and foster human capital development. On the other, it risks exacerbating fiscal deficits, fuelling inflation, and raising production costs, and potentially stifling employment and economic stability. Conversely, maintaining a "symbolic" wage may contain short-term fiscal and inflationary pressures but perpetuates multidimensional poverty, inequality, and underinvestment in human capital. This tension frames the wage-setting process as a cooperative bargaining problem between the government and labour unions, wherein both parties stand to lose from non-cooperation, yet must negotiate a division of limited fiscal resources.

Game theory provides a structured framework for analysing such strategic interactions. In a cooperative game, players form binding agreements to achieve collectively superior outcomes, as opposed to non-cooperative conflict, which often yields suboptimal payoffs for all (Bayer, 2019). Solution concepts such as the Nash bargaining solution, the Kalai–Smorodinsky solution, and notably the Shapley value, introduced by Lloyd Shapley in 1953, offer mechanisms for distributing gains fairly based on each player's marginal contribution to the coalition. Applying this lens to Nigeria's wage negotiations helps to identify equitable and efficient settlements that balance worker welfare with fiscal sustainability.

Between 1981 and 2024, Nigeria has enacted five national minimum wage acts, each amid union agitation and macroeconomic uncertainty. The most recent, passed in July 2024, continues a pattern of nominal increases that often fail to translate into real welfare gains due to inflation and exchange rate volatility (Alege, 2021). Studies indicate that without indexation to inflation, wage hikes may yield minimal real benefits (Vázquez et al., 2017), while the macroeconomic repercussions, both positive and negative, remain ambiguous and context-dependent (Alessandrini & Milla, 2024; Baducco & Janiak, 2018).

This study, therefore, seeks to analyze the budgetary trade-offs in minimum wage adjustments in Nigeria through the analytical lens of cooperative game theory and the Shapley value. It aims to determine how cooperative bargaining can produce a sustainable wage policy that supports human capital development without compromising fiscal stability, thereby contributing to both theoretical and policy discourse on equitable and efficient wage-setting institutions.

2. Literature review

2.1. Theoretical Framework

Controversies have surrounded the determination of the lowest and acceptable level of renumeration payable to a worker as far back as the 19th century when Karl Max extensively developed the theory of "surplus value", a monetary surplus arising from human labour in a productive action. To make a profit, Marx argued that the capitalist appropriates this surplus value and exploits the labourer who receives less than the value their labour has added to the goods, usually only enough to maintain them at a subsistence level. Conversely, several economists such as J.B. Clark (1847-1938), P.H. Wicksteed (1844-1927) and J.G. Knut Wicksell (1851-1926) at different times contributed to the popularization of the marginal productivity theory which holds that, under conditions of perfect competition, every worker of same skill and efficiency in a given category will receive a wage equal to the value of the marginal product of that type of labour. This theory assumes perfect competition, perfect mobility of labour from employment to employment, homogeneous character of all labour, constant rates of interest and rent and given prices of the product. These conditions are not obtainable in a dynamic world and factors assumed to be constant are actually fitful but the marginal productivity theory is still valuable in understanding the basic forces that determine wages.

However, Davidson (1898) in his bargaining theory of wages holds that wages, hours of work and working conditions are determined by the relative bargaining strength of the parties to the agreement. Labour agents and policy makers in Nigeria and many other countries of the world have had the need to initiate and participate in this bargaining process as a result of the rising cost of living aggravated by inflation. Davidson (1898) maintains that the determination of wages is an extremely complicated process involving numerous influences that interact to establish the relative bargaining strength of the parties and argues that no one factor or single combination of factors determines wages and that no one rate of pay necessarily prevails. Instead, there is a range of rates, any of which may exist simultaneously. The upper limit of the range represents the rate beyond which the employer refuses to hire certain workers. This rate can be influenced by many factors, including the productivity of the workers, the competitive situation, the size of the investment, and the

employer's estimate of future business conditions. The lower limit of the range defines the rate below which the workers will not offer their services to the employer. Influences on this rate include minimum wage legislation, the workers' standard of living, inflationary pressure, the workers' appraisal of the employment situation, and their knowledge of rates paid to others. This theory justifies the existence of unions, succinctly explains wage rates in short-run situations such as the existence of certain wage differentials but over the long run it has failed to explain the changes that are observed in the average levels of wages (Boulding et al, 2023). The bargaining theory of wages is elegant, realistic, dynamic and obtainable in many nations of the world including Nigeria.

2.2. Empirical Review

2.2.1. Minimum wage in Nigeria

To reduce poverty in Nigeria, several poverty reduction strategies, such as Minimum Wage Repeal Acts, Operation Feed the Nation (OFN), National Directorate of Employment (NDE), National Poverty Eradication Program (NAPEP), Subsidy Reinvestment and Empowerment Program (SURE-P), as well as National Social Investment Programmes (NSIP) have been adopted by government over the years (Ewubare & Okpani, 2018). However, these strategies have proven ineffective and almost 83% of Nigerians live below the poverty threshold according to a 2020 report from the National Bureau of Statistics and the world bank (World Bank, 2020). Urama & Iheonu (2019) attributed the ineffectiveness of these policies to political corruption, political instability as well as leadership failure. The prospect of the minimum wage to improve living standard has over the years failed to serve its purpose due to inflation and exchange rate volatility. The depreciating value of the Naira and the failure of government to alleviate poverty clearly signify the socio-economic challenges confronting minimum wage earners in Nigeria (Olanrewaju, 2022).

It has also been observed that under paid workers are susceptible to early mortality, significant under nourishment for them and their households, persistent morbidity and illiteracy. (Dakuku, 2024) during the debate on minimum wage increase lamented on the absence of enforcement for labour laws in Nigeria as follows; "The problem with government-induced increase is that only a limited number of workers, civil servants at the federal level, will get the money; many states may claim they need the means to pay that. Even if the state civil services pay that, combined with the federal civil service, they make up less than 25% of the employed workforce in Nigeria. Most of our workforce comprises low-wage workers, whom SMEs and organized private sector firms employ. These small businesses are struggling to pay the ₦30,000 per month minimum wage, much more the new minimum wage. This minimum wage will make these workers poorer if they do not get it like the civil servants because they all buy from the same market."

2.2.2. Minimum wage expansion and resultant effect

In the past, the expansion of the Chinese minimum wage system was accompanied by controversy regarding the suitability of the policy for the Chinese economy. The same nature of controversy is presently on going in Nigeria. In China, proponents argued that it is a necessary means to warrant sufficient living standards for vulnerable workers and that it introduces incentives for companies to upgrade excessively labour-intensive production technology, while opponents of the minimum wage policy argued that the policy interferes with the transition to a market economy and that it raises production costs which in turn harms the international competitiveness of Chinese companies (Cooke, 2005; Wang & Gunderson, 2011). Cuong (2013) employs a difference-indifference methodology with propensity score matching and finds no statistically significant effect on firm profits in Vietnam after a minimum wage hike of about 20% in 2005.

Draca et al. (2011) equally adopted a difference-in-difference approach and found that the introduction of the UK minimum wage in 1999 has reduced firm profitability. Metcalf (2008) in his study concluded that the ability of firms to absorb the increase in labour costs through a reduction in company profits is one of the reasons for an absence of a negative employment effect of the policy in the UK. Cahuc & Michel (1996) showed that minimum wage can have a positive impact on growth by inducing more human capital accumulation and reducing unemployment caused by low demand for unskilled workers.

However, Rama (1999, 2001) finds that doubling the minimum wage in Indonesia during the early 1990s has led to a decrease in employment by 2% and a decrease in investment by 5%. Based on a model of labour markets with frictions, Pischke (2005) argues that labour market institutions such as unions and wage policies, which distribute rents to lower skilled workers, raise the incentive for firms to invest in their training and the fixed capital that is associated with their jobs. His empirical analysis based on OECD economies and differences in labour market institutions between Europe and the US roughly supports this theory. Various studies on minimum wage affirm that minimum wage increase in Nigeria does not lead to better standard of living for low-income households (Nwude, 2013; Anake, 2014; Aderemi & Ogwumike, 2017; Ogwumike, 2017; Alege et al, 2021; Usman et al, 2021). Economic theories have also submitted that

productivity in a free-market environment is driven by market forces and market competitions. Therefore, a public sector that is too large and does not have proper control of productivity is the reason for general low productivity and labour productivity is a significant factor influencing the level of minimum wage (Dobija, 2011). Again, a world bank report argues that minimum wage by itself is not a sufficient tool for protecting the income of the poorest households, and that other social protection tools are necessary to complement it (World bank, 2021). The inconsistency in previous studies underline the fact that significant scope exists for future research in this field of study.

3. Methodology

This study employs a descriptive research design with the application of cooperative game theoretic approach to investigate the possible outcome of the labour union's minimum wage policy requests, the response from policy makers and the resultant effects of their decisions on the minimum wage earners in Nigeria. In game theory, a cooperative game is a game with groups of players who form coalitions with an external force enforcing cooperative behaviour. Cooperative game theory provides a solution concept in a grand coalition, smaller coalitions or to subgames birthed by any newly formed coalitions. It therefore has a basic assumption of the existence of a coalition. That is, for a cooperative game to take place, a coalition is to be formed. Cooperative games are analysed by focusing on coalitions that can be formed and the joint actions that groups can take as well as the resulting collective payoffs (Brandenburger, 2007).

3.1. Solution concepts

This game features two coalitions or groups identified as player 1 and 2. Player 1. The Labour Union: A labour union is an organization of workers in a country or an industry created to represent wage earners in negotiations over issues of wage payment, benefits, and working conditions. The interest of this coalition in the game therefore is to protect wage earners (themselves) from exploitation and improve their living standard.

Player 2. The government: They are a group of people with the authority to govern a country or state, an institution or a particular ministry in office. They provide public goods and services that are non-excludable and manage externalities. They equally decide on government spending and determine the pattern of distribution of income. The interest of this coalition or group in the game is to ensure a stable economy through controlled or planned expenditure. The agreement of both players will be made into a bill and signed into law by the House of Assembly.

Cooperative bargaining: This takes place when two players undertake the task of deciding how to share a surplus which they jointly generate. There are numerous possible sharing formulas which drives the players into negotiating which division of payoffs to adopt. This situation is called the bargaining problem. An optimal decision is made when both parties are willing to cooperate in implementing the fair solution. Such solutions are used to solve economic problems such as labour-management conflicts (Thomson, 1994)
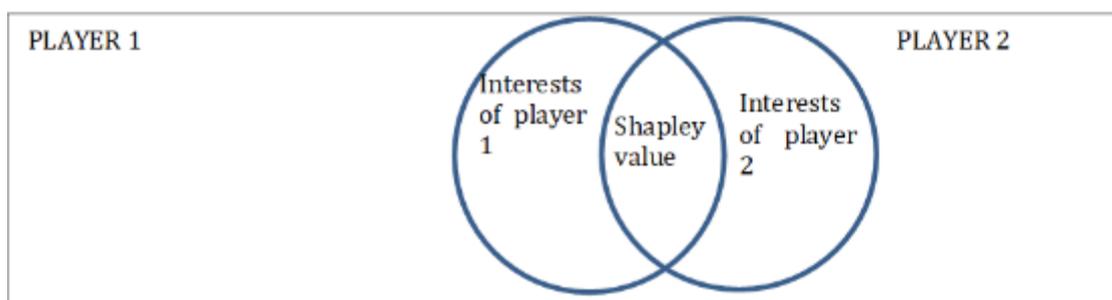

Figure 1 Shapley value solution

The Shapley value: This is a solution concept that involves the fair distribution of both gains and costs to several actors working in a coalition and the sum of the Shapley values of all agents equals the value of the grand coalition such that if the cooperation has positive externalities, all agents (weakly) gain, and if it has negative externalities, all agents (weakly) lose. It assigns values to the individual agents in a grand coalition but has been generalized to also apply to a group of players called coalitions treated like individual players (Grabisch & Roubens ,1999).
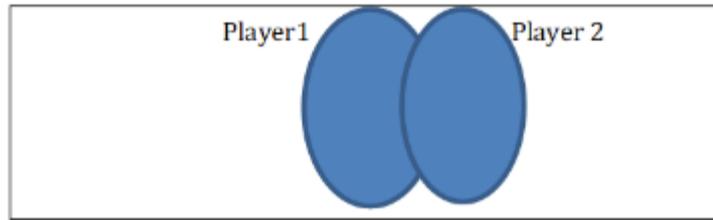
Figure 2 The Core solution

The core solution: This is the set of feasible allocations where no coalition of agents can benefit by breaking away from the grand coalition. At the core, it is possible to sustain unreserved cooperation among all agents. A coalition is said to block a feasible allocation if the members of that coalition can generate more value among themselves than they are allocated in the group. As such, that coalition does not have any incentive to stay with the grand coalition. An allocation is said to be in the core of a game if there is no coalition that can improve upon it. That is, there is no better deal outside the agreement of the grand coalition.
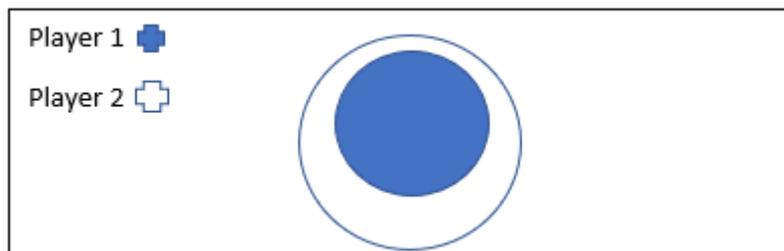
Figure 3 The Nucleolus solution

The Nucleolus solution: This is achieved when payoff jointly created by players are equitably allocated. The two coalitions all have their desires fully satisfied. This solution maximizes the smallest excess of a coalition (where the excess is the difference between the payment given to the coalition and the value the coalition could get by deviating). A nucleolus solution is achieved when the welfare of the worse treated coalition is maximized.

4. Analysis and discussion

Inflation, high cost of living and the poor purchasing power of the Naira in recent time has made consumption spending dreadful and triggered the demand by the labour union for the government to raise wages through increasing the minimum wage. Increasing the minimum wage will reduce income inequality, alleviate poverty and improve on the distribution of the nation's resources. In order to achieve a fair and suitable resource redistribution through wages, a cooperative bargaining process is applied by the parties' called coalitions with the aim of arriving at a solution. The coalitions are therefore faced with the problem of determining what solution is most appropriate. The grand coalition cannot share values not earned and sharing benefits with respect to the inputs of the coalitions will reduce the incentive to deviate from the bargaining process (Not cooperate) to the barest minimum.

Table 1 The Game payoff matrix

PLAYER 1			
PLAYER 2	Minimum wage dynamics (Bargaining strategy)	Cooperates during bargaining	Deviates during bargaining
	Cooperates during bargaining	Both players are better off equally A	Player 2 is more worse off than player 1B
	Deviates during bargaining	Player 1 is more worse off than player 2C	Both players are worse off equally D

Table 1 Shows that if the labour union and the government resolve not to deviate during the bargaining process, they will reach a solution that will favour the individual coalition and the grand coalition. However, if the labour union decides to deviate during bargaining, suppose they can get a better deal without cooperating, it will slow down productivity, economic activities and adversely affect the economy. The same scenario and outcome will be obtained suppose the government deviates. Such deviation will aggravate instability and stifle the economy. The grand coalition suffers in the face of conflict as seen in segment D of Table 1. Game theoretic steps may take any dimension but evidently, the eventual outcome of non-cooperation in a bargaining game is a non-desirable payoff for both players or the grand coalition.

Therefore, the solution to the cooperative bargaining game in this study is not at the nucleolus because of the economic down turn in Nigeria. The Nigerian economy does not have the capacity to fully maximize the welfare of wage earners. The new national minimum wage bill for federal workers passed into law in July 2024 pegged the minimum wage at ₦70,000 whereas the world bank advocates living on 1.90 dollars or above a day in order not to be classified as extremely poor. This puts the acceptable minimum wage at above ₦90,000 and at above ₦360,000 per month for an average household. The solution is not at the core either because in practice, it is impossible to sustain an unreserved cooperation from both coalitions. The Nigerian government does not prioritize social welfare. There is no framework for the maximization of the welfare of wage earners. However, conflict between the labour union and the government will harm the general economy (grand coalition). Therefore, the players have to reach a consensus, a middle ground, a point of "fairness", "balance" which the Shapley value solution featured in segment A of Table 1 offers. The Shapley value of a cooperative game theory provides a fair distribution bench mark in all sorts of economic and political negotiations (Agnew, 2022).

5. Conclusion

This study has employed the Shapley value framework from cooperative game theory to model the critical budgetary trade-offs between the government and labour unions in Nigeria's minimum wage negotiations. The analysis shows that cooperation, achieved through fair, Shapley-based bargaining, yields Pareto-superior outcomes, while non-cooperation deepens fiscal strain, fuels inflation, and harms human capital development. Consistent with the findings, Nigeria's fiscal space remains too constrained to support an unrestricted living wage without exacerbating macroeconomic distortions. Yet, retaining a purely symbolic wage perpetuates poverty, undermines skill acquisition, and stifles long-run growth, particularly detrimental in a knowledge-driven economy where human capital is vital (Sen, 1999; Alessandrini & Milla, 2024). Therefore, sustainable wage policy must balance workers' welfare with fiscal realism through institutionalized tripartite dialogue, ex-ante fiscal impact assessment, and enhanced revenue mobilization, measures derived directly from the cooperative game solution. Notably, embedding the Shapley value into Nigeria's wage-setting framework offers a viable mechanism for achieving equitable and economically sound agreements. Such an approach can reconcile the competing objectives of social protection and macroeconomic stability, fostering both human capital development and sustainable economic growth in Nigeria.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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