Of Deprivation and Well-being: Essays in Applied Economics

by

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Abstract

This dissertation comprises four chapters in applied economics, addressing various dimensions of deprivation and well-being. The first chapter contributes to the identification of individuals experiencing poverty. Using a novel statistical approach called the double-fuzzy model, applied to the Tunisian National Survey on Household Budget, Consumption, and Standard of Living (2015), this study expands the existing literature on multidimensional poverty measurement. The second chapter investigates the distribution of resources and deprivations in families. By employing Cragg's double-hurdle model on the time-use module of the Tanzanian Integrated Labor Force Survey (2006), the study explores gender differences in children's time use in Sub-Saharan Africa, shedding light on family resource allocation beyond monetary aspects. The third chapter focuses on the impact of non-physical deprivations on well-being, with a particular emphasis on the COVID-19 pandemic and the ensuing policies. Using the Group-Based Trajectory Modelling approach on data from the UK Household Longitudinal Study (2020-2021), the study examines the relationship between loneliness, job insecurity, and mental health trajectories in the UK population. It contributes to the field of health and positive economics, particularly in the domain of mental health. Lastly, the fourth chapter takes a macroeconomic perspective, exploring the long-term relationship between economic growth and income inequality in a developing country. By conducting a cointegration analysis of Indonesian data on GDP and the Gini index, along with a descriptive analysis of the country's political and economic history, the study aims to enrich the knowledge of the Indonesian economy and its implications for individuals' experiences.

Foreword

Poverty is, undoubtedly, one of the world's most significant issues, defined by Sen (1985) as 'the deprivation of capabilities, choices and opportunities that are necessary for living a life of dignity and empowerment'. The economic study places scarcity at the core of its inquiry, rationalising the mechanisms of production, allocation, and consumption under the limited availability of resources. As an extreme form of scarcity, poverty is profoundly felt as a social phenomenon, especially on the household and individual levels. A lot of effort has been poured into initiatives to help the poor in the form of social benefits. From food banks, disability benefits, and universal credits, society recognises the importance of providing aid to those who need it. As necessary as it is to invest in poverty alleviation, it is equally significant to understand the root cause of poverty.

While numerous attempts have been undertaken to tackle the problem of poverty, it is important to identify our adversary. Throughout the past century, our understanding of what poverty is has evolved as our society progressed. In the late 19th century, Booth divided the London populace into two groups: those living in poverty and in comfort, based on their weekly wages. His work is considered to be among the earliest attempts to draw a poverty line as we know it. Ever since then, poverty, and the ability to combat it, have grown into a measure of societal progress. The term *in comfort* perfectly encapsulated what we should strive to achieve as a society: providing for everyone beyond the bare minimum necessity a human being requires not to perish.

Today the field of economics recognises the concept of well-being. As a society, we understand that a good quality of life is our main objective. Technological developments are undertaken in an attempt to create a better life for all because there are many things beyond monetary resources that we require to achieve this goal. Living a good life in a developed society also means having access to healthy nutrition and lifestyle, maintaining a good work-life balance, enjoying an eco-friendly and sustainable environment, pursuing hobbies and interests, and having the ability to strive for self-fulfilment. Our objective as human species is to create a world in which everyone has a chance to live a dignified

existence. The idea of living *in comfort* thus becomes something that is less of a luxury, but something that is within our reach and very much attainable.

Because of the above, I find that this intertwining between poverty and well-being is crucial for understanding which steps we need to take as a society to help reduce poverty and improve people's livelihoods. This dissertation project consists of four essays, each of which sets forth an aspect of the discourse on poverty and well-being. Every essay revolves around an underlying question, namely, who are the poor? How are resources and deprivations distributed in the family? And does economic growth deliver on the promise of shared prosperity? Below, I will review each question in more detail.

Who are the poor?

As I have outlined in the opening paragraph, the question of who are the poor has been the subject of many studies for years. Rowntree (1902) further developed the ideas first proposed by Booth (1887), and ever since then, there have been numerous contributions in this field of study. Both Booth and Rowntree agreed that the poverty threshold is a testament to one's ability to subsist and survive, but as time progressed and more sophisticated approaches were offered to draw the poverty line, the idea of *in comfort* gained more importance. It has become a consensus that dignity is a human right and thus has to be considered when speaking of poverty[1]. We must move beyond the idea of bare minimum requirements to subsist and survive.

Figure 1: Distribution of the world's population on different poverty thresholds 1820-2018 (Source: Our World in Data)

We have come a long way since the days of Booth. During the past century, improvements in many aspects of our life meant that the term *comfort* has become a moving target,

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[1]An interesting discussion about human dignity and poverty, especially referencing the European philosophical tradition, is summarised in Althammer (2022).

especially if we are to also consider the *dignity* aspect of living. Take one innocuous aspect of our life that has become a testament to how far we have come: smell. Inquiries into historical testimonies are frequently peppered with descriptions of olfactory sensations. Be it the lack of sanitation infrastructure, or simply the lack of consideration for personal hygiene, the smell became a great divider between the haves and the have-nots. Amidst the blanketing stench of cities like London or Paris, we have those who douse themselves in perfume to avoid the miasma the unfortunate ones must stomach. Those without the means to mask the odours simply grew accustomed, slowly building an insensitivity. Literary works such as Patrick Süskind's *Perfume* 1986 built a metaphor through the birth of its protagonist from his fishwife mother in the heat of the Parisian market as something that haunts him through his adolescence: his inability to deliver himself from the stench of rotting fish. With foul odours being omnipresent, in earlier times, going about one's business while smelly was not perceived as a problem.

Fast forward to today, with its wonders of running water, sewage system, strict urban regulations, and affordable and accessible sanitary products, offensive body odour is no longer tolerated. In the 2019 Academy Award-winning social thriller *Parasite*, a poignant criticism of his native South Korean society, director Bong Joon-ho made smells an essential aspect of his storytelling. No matter how strongly the down-on-their-luck Kims attempt to swindle their way into the upper-class Parks' personal space with nice clothes and fine demeanours, they can never escape the stench of poverty. 'The smell crosses the line', says the patriarch of the Park house in one scene, as if alerting the viewers. It is the stench of the Kims' musty semi-basement apartment, soiled in the urine of the inebriated passersby that trickles down the walls into their dwelling. It is the cocktail of human odours that amalgamate in the subway: of the dumpster-adorned way to the station, of the sweat, of the pollution. The stench of poverty is a barrier to those seeking to escape it. Yet amidst the growth of literature exploring the 'other' factors perpetuating the 'poverty trap' problem, be it nutrition, geography, natural degradation, and education to name a few, decent smell, as a basic attribute of human dignity is often not considered.

In an attempt to deconstruct and oversimplify poverty into some sort of 'essence', those in charge come up with a supposedly universal threshold. The infamous $2-a-day line has been used as the International Poverty Line (IPL) by the World Bank. Developed initially by Ravallion et al.[2] to reflect the level of extreme poverty, it has been adopted by most governments and international organisations to provide a point of comparison for poverty alleviation measures.

Poverty is measured in terms of lack of basic goods and services, including food and shelter, access to healthcare and education, and often, political participation. In recent times, we have come to recognise the multidimensionality of poverty, i.e., that monetary resources are not the only concern. Factors concerning the availability of basic infrastructure, such as access to running water and sewage system, play an indirect but crucial role. The concept of multidimensional poverty index (MPI) thus entered the mainstream discourse and has become increasingly popular among policymakers. **?** developed and popularised the useful index of multidimensional poverty by grouping the indicators to three dimensions aside from the monetary resources: health, education, and living standards. The three-dimensions classification was previously introduced by Margit Kollanyi (1996) in the Human Development Report 1996 under the proposal an index called human poverty index (HPI). In 2010 it was eventually replaced by MPI with a support from UNDP. As the successor of HPI, MPI focuses on the household level poverty instead of the average population level. As such, it allows for a more granular understanding of the group of

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[2]To be more accurate, it is $1.90 instead of $2. This line, in turn, was an update to the previous threshold World Bank (1990) based on Ravallion et al. (1991). More recently, it has been updated to $2.15 (Jolliffe et al., 2022).

people who experience poverty. Such development in the poverty measurement approach formalises commitments that seek to include dignity in the study of poverty.

As the delicate line between those living in poverty and those living in comfort changes every single day, the classification also becomes a moving target. Sophisticated methods have been offered by esteemed scholars in search of the golden standard of poverty measurement. Politicians actively seek mechanisms allowing them to help the least fortunate while not provoking anger from taxpayers who feel a sense of injustice. Atkinson (2019) warned his peers about the shortcomings of such pursuits. With the different levels of economic development around the globe, one golden standard cannot be used to determine the poverty line. While those in the developed world do not concern themselves with the availability of running water, such indicators are still useful in the developing world to describe living conditions. In constructing a measure of poverty, It is thus important to localise efforts by addressing the most crucial aspects of daily life experienced by individuals in specific places across the planet.

By taking into consideration the regional uniqueness of the poverty problem, we come one step closer to the root of the cause. However, when such a measure is used as a basis of poverty-targeting policies, i.e., determining who is or is not eligible for support, the burden becomes greater. By adhering to the dichotomy of poor and non-poor, we risk the under- or over-exploitation of resources to achieve the policy goal. A strand of studies offered an alternative to this approach using fuzzy measurement. First explored by Cerioli and Zani (1990), this area of study has expanded in more recent years to the greater area of empirical economics and is especially suitable for application to multidimensional poverty measurement. The idea that poverty is a matter of degree means that the tools we have in hand to determine who is poor and who is not will be more sensitive.

The first chapter of this dissertation is thus dedicated to multidimensional poverty measurement through the use of a fuzzy approach. Fuzzy logic was initially used largely in computer science. In situations where a clear division of true or false can be given, the fuzzy approach offers an opportunity to explore the grey area. Incidentally, it is suitable for the poverty measurement study. The issue of those who are 'somewhat' poor, not quite within or outside the category of being poor, is a sensitive one. This project specifically offers a novel improvement upon the established model by recognising the intertwined nature of deprivation; namely, how more than one dimension is reflected by the same indicator, in an attempt to create a better indicator of determining who is poor.

How are resources and deprivations distributed in the family?

The household, as a basic unit to which poverty is often attributed, has evolved. Although studies typically speak of a nuclear family consisting of a mother, a father, and children, many households take different forms. A single-parent household and a multi-generational housing arrangement are among examples of how the smallest unit of society can take form. Even in the more traditional form, family life has changed due to the shift in gender roles. If in the US in the 1970s there were 46% of households consisting of a full-time working father and a stay-at-home mother, there are only around 26% of them in 2015. Meanwhile, the share of full-time working two-parent households has increased from 31% in 1970 to 46% in 2015 (Pew Research Center, 2015). 4.9% of the population identify as stay-at-home parents, with 85% being the mother US Bureau of Labor Statistics (2021).

Regardless of the family form, its internal dynamic means that the division of resources is unique in each family. Some families obey the traditional assignment of chores based on gender, while in some, the priority vote on the allocation of tasks and consumption of resources lies on the higher-earning adult. With such variation, the state of poverty or comfort in the household can be experienced differently across individuals. It is thus

In Nearly Half of Two-Parent Households, Both Mom and Dad Work Full-Time

% of couples, by work arrangement

Mom & Dad NOT EMPLOYED

Mom FULL TIME,
Dad PART TIME or NOT EMPLOYED

3% — 2%
2 — 6

Mom NOT EMPLOYED,
Dad FULL TIME

46 — 26

Mom PART TIME,
Dad FULL TIME

17 — 17

Mom FULL TIME,
Dad FULL TIME

31 — 46

1970   1980   1990   2000   2010 2015
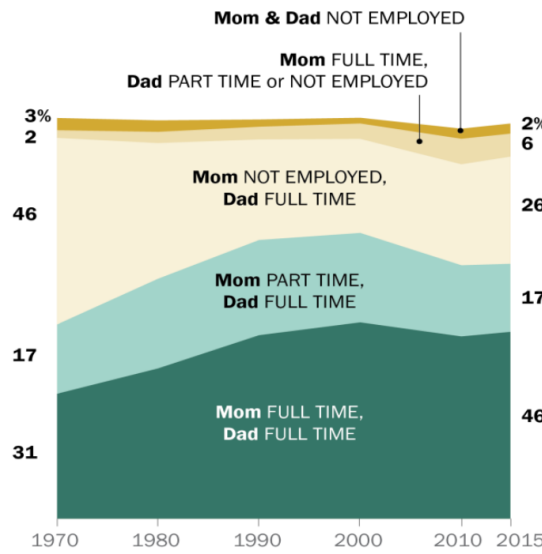
Note: Based on employment status in the prior year among
male/female married couples with at least one child younger
than 18 in the household. Both married and cohabiting
couples included since 2010. Data regarding cohabiting
couples unavailable for earlier years. Other work
arrangements not shown; same-sex couples are excluded.

Source: Pew Research Center analysis of March Current
Population Surveys Integrated Public Use Microdata Series
(IPUMS-CPS), 1970-2015

Figure 2: Historical share of working mother and father in US households 1970-2015 (Source: Pew Research Center (2015))

important to study the division of resources and responsibilities within the household to better understand inequality in its most basic, intimate setting.

Of many factors studied within the multidimensional poverty context, time is certainly one of the most crucial ones. Although some might argue that everyone is granted the same amount of time, i.e., 24 hours a day, it cannot be farther from the truth. The availability of time is closely intertwined with that of monetary resources. Studies in time poverty suggest that time can be 'bought' (Zacharias, 2011), just like any other commodity. It is true in the sense that time is available for purchase in the form of convenience or services, such as food delivery, child care, and cleaning services, to name a few. In circumstances when the market is sophisticated enough to put a price tag on one's time, it is especially sensible to purchase time from other people when their time costs less than one's own. One widespread example concerns new mothers' participation in the job market. If previously a new mother was expected to perform her duty by tending to her infant in the confines of her home, she now has more choice. If she can sell her own time in the market through employment, and the hourly rate of her earnings exceeds the cost of child care, it might make more sense monetarily for her to be a working mother. This, of course, comes purely from the cost perspective and does not take into consideration the emotional gains she might attain by watching her child grow before her eyes. Should she consider the satisfaction she earns from being a stay-at-home mother as exceeding any monetary gains she will generate by working and purchasing child care, she might elect to not work. But although the decision is for her to make, it might not be entirely up to her own devices. Social norms, for one,

might dictate what roles she is expected to fulfil, reminding her of her place in the world. The woman's traditional role as a caretaker is often indisputable, and thus it becomes taboo to suggest expressing her contribution to the family in a monetary value. This, in turn, causes widespread ignorance of the real cost of care.

The second chapter of this work deals with the issue of how children spend their time. A child, upon their birth, is enveloped in a system of norms and values of the family. Their place is well-defined, and so is the future expectation they are to fulfil. Based on their gender alone, the child is raised with an assigned role that they will assume one day. By observing the adults in the household, they begin internalising the worldviews exhibited by the previous generations. It is then natural for them to mimic their parents by imprinting on the gender division, further handing down the pattern to the generations after them. By studying the time-use of boys and girls in Tanzania, I aim to understand whether the pattern that exists among the adults is already evident among their children. It is important to not only compare the probability and time spent on activities relating to household chores and care but also on leisure and learning.

Do non-physical deprivations affect one's well-being?

There are physical needs that have to be fulfilled for one to be able to live well: food on the table, a roof over one's head, good health, and proper habiliments, allowing him or her to be accepted by society, to name a few. Beyond that, one requires a set of less tangible needs to live well. The companionship of fellow men and a sense of security are widely regarded as fundamental as outlined in Maslow (1943) hierarchy of human needs.
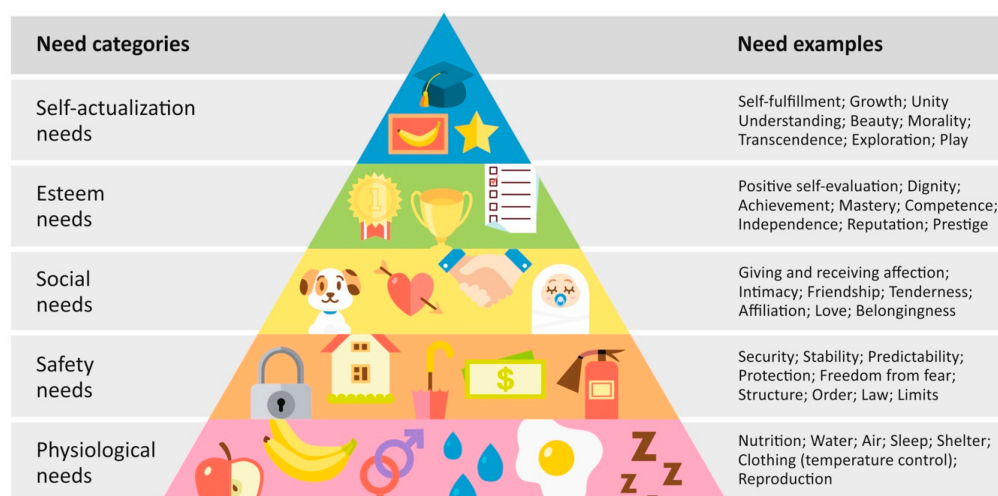
Figure 3: The Maslow's hierarchy of needs (Source: Desmet and Fokkinga (2020), based on Maslow and Frager (1987))

The detrimental effect of psychological deprivation is as dire as its physical counterpart and should be reckoned with. Insecurity and loneliness impair one's ability to make sound decisions, and the resulting mental toll prohibits one to fulfil their potential. Mental health distress has often been cited as a cause of many societal problems in various settings, from family to the local community. Issues such as homelessness, chronic unemployment, alcoholism, and suicide have been attributed to underlying mental health problems Padgett (2020); Farré et al. (2018); Coakley et al. (2021); Teismann et al. (2019). Beyond that, the widespread acceptance of mental health issues as an integral part of health Prince et al. (2007); Ohrnberger et al. (2017) means that their consequences take a very concrete form of economic cost, especially for the healthcare system.

The COVID-19 pandemic has posed the most significant challenge to mental health in our generation. The colossal scale of lockdown policies around the globe grounded the world to a halt, from economies, trade, and business operations all the way down to our personal lives. We were forced to rethink many aspects of our existence as we stayed at home, isolated from both the virus and society. To a certain degree, we were still able to go about our business as usual, some working remotely from the safety of our own homes, and some as 'essential' workers, who braved the fear of uncertainty to ensure that life could carry on. Meanwhile, some of us just stayed at home to wait for the plague to pass. The stay-at-home mandate effectively cut our relationship with those outside of the confines of our four walls. Exacerbated by the isolation, loneliness became more widespread and intense, while the insecurity that came with the closure of businesses agonised those whose jobs were affected.

The third essay explores a very contemporary phenomenon that took place early into my doctoral training: the COVID-19 pandemic, and its effect on people's mental health in the United Kingdom. The UK government decided to step in quite early into the pandemic, anticipating the impending arrival of business closures by temporarily shouldering part of the labour cost. The furlough scheme allowed both the employees and the self-employed to continue receiving a part of their wages or income, though not everyone was eligible. We thus had a population, part of which was able to endure the pandemic with minimal detrimental effects, while the rest had to weather the challenge, both financial and psychological. By using the COVID-19 module that was compiled by the Understanding Society longitudinal survey, I was able to study the mental health trajectories among UK adults. The essay is particularly interested in how one's assignment to a particular trajectory is determined by socio-economic factors, perceived loneliness status, and job insecurity.

Does economic growth deliver on the promise of shared prosperity?

Keynes (2010) and Russell (2004) mused that our society's aim is to create a world in which there is no longer a necessity to work exorbitant hours. The technological advances that we achieved should eliminate the deprivation of leisure by increasing our productivity and boosting economic growth. At the very least, it should liberate the unfortunate from their misery by rewarding them with a piece of the cake representing our societal progress. A more pragmatic inquisition was offered by Kuznets (1955) with his curve, famously postulating that inequality is a part of the journey to shared prosperity. Indeed, the fruit of progress will eventually be shared by everyone, but the sharing process is gradual. Part of the society will be able to accumulate wealth and eventually improve the livelihoods of everyone else around them by investing, consuming, and creating jobs. Trickle-down economics explains that the benevolence of those in the higher income quintile will ensure that everyone will be better off.

Countless empirical works have attempted to either verify or disprove the existence of the Kuznets curve. Meanwhile, inequality remains a problem plaguing societies around the world. Although there are a plethora of studies that offer explanations for the mechanism by which growth and inequality affect each other, it seems that there is hardly a possibility of arriving at a consensus. For some time, the focus of such studies has been directed towards the developed world. For a mostly pragmatic reason of data availability, the developing world has attracted limited attention.

The fourth essay is dedicated to an empirical study of a long-run relationship between economic growth and inequality in Indonesia. Through the use of a time-series econometrics tool, this chapter attempts to explore the existence of a long-term relationship between economic growth and inequality in the country. My choice of geographic region here is also
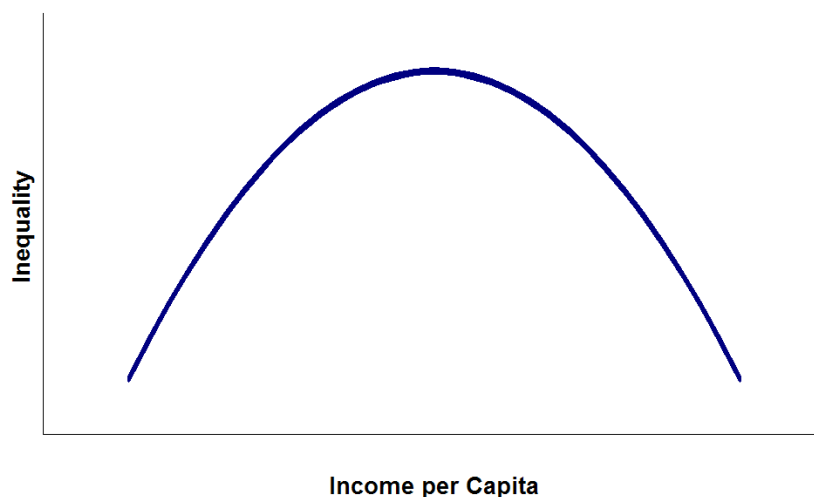
Figure 4: The Kuznets curve depicting relationship between economic growth and income (Source: Wikimedia)

personal, as I see this as an opportunity to amalgamate my academic training in economics, and put it into practice within the context of my homeland. By taking into consideration historical events such as local political turmoil, and various global economic spillovers that the country went through, I aim to paint a somewhat coherent picture of the relationship between growth and inequality over time. This chapter serves as a reminder of the close intertwining between the macro- and micro-sphere of the economic system.

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Across the four essays, I use various empirical approaches, attempting to demonstrate the importance of facing the research question with a sense of openness to what the data can show. In this, I take inspiration from a 2017 talk given by Esther Duflo at the American Economic Association, in which she proposed that the economist adopts the mindset of a plumber, who 'try to predict as well as possible what may work in the real world, mindful that tinkering and adjusting will be necessary since our models gives [sic] us very little theoretical guidance on what (and how) details will matter.' (Duflo, 2017). This dissertation project, albeit modest and limited in its scope and scale, is my humble attempt to tackle the *real world* issues of development economics, all the while remaining mindful that hidden behind data points are real people suffering from inequality, poverty, and loneliness. If one day, any of this will help to make at least one human life better, I shall consider my aim to have been justified.

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Chapter 1

The 'Double fuzzy set' approach to multidimensional poverty measurement

Co-authored with Gianni Betti (University of Siena)

Abstract

In recent years, there has been a growing in the field of development studies that poverty is a multidimensional deprivation that extends beyond the more commonly used monetary perspective. Although it is gaining favour among policymakers, it remains based on a clear distinction between the poor and non-poor via an arbitrary threshold. A multidimensional poverty measurement with a fuzzy-set approach, which allows for the recognition of deprivations as a matter of degree, is one alternative to such an approach. Although the integrated fuzzy approach allows for this, there is an unexplored opportunity to recognise that two or more dimensions can be assigned to a single item or attribute. The purpose of this paper is to contribute to this line of research by introducing a 'Double-Fuzzy' approach. The methodology is applied to Tunisia using the 2015 Tunisian National Household Budget and Consumption Survey (HBS).

Keywords: *multidimensional deprivation; fuzzy sets approach; poverty*

1.1 Introduction

Poverty is one of the most serious issues we face as a society. Its significance earned it a spot among the UN's SDG goals. However, there has yet to be a consensus on the definition of poverty. One of the earliest definitions considered poverty to be a criterion representing the level of bare subsistence (Rowntree, 1901). To move forward with poverty measurement, the concept of a poverty line must be introduced. Although it may appear to be a simplification, it establishes a foundation from which the study can proceed. As more attention was paid to this issue, the definition expanded to include dignity. Subsisting is not the same as living; instead, an individual should achieve an acceptable standard of living (Townsend, 1979). Ever since, the field has come to accept that poverty should be defined by more than just an individual's ability to achieve a certain monetary threshold.

In the last decades, several works have theoretically developed this issue, taking into consideration the multidimensional nature of poverty, which can be only partially captured by a single indicator that is usually based on income or consumption[1]. More specifically, poverty is a complex problem that often manifests itself in a multidimensional framework. This notion is instrumental since individuals may suffer from a different deprivation profile across a geographical context. Notably, developing countries might face several fundamental problems, such as access to water, healthcare, and education, which are more widely available in the developed world (Anand and Sen, 1997).

Various empirical works have shown that income poverty might not give us the complete picture. Chilean data shows that income does not convey a comprehensive view of poverty very well (Ruggeri-Laderchi, 1997). Indian data, instead, indicates that 53% of malnourished children do not live in income-poor households (Stewart et al., 2007). As the field of multidimensional poverty increasingly becomes the norm, it is essential to measure the various dimensions and factors involved. Thus, it is necessary to ensure that the individual has achieved the minimally accepted levels of these attributes (Sen, 1992). Measurement mechanisms such as the multidimensional poverty index (Alkire and Foster, 2011) have become widely accepted for approaching various policy issues. However, the dichotomy between poor and non-poor remains at the centre of the discussion. Although it offers a more straightforward explanation of the current situation, it is evident that such a clear-cut division causes a lack of information and eliminates the nuances that exist between the two extremes of substantial welfare on one end and material hardship on the other (Belhadj and Limam, 2012). To deal with this issue, it is necessary to explore an alternative approach.

Based on the fuzzy set theory (Zadeh, 1965), Cerioli and Zani (1990) introduced the fuzzy set approach in poverty analysis to overcome many of the problems listed above. Since then, many authors have made seminal contributions, including on multidimensional poverty. In particular, Clark and Qizilbash (2008) innovated by introducing the distinction between vertical and horizontal vagueness; continuing with Deutsch and Silber (2005) and the book edited by Lemmi et al. (2006) by describing the philosophical, mathematical and axiomatic aspects of the fuzzy methods; until the last contributions of Fattore (2016) and Fattore and Arcagni (2019), based on Fattore and Maggino (2014). All these methods define at least three main steps:

(i) the definition of the poverty indicator for each item of poverty or deprivation;

(ii) the identification of the dimensions;

(iii) the aggregation of items within each dimension.

In some of these methods, including the present contribution, there is an additional step:

(v) aggregation over dimensions.

This step is fully described in Clark and Qizilbash (2008) with the characteristics of horizontal vagueness. On the other hand, some other contributions, such as Fattore (2016) and the family of the posetic approach, are non-aggregative, which is their peculiarity.

In the present paper, we identify an important gap in such literature: assigning an indicator to one single dimension is often difficult. For instance, consider items/variables such as a leaking roof or mould in the walls. Do they belong to the dimension of housing conditions or environmental problems? Probably they belong to both and have different causes that vary to different degrees, representing membership functions in terms of fuzzy sets. Another example is the construction of fuzzy multidimensional Sustainable Development Goals (SDGs). Even in the construction of the traditional SDGs, some "targets"

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[1]See Atkinson and Bourguignon (1982); Bourguignon and Chakravarty (1999), and Atkinson (2003) among others

may belong to more than one SDG[2]. Moreover, within data-driven approaches, the results from factor analyses are often doubtful or not clear at all.

We aim to close this gap with an original methodological contribution within the broader approach of fuzzy set methods: we have named it 'the Double Fuzzy Set' methodology (DFS), which is fully presented in Sect. 3. Before that, in Sect. 2, we outline the characteristics of the broader fuzzy set approach and the evolution of its incorporation into the literature on multidimensional poverty measurement. These brief explanations serve as an introduction to the proposal of our methodology, in which we permit that one single poverty item/indicator belongs to more than one dimension with different degrees of membership. The paper also has a second important contribution, but, in this case, on the empirical side. This contribution is reported in Sect. 4 and consists of applying the DFS to the Tunisian Household Budget Survey 2015. This dataset is interesting for at least three main reasons. First, it allows empirical analysis linking several dimensions of quality of life that reflect a developing country. Second, an established part of the literature on the fuzzy approach to poverty measurement has been done on this dataset, thanks to works by Besma Belhadj and co-authors. Third, the increasing interest from the World Bank in developing poverty measures in Tunisia at a regional level has led to a survey conducted in 2021 on a larger sample size base Betti et al. (2021).

Finally, the last section of the paper concludes and proposes further developments of the methodology and its application in the social sciences.

1.2   The Fuzzy Sets Approach and Poverty Measurement

The fuzzy set approach was firstly introduced in the field of computer science. It is based on the idea that there are conditions in which the full truth cannot be observed. The world is complex, and sometimes it is not possible to assign an observation to a particular set with full certainty. To understand this better, the most straightforward analogy would be age. A person cannot be assigned entirely to a category of old or young, instead, they are on a degree of oldness or youngness. Fuzzy logic is suitable for handling such partial truth. Moreover, fuzzy sets *"… welcome a certain degree of ambiguity that is present in several social science constructs.…"* (Henriques et al., 2018), and thus they permit to properly incorporate measurement errors intrinsically connected with the "ambiguity" of subjective multidimensional assessment of poverty. Instead of approaching matters with the traditional crisp and Boolean logic that requires an absolute membership to only one set (i.e., 1 OR 0), the fuzzy set approach acknowledges that there is a gradual transition between the extreme (i.e., between the interval [0, 1]). This idea is compatible with the reality of poverty, which is not simply present (= 1) or absent (= 0); instead, it exists as a degree. The theory itself was proposed by Zadeh (1965), but the attempt to incorporate it into the multidimensional poverty framework was made much later by Cerioli and Zani (1990).

Once the identification of items to be included in the indices is performed in the first, they define a quantitative membership function in the range [0,1], determined for each item j, as follows:

$$\mu_j(x_{ij}) = \begin{cases} 0 & x_{ij} = min(x_j) \\ \frac{max(x_j) - x_{ij}}{max(x_j) - min(x_j)} & min(x_j) < x_{ij} < max(x_j) \\ 1 & x_{ij} = max(x_j) \end{cases} \quad (1.1)$$

where $min(x_j)$ is the category associated with the lower poverty level, and $max(x_j)$ is the category associated with the highest poverty level.

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[2]see https://sdgs.un.org/goals.

Since then, there have been two main periods, defined as development and expansion. In fact, the method was further developed by Cheli and Lemmi (1995), which resulted in the Totally Fuzzy and Relative (TFR) approach. The development of the study did not stop there, as it was later refined by Betti et al. (2006), which yielded the Integrated Fuzzy and Relative (IFR) approach. The book by Lemmi et al. (2006) concluded this first period of development with the definition of an overall framework based on the philosophy of fuzzy sets, on mathematics through an axiomatic approach, and on various economic aspects. From 2006, as the new period of expansion, the fuzzy method has moved in several directions. First, through the introduction of the fuzzy approach, two additional factors are to be decided:

  (i) the choice of the membership function and

  (ii) the choice of rules for manipulating the resulting fuzzy sets.

The former refers to the quantitative specification of the deprivation risk faced by individuals based on their respective populations and the diverse non-monetary aspects that determine their living conditions. The latter focuses on a more technical counting aspect concerning intersections, unions, and averaging of the sets (Betti and Verma, 2008). Betti et al. (2006) used a more generalised form of the membership function which defined deprivation suffered by individual i as:

$$\mu_{i,K} = \left(\frac{\Sigma_{\gamma=i+1}^{n} w_{\gamma}|X_{\gamma} > X_i}{\Sigma_{\gamma=2}^{n} w_{\gamma}|X_{\gamma} > X_1} \right)^{\alpha_K - 1} \left(\frac{\Sigma_{\gamma=i+1}^{n} w_{\gamma} X_{\gamma}|X_{\gamma} > X_i}{\Sigma_{\gamma=2}^{n} w_{\gamma} X_{\gamma}|X_{\gamma} > X_1} \right) \tag{1.2}$$

where X is the equivalised income in the monetary deprivation, w is the sample weight of individuals of rank γ in the ascending income distribution, and α_K (K=1,2) are two parameters corresponding respectively to monetary and non-monetary deprivation. The monetary-based indicators are then defined as Fuzzy Monetary (FM) while the non-monetary based ones are defined as Fuzzy Supplementary (FS).

The duality allows for a composite measure encompassing non-monetary deprivations such as education, health, and living standard (housing, etc.) without completely disregarding the importance of monetary deprivation. Once the identification of dimensions in the second step is performed, the aggregation of items or their membership functions within each dimension constitutes a crucial step in constructing multidimensional poverty indicators. The literature is rich in methods for the calculation of such aggregating weights. In general, these weighting methods capture two aspects: the "prevalence weights", which accounts for the statistical dispersion of the items; and the "correlation weights", which accounts for the correlation with other items in the same dimension.

Betti and Verma (2008) proposed one weighting system which considers both aspects: the dispersion of a poverty item and its correlation with other items in the given dimension. This method can be represented as $w_{hj} = w_{hj}^a \cdot w_{hj}^b$, $h = 1, 3, \ldots, m$; $j = 1, 2, \ldots, k_h$ where h is a generic dimension and j a generic poverty item. The first element of this equation is the coefficient of variation of the complement of 1 of the membership function's value of an item, specified as follows:

$$w_{hj}^a \propto \frac{std_{hj}}{1 - mean_{hj}} \tag{1.3}$$

The second element, defined as a measure of the correlations, can be computed in the following form:

$$w_{hj}^a \propto \left(\frac{1}{1 + \sum_{j=1}^{k_h} r_{e_{hj,hj'}}|r_{e_{hj,hj'}} < r_{e_{hj}}^*} \right) * \left(\frac{1}{1 + \sum_{j=1}^{k_h} r_{e_{hj,hj'}}|r_{e_{hj,hj'}} < r_{e_{hj}}^*} \right) \tag{1.4}$$

where $r_{e_{hj,hj\prime}}$ is the correlation coefficient between items j and $j\prime$ in the h-dimension and $r^*_{e_{hj}}$ is a critical value of the correlation coefficient[3].

Empirical results on multidimensional poverty have been produced based on the fuzzy approach, notably in the countries of the European Union (Betti et al., 2015), which have identified a well-established set of dimensions. From that point, the fuzzy set method has been extended to other fields in the social sciences, namely to the quality of life, violence against women, employment status, and educational mismatch, which have been well summarised by Betti and Lemmi (2021).

1.3   The New 'Double Fuzzy Set' Approach (DFS)

More recently, with data availability, it is possible to develop the fuzzy methodology further. For instance, questions asked in a survey are often attributable to more than one dimension. This fact highlights the multidimensional nature of poverty and how attributes are commonly interlinked. By assigning a response to only one dimension and ignoring the possibility of a second or even third dimension, we risk losing a layer of observation. Based on this notion, we attempt to further refine the current state of the art in fuzzy poverty measurement by introducing the double fuzzy set methodology. In this proposed method, we explore a second area where the concept of degree can be identified instead of a simple presence or absence that takes place in the Fuzzy Supplementary measures.

To explain the method in detail, it is useful to recall that the most innovative contributions in multidimensional poverty measurement (both fuzzy and crisp) adopt step-by-step procedures. These studies usually include at least three main steps:

(i) the definition of the poverty indicator for each item $j : 1, \ldots, J$ of poverty or deprivation over the $i : 1, \ldots, n$ individuals or households;

(ii) the identification of the M dimensions; and

(iii) the aggregation of items within each dimension.

Our original proposal makes innovations within step (ii). Different from our method, previous methodological proposals assign each indicator to one and only one dimension (see Fig 1), even when some indicators are highly correlated with other dimensions. We define these methods as "crisp", recalling the traditional poverty analysis in which each individual is assigned to either the crisp set of poor or non-poor people.

As elaborated in the previous section, the crisp assignment of an indicator to only one dimension can be misleading or inaccurate because it disregards the fact that it might be related to another dimension. For instance, an item of 'leaking roof' or 'mould in walls' can belong to both 'housing conditions' and 'environmental problems' dimensions. However, by assigning them to only one dimension, we risk losing important information, especially in the context of poverty measurement. Another emerging example in the recent literature is the construction of fuzzy multidimensional Sustainable Development Goals (SDGs), where the "targets" may belong to more than one SDG. In this case, the DFS approach can also be very useful.

In order to solve these problems, we propose an approach where we introduce the second aspect of fuzziness in the membership function for each indicator: we assign these indicators to more than one dimension resulting in various membership degrees. This assignment is illustrated well in Fig. 2, where several lines from each indicator go to one or more dimensions. From a technical and mathematical point of view, we propose a set of M membership functions for each indicator j $(j : 1, 2, \ldots, J)$, one for each dimension described in Fig 2. These dimensions could be seen as a set of M fuzzy states, and the

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[3]A detailed and technical definition of such critical value can be found in Betti and Verma (2008)
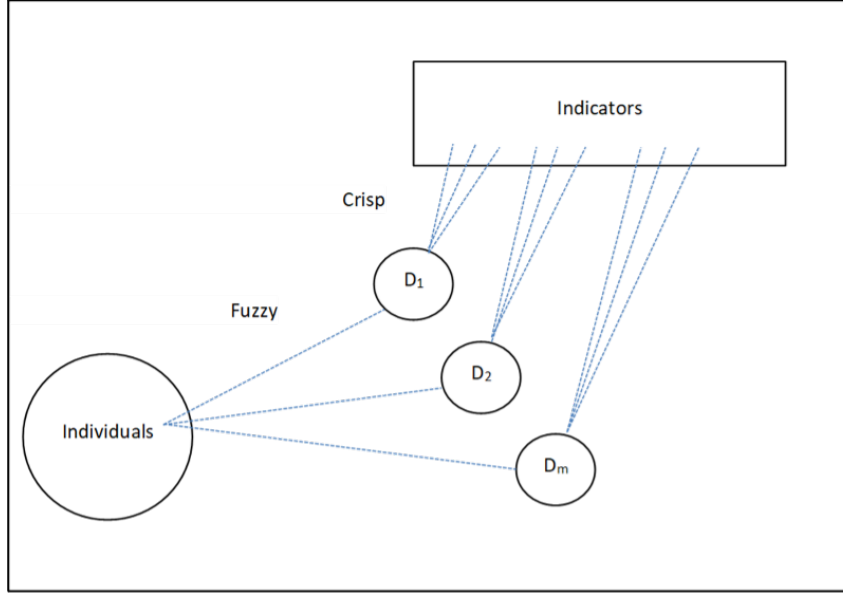
Figure 1.1: Step (ii) in multidimensional fuzzy approaches

corresponding membership could be written as follows[4]:

$$\mu_{j,m} \in (0,1) \text{ with } \sum_{m:1}^{M} \mu_{j,m} = 1$$

(1.5)

Given the proposed method, we can now define the proposal of Cerioli and Zani (1990) in Eq. (1) as Single Fuzzy Set (SFS) methodology. In the same way as in Cerioli and Zani (1990), we can use different membership functions while using the DFS method. The membership function in Eq. (2) is a possibility, but authors may choose the membership function that best fits their purposes.

In this paper, we propose to adopt the results obtained in the identification of the M dimensions in step (ii) performed with multivariate statistical methods, in particular the exploratory factor analysis (EFA) firstly proposed by Whelan et al. (2001) and later implemented in Eurostat (2002) and Betti et al. (2006). In such SFS approaches, these factor analyses are performed in order to assign each indicator (often referred to as individual variables or items) to one specific dimension within the multidimensional approach.

In our proposal, the membership function $\mu_{j,m}$ of the DFS in Eq. (5) is determined based on the factor loadings $\lambda_{j,m}$ of each indicator j in any factor (dimension) m. From these loadings, the membership functions $\mu_{j,m}$ are defined as:

$$\mu_{j,m} = \frac{\lambda_{j,m}}{\sum_{m:1}^{M} \lambda_{j,m}} \tag{1.6}$$

For each indicator j, any membership function μ_j, represents the degree of each dotted line reported in Fig. 2 linking the indicator j and the dimension D_m ($m:1,2,...M$). An alternative proposal could be based on the "correlation" in line with the principle contained in Eq. (4). Such correlations could be used in two steps: in the first step, the correlation

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[4]Indicators refer to the survey items such as 'type of walls', while dimensions refer to a group of survey items such as 'housing condition'.
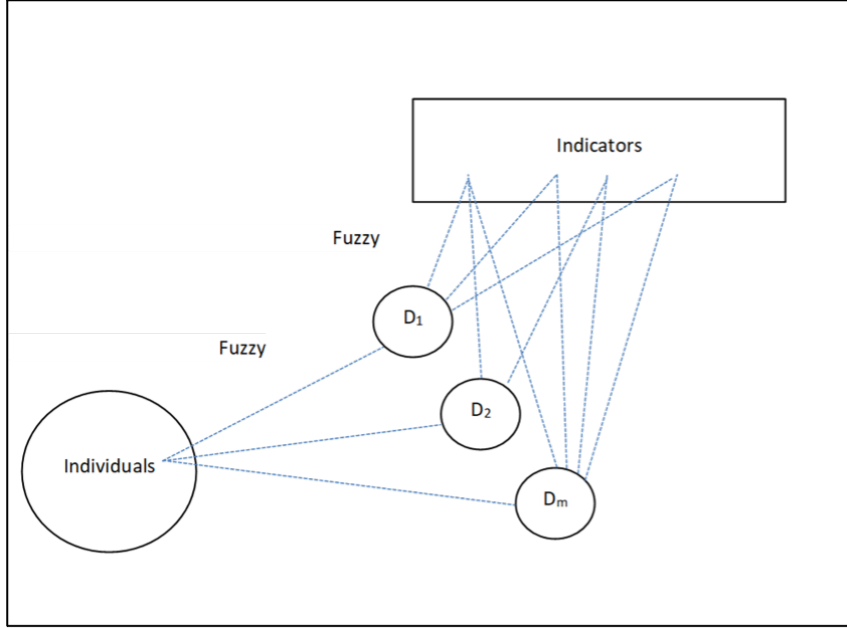
Figure 1.2: The double fuzzy set approach (DFS)

between an item j and a dimension $m\rho_{j,m}$ is used for calculating the membership function $\mu_{j,m}$ as follows:

$$\mu_{j,m} = \frac{\rho j, m}{\sum_{m:1}^{M} \rho j, m} \tag{1.7}$$

In the second step, the correlations are used in order to calculate the relative weight of each item j in a specific dimension m, as the product of $w_{j,m} * \mu_{j,m}$.

1.4 Empirical Illustration of the DFS Approach

In this section, we present the new Double Fuzzy methodology based on the 2015 Household Budget Survey conducted in Tunisia. As already highlighted in the introduction, this is an interesting data base to be used as a case study for at least three main reasons:

(i) There is a vast body of literature on the fuzzy set approach to poverty measurement that uses this dataset. This is due to the research of Prof. Besma Belhadj and co-authors, based on the 2015 HBS in Tunisia or previous surveys.

(ii) There is increasing interest from the World Bank in exploring poverty measures in Tunisia at the regional level, which has led to a new survey conducted in 2021 with a larger sample size (Betti and Lemmi, 2021). Such interest is also present in Algeria, with the new Household Budget Survey conducted in early 2022.

(iii) There is an emerging literature that aims to analyse the effect of COVID-19 on several dimensions of quality of life. Tunisia could be the first African country to apply Tavares and Betti (2021) new method.

As already mentioned, studies on multidimensional and fuzzy poverty in Tunisia have multiplied in the last decade. Belhadj (2011) firstly analysed multidimensional poverty using fuzzy set theory, applied to Tunisian data from the 1990 budget and consumption survey. Later, Nasri and Belhadj (2017) used household expenditure, considering consumption for only three pillars: food, health, and education. For other seminal contributions,

see, among others, Belhadj (2012), Zedini and Belhadj (2015), and Nasri and Belhadj (2018).

This section begins with a brief description of the so-called traditional approach to poverty measurement in Tunisia, which constitutes the benchmark for the second subsection on fuzzy measures.

1.4.1 The Traditional Poverty Approach in Tunisia

	2000 (%)	2005 (%)	2010 (%)	2015 (%)
National	25.4	23.1	20.5	15.2
International ($1.90 PPP)	6.0	3.4	2.0	0.2
Lower middle-income class ($3.20 PPP)	22.9	15.2	9.2	3.0
Upper middle-income class ($5.50 PPP)	50.6	41.5	30.5	17.5

Table 1.1: Comparison of poverty thresholds in Tunisia

Although the four measures show the same story of declining poverty rate in the past two decades, the scale they exhibit is of different magnitude. Take the international poverty line, with the threshold of $1.90. We started at 6% in 2000 and arrived at 0.2%, a decrease of 97%. While it sounds encouraging, the starting point might lead us to believe that there is very little incidence of poverty in Tunisia in the first place. Further, the end point gives the impression that poverty might have been eradicated entirely. It is dangerous to assume so, especially if this threshold is meant as a building block of a policy-making process which otherwise would be able to improve life of many people. Meanwhile at the same time the national poverty line[5] shows a different story. It starts with roughly a quarter of the population being under the poverty line and reached 15.2% in 2015, a decrease of 40%. The figure is less than half of what the international poverty line shows. It is much more representative of the reality, due to the selection done by the officials which differentiates between spatial units. Living cost varies across geographical location, and this should be taken into consideration when drawing such line. Given the same amount of money, those who live in a rural area grown would be able to stretch it longer compared to their peers in the metropolitan area due to price differences. It is possible to increase the line if there is such need, as shown by the two additional measures. The thresholds are supplied by the World Bank dataset, pegged at the level of $3.20 PPP and $5.50 PPP respectively. Both showed a rather sharp decline in poverty with the latter put half of the population under the poverty line, which is almost twice of what the national threshold reports. Thus, the measurement choices present dilemmas to the audience of the data: one might overestimate, while the other underestimate. Although the national and middle-upper class threshold present a more believable story, it does not address the instability risk of those who are located around the cut-off.

In addition to the issue, poverty line is largely perceived from the monetary point of view. This is no longer adequate, especially as a concept of multidimensional poverty has gained a wider acknowledgement. Financial situation provides one side of the story, but it is not the whole story. To solve this problem, Betti et al. (2008) proposes the fuzzy measures which allows a compartmentalisation of such deprivation: monetary and non-monetary.

Figure 4 on the left is of the fuzzy monetary while the right Figure 5 is of fuzzy supplementary. Notice that different shades represent the degree of poverty as presented

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[5]The determination of national poverty line is done by the National Institute of Statistics (INS) to define the minimum standard of living in the country. The welfare aggregate is spatially adjusted to mirror the requirements in different spatial unit. There are three poverty lines in Dinars (TND) per person per year: Metropolitan areas (TND 1878), Communal (TND 1703), and Non-Communal (TND 1501). On average, the poverty line is at the level of TND 1706 or roughly $2.5 USD/PPP.

■	0,2 - 5,0
■	5,0 - 8,5
■	8,5 - 12,0
■	12,0 - 16,7
■	16,7 - 20,7
■	20,7 - 25,9
■	25,9 - 33,4
■	33,4 - 52,7
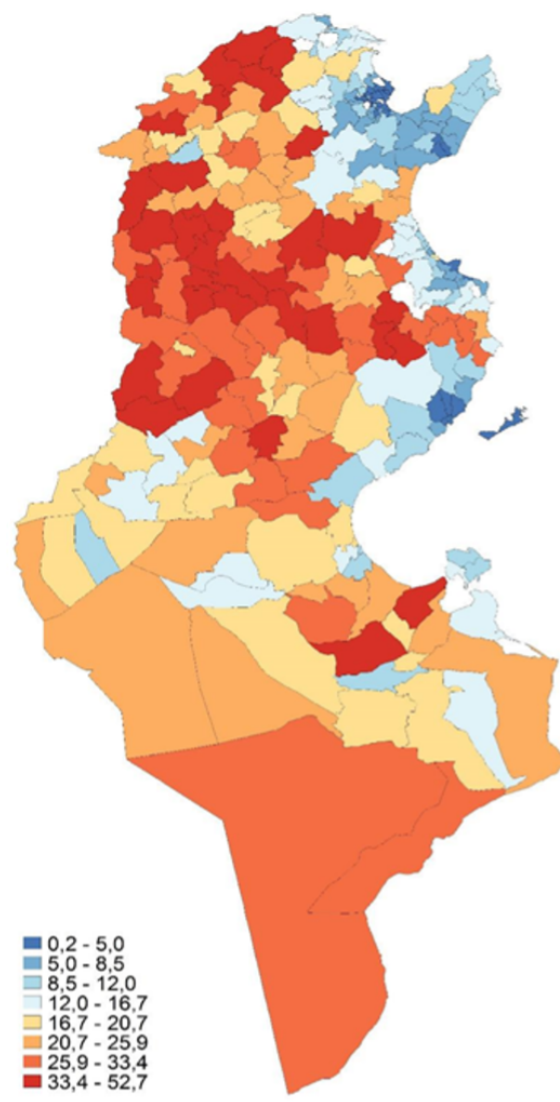
Figure 1.3: Poverty rate across Tunisia (2015)

with the fuzzy measures, and not the percentage of poverty incidence as presented on Figure 3. The concentration of a darker color on the north-west coincides in both fuzzy monetary and supplementary. We can see that there is slight variation between the two, especially from on the intensity. From the fuzzy monetary perspective, the governorates that are doing worse are Kef, Kasserine, Béja, and Kairouan. However, it seems that in general there is a clear difference between the northwest and centre-west, with the rest of the country. This is consistent with the finding of the National Institute of Statistics (2012) which in which both regions exhibited highest number of poverty rate in the country, followed by southeast and southwest regions. The same theme can be found when looking at the fuzzy supplementary although the magnitude is not as pronounced as the monetary one. Fuzzy supplementary is based on the multidimensional approach to poverty, and thus can be disaggregated. In building the indicator, we found six major dimensions to be studied: health, education, work, housing, durables, and distance. They form a picture of necessity for an individual to live a dignified life. However, as we allow items on the survey to be assigned to a secondary set, an additional layer of observation can be obtained. The difference between this approach with the previous one is on this step of assignation to the second dimension. Whereas IFR assigns each item to one dimension, we consider a second

(a) Fuzzy Monetary   (b) Fuzzy Supplementary
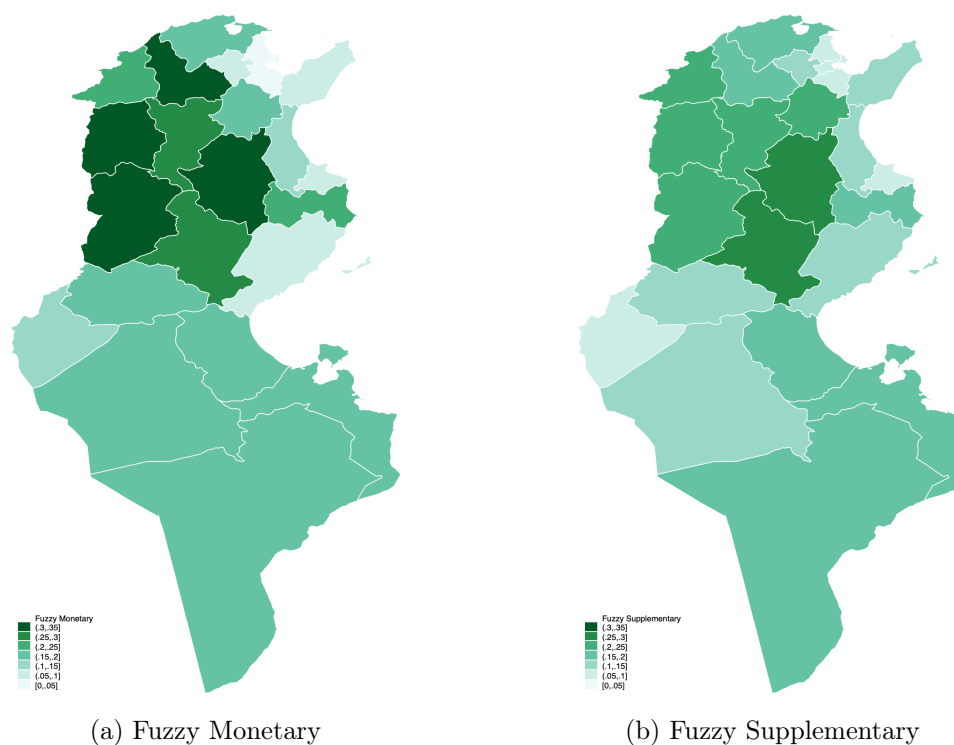
Figure 1.4: Fuzzy Indicators

suitable dimension. For example, survey questions regarding access to health, work, and education asked the reason why the individual was deprived of such service. Although they may vary, a common theme of distance emerged. This fact highlights the divide between urban-rural area and allows us to take a glimpse into the spread of deprivation across the country. Maps in Figure 6 portray the six categories we discovered in the Tunisian HBS. The first category is health. Most Tunisian have a form of access to the healthcare. Tunisia boasts a low infant mortality rate compared to the rest of Africa. However, there is a divide among regions in this matter. Infant mortality is higher in the central west and south compared to the rest of country (Africa Development Bank, 2014). There are several possible explanations. Although social security coverage is available, the availability of medical practitioners is unequal among governorates, favouring those on the coasts: Tunis, Sousse and Monastir (on the central east, also known as the Sahel). Income inequalities also play a part in this narrative. As out-of-pocket health expenditure is still required, the monetary disadvantage means that the incidence of deprivation can be a problem in low-income regions. The inequality across the governorates is not unique to health, as we will explain further. The second category is education. Tunisia has a quite high literacy rate with mandatory primary education in place. However, inequalities between regions can also be seen with north and central west suffering most. There is an issue with the access to higher education due to its high demand. There is a clustering of universities in the coastal area especially in Tunis, while there are barely any in the other part of the country. This incidence permeates to the third category, work availability. Internal migrations from the inner part of the country to the coastal area, especially the Greater Tunis (Tunis, Ariana, Ben Arous, and Manouba) is a major phenomenon (Amara and Jemmali, 2018). This can be attributed to the uneven investment among regions. While the north and central west are abundant with natural endowments, development has largely been focused on those around the Sahel or the central east, creating a division between the least favoured and the most favoured region in almost all aspects (Africa Development Bank, 2014).
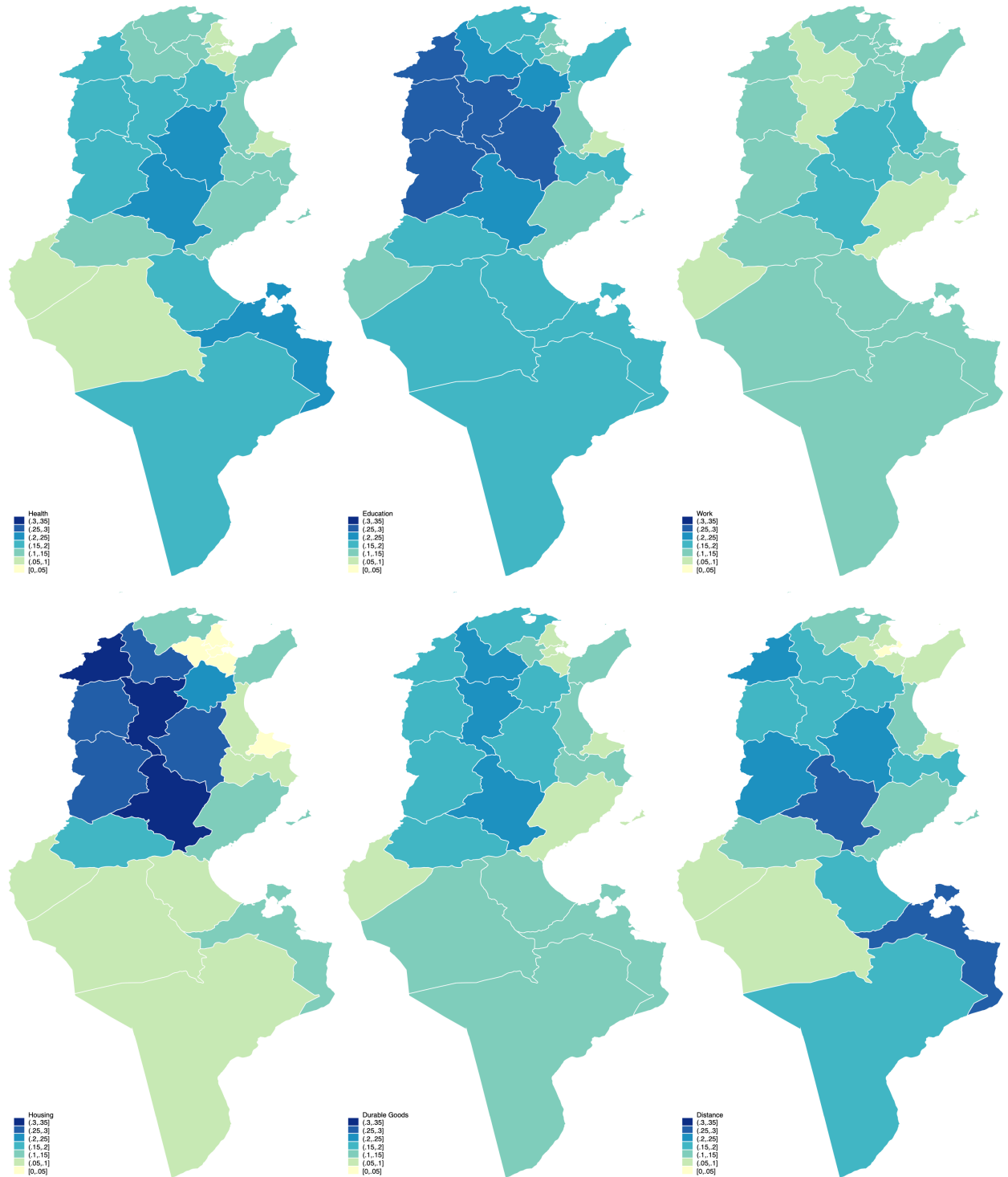
Figure 1.5: Fuzzy Supplementary all dimensions

In addition, the natural endowments do not seem to improve the local life as it is instead used to improve the Capital. As the dimensions are interlinked to one another, it is not surprising to find that the same pattern emerges in the fourth and fifth categories: housing and durable goods. It seems that the unequal distribution of investment creates a wide regional divide not only between rural versus urban, but specifically the Sahel versus the rest of the country. There seems to be a strong clustering of infrastructure investment around the Greater Tunis area. This brings us to the final dimension which we observe to

be interlinked with almost all five previous categories: distance to services. The divide also means that jobs, educations, and health services are more accessible around the capital than the rest of the country, which amplify other dimensions in the measurement. When combined, the six dimensions provide us with a picture of multidimensional deprivations that complement the poverty line approach by adding a layer of observation.

Governorate	Size	HCR	FM	FS	FS1 Health	FS2 Education	FS3 Work	FS4 Housing	FS5 Durable	FS6 Distance
Ariana	4144	0.054	0.046	0.093	0.088	0.121	0.109	0.046	0.085	0.064
Beja	2591	0.320	0.308	0.193	0.125	0.231	0.089	0.278	0.201	0.177
Ben Arous	4316	0.043	0.046	0.084	0.065	0.105	0.119	0.016	0.061	0.069
Bizerte	4321	0.175	0.189	0.164	0.104	0.173	0.127	0.136	0.165	0.110
Gabes	5514	0.158	0.164	0.150	0.155	0.178	0.122	0.066	0.124	0.194
Gafsa	5702	0.180	0.181	0.149	0.117	0.156	0.120	0.195	0.157	0.119
Jendouba	4431	0.224	0.237	0.237	0.190	0.265	0.118	0.310	0.164	0.217
Kairouan	5665	0.349	0.341	0.259	0.217	0.264	0.182	0.252	0.176	0.216
Kasserine	5425	0.328	0.311	0.244	0.196	0.273	0.133	0.252	0.181	0.237
Kebili	6197	0.186	0.196	0.115	0.071	0.165	0.119	0.085	0.109	0.061
Le Kef	3740	0.342	0.313	0.215	0.152	0.258	0.113	0.283	0.167	0.181
Mahdia	2574	0.211	0.236	0.175	0.114	0.186	0.145	0.066	0.147	0.166
Manouba	2241	0.121	0.097	0.135	0.117	0.153	0.150	0.031	0.101	0.093
Madenine	5447	0.216	0.199	0.171	0.230	0.167	0.140	0.103	0.141	0.265
Monastir	2393	0.083	0.059	0.079	0.098	0.094	0.124	0.026	0.066	0.074
Nabeul	4085	0.074	0.094	0.145	0.119	0.166	0.131	0.135	0.131	0.085
Sfax	5051	0.058	0.080	0.115	0.113	0.147	0.092	0.114	0.085	0.119
Sidi Bouzid	5696	0.231	0.253	0.265	0.250	0.247	0.172	0.328	0.233	0.266
Siliana	2403	0.277	0.273	0.219	0.155	0.272	0.087	0.309	0.207	0.165
Sousse	4660	0.161	0.136	0.134	0.107	0.132	0.151	0.053	0.147	0.100
Tataouine	6590	0.149	0.159	0.161	0.166	0.192	0.137	0.080	0.126	0.189
Tozeur	5543	0.146	0.148	0.089	0.092	0.122	0.089	0.074	0.083	0.085
Tunis	3798	0.035	0.034	0.098	0.082	0.124	0.131	0.015	0.074	0.041
Zaghouan	2483	0.122	0.167	0.206	0.160	0.232	0.124	0.246	0.162	0.179

Table 1.2: Poverty measures at the governorate level

For the visualisation, we have decided to use a uniform bracket. This results in an across dimension observation in which we can compare the degree of deprivation between them. It is very noticeable that housing is the dimension that exhibits the most inequality, with severe deprivation found in the north and central-west regions. The dwelling situation is central to many different aspects as it can determine the family's living conditions. Poor dwelling can be a source of ill health and a host of problems that would not allow individuals to achieve their full potential. It is followed by education, which we suspect to manifest in the fact that there are very few higher education institutions outside of the Greater Tunis area. The indication that there is not enough investment in this dimension would mean that those who can afford it would migrate to study elsewhere or simply drop out of school. One literature that highlights the theme of internal migration in Tunisia indicates this issue and might be why the work dimension does not seem to be contrasting between regions (Amara and Jemmali, 2018). It is because those who could afford to move have migrated. Education is then followed by the distance, which indicates mobility challenge to access basic service and durable goods and health, which show a similar pattern and intensity.

1.5 Concluding remarks

During the last decade, the Fuzzy Set approach has been developed and extended to other social fields: among others, marital disruption (Aassve et al., 2007), violence against

women (Bettio et al., 2020), financial literacy measurement (Hizgilov and Silber, 2021), and labour employment (Belhadj, 2011). The book by Betti and Lemmi (2021) provides an exhaustive list of such topics. In this context, the double fuzzy approach could have further applications: an example could be the inclusion of individual items into more than one dimension, as in the case of SDG targets in more than one SDG. Moreover, since the single fuzzy approach measures provide smaller standard errors than traditional or "counting" approaches, the introduction of the double fuzzy may further reduce these standard errors, which will be a future area of research, following the line of research carried out by Betti et al. (2008). In conclusion, the DFS approach may improve the measurement of poverty in at least three aspects, as highlighted in Table 3:

(i) Lack of arbitrariness: compared with the traditional approaches, there is no need to define an arbitrary poverty line. Moreover, compared to the IFR approach, there is no need to (it is sometimes arbitrary) assign any indicator to one and only one specific dimension

(ii) (Statistical) precision: standard errors would be greatly reduced compared with the traditional approach, in line with Betti et al. (2018).

(iii) Dimension completeness: each dimension of the DFS approach can incorporate as many individual items as possible so as to maximise its complete description of the phenomenon under investigation.

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Chapter 2

A Play and Learn O'clock?: On Time-use Among Children in Tanzania

Abstract

This study examines how children spend their time differently across four categories of activities: chores, care, learning, and leisure. In particular, I am interested in the difference that between the decision to perform the activities and the hours they dedicate among boys and girls. The data used in this study is taken from the Tanzanian Integrated Labor Force (ILFS) survey, specifically the Time-Use module. The choice of country in particular is an attempt to describe the dynamic of time-use within a household in one of the developing countries, specifically from Sub-Saharan Africa. To estimate the probability of performing the role and time spent on each category, I use Cragg's double hurdle model to handle the zero-inflated nature of the dependent variable. This study contributes to the understanding of gender gap issues in time use among children.

Keywords: *gender gap, time use, children, Tanzania*

2.1   Introduction

All happy families are alike, all unhappy families are unhappy in their own way. The Anna Karenina principle has been applied in the field of development economics, where shortcomings are intertwined with a multitude of diverse factors. The traditional approach of household-level aggregation, as rationalised by Samuelson (1956), fails to account for the intra-household dynamics at play. In reality, there is a struggle within the families in determining who gets what. The phenomenon of imbalanced resource allocation within families has been explored in various studies, delving into the social bargaining and negotiation process (Curtis, 1986). Whether it is the allocation of resources or tasks, each family is guided by a distinct set of values (Sauer et al., 2021), often influenced by factors such as gender, age, and culture. Cultural aspects, in particular, play a role in determining power hierarchies within the family, often based on principles of patriarchy (or matriarchy) and seniority. While the negotiated resources can take various forms, including monetary and subsistence-related necessities, time is another crucial resource whose importance is often underappreciated.

The division of labour is a complex issue, with some arguing that it reflects a trade-off

based on biological advantages (Becker, 1965), while others claim that it is a solution to a coordination problem in the marriage market where participants lack full information about their potential spouse (Hadfield, 1999). In societies adhering to traditional gender-assigned roles, the woman typically undertakes domestic-related duties while the man assumes the role of breadwinner. But while the value of time spent in paid work is readily apparent due to the existence of the labour market, that for domestic work is more challenging to measure. The consequences of this lack of a pricing mechanism are that domestic work often goes undervalued. It is seen as difficult to quantify and less relevant to policy considerations (Ferrant, Gaëlle et al., 2014), adding to the perception that women are less important contributors to the family. The classification of household work as a sedentary activity in the World Health Organisation (Passmore et al., 1974) alongside light work, in which it is pooled together with male unemployment, further perpetuates its underevaluation (Sen, 2001). Even in regions with perceived greater gender equality, such as in Europe, women still suffer from time allocation inequality, as they are expected to compensate for their perceived 'lack of contribution' by working longer hours (Gimenez-Nadal and Molina, 2020). This can limit women's opportunities to engage in other endeavours, such as pursuing commercial activities or self-development initiatives, further reinforcing traditional gender roles and potentially influencing how children in the family perceive the allocation of their own time and resources. A work such as Menta and Lepinteur (2021) has shown that for instance the family size is related with the gender gap in housework gender gap. At age 16, girls in a large household are significantly more likely to contribute to the chores while such effect is not exhibited by boys. The persistent effect of family size is thought to be caused by adoption of behaviors in line with traditional gender roles such as a lower likelihood of employment and shorter commutes for women along with a higher employment probability for their partner. Simply said, women's time is valued less than that of men's. Efforts to formalise the value of time in household production activities have been made by Zacharias et al. (2014) through the introduction of a two-dimensional poverty measure that considers both income and time poverty that coexist in a substitutive relationship.

Research on the gender difference in time use has witnessed a growing number of studies, owing to the increasing availability of time-use surveys. Early studies in this area were predominantly theoretical, with seminal contributions by Becker (1976) and later Vickery (1977). Becker's work emphasised the allocation of time within households, highlighting how household consumption involves both monetary transactions and household production, which require time as an input. Vickery, on the other hand, drew attention to the concept of time poverty. More recent studies made use of time-use datasets, such as the Multinational Time Use Study (MTUS), American Time Use Survey (ATUS), Harmonised European Time Use Survey (HETUS), UK Time Use Survey (UKTUS), and various other national surveys that include time-use modules. This has led to a growing body of literature that focuses on different aspects of time use, such as the measurement of time poverty (Bardasi and Wodon, 2010; Gammage, 2010; Arora, 2015) and examination of the gender gap in unpaid work (Rios-Avila et al., 2021; Gimenez-Nadal and Molina, 2020).

2.1.1 The Tanzanian case

Tanzania presents an intriguing case for exploration in the context of time use. Geographically, the country encompasses a blend of urban and rural areas, with a significant proportion of households (65%) engaged in agricultural activities Tanzania National Bureau of Statistics (2021). This living arrangement often results in children being actively involved in household chores, making Tanzania an ideal candidate for a time-use study. However, it is important to note that Tanzania, like other East African countries, particularly those with agricultural households, has distinct patterns in coping with shocks. Girls

are frequently married off at a young age, while boys are sent out to work. Furthermore, the country faces a considerable burden of child poverty. Data from Tanzania National Bureau of Statistics and United Nations Children's Fund (2016) reveals that although only 29% of Tanzanian children are considered monetarily poor, over 70% experience multidimensional poverty(with a $k \geq 3$).

Examining the dynamics of time use in the developing world allows for a contrast in gender dynamics and cultural aspects of resource allocation. While women in more advanced economies have achieved a significant level of empowerment, countries like Tanzania still adhere to patriarchal norms. Similarly, the line between chores and child labour is less distinct in the developing world. UNICEF acknowledges the challenge of defining child labour, as it encompasses various situations[1]. Edmonds (2007) discussed the lack of consensus on what comprise as child labour, although there is a certain agreement that it is based on the way a child spend their time in various activities, such as a wage-earning activity or human-capital development. This notion often clash with the sacralisation of childhood introduced by the progressive era (Zelizer, 1994). However, In agrarian communities prevalent in Tanzania, children often assist their parents with family enterprises. They are often not considered as a child labour, as they merely help as other family members do. This arrangement is less common in advanced economies, making it important to pay attention to such contexts.

The Integrated Labor Force Survey (ILFS) in Tanzania has been collecting time-use data since 2006, offering a unique opportunity to study how individuals, including children, allocate their time. By leveraging this dataset, this research will focus on the gender differences in time use among Tanzanian children. Accounting for the socio-economic heterogeneity in household characteristics, the study aims to predict the likelihood of children engaging in specific activities and estimate the number of hours they spend on each activity.

2.2 Literature Review

2.2.1 Household allocation process: a clash of genders?

One of the earlier models of household allocation is the Unitary model attributed to Becker (1976)[2]. This model assumes a single decision-making unit, in which all individual preferences are aggregated at the household level. However, this model has faced criticism, which can be categorised into two main groups. The first criticism is related to the 'Rotten kid theorem', which suggests that if the household head acts as a benevolent and altruistic dictator, it would be in the best interest of family members to maximise total family income, even if it makes them worse off (Becker, 1976). This assumption is highly specific and cannot be generalised, and it cannot be assumed that the family head will exhibit such a behaviour (Bergstrom, 1989). The second criticism pertains to income distribution. The model posits that income pooling makes it irrelevant who earns the money, which is known as the 'anonymity implication' (Apps and Rees, 1988). However, empirical evidence has disproved this assumption (Fortin and Lacroix, 1997; Schultz, 1990; Lechene and Preston, 2011; Woolley, 2003).

Later works, such as Becker's treatise 1991, introduced the specialisation theory, which suggests that within a family with a single utility function, the main earner (typically the husband) should focus on paid work, while the secondary earner (typically the wife)

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[1]See UNICEF-IRC's glossary.

[2]The term is coined by Browning and Chiappori (1998) and is closely associated to the New Home Economics concept (Becker, 1991) that recognises unpaid time when combined with products purchased from the market yields valuable 'home production'.

should focus on unpaid activities[3]. However, alternatives to the specialisation theory have been proposed by various studies, including the resource bargaining or social exchange model (Blood and Wolfe, 1965; Heer, 1963). These models view domestic labour as part of an exchange relationship, in which power derived from resources influences outcomes and one's sense of equity. They consider domestic work division as gender-neutral and focus on pure economic exchange. By portraying the work allocation as an exchange mechanism, these models paved the way for further studies on bargaining, which can be explored from cooperative bargaining (Manser and Brown, 1980; McElroy and Horney, 1981) and non-cooperative bargaining (Konrad and Lommerud, 1995; Leuthold, 1968; Bourguignon, 1984; Lundberg and Pollak, 1993, 1994; Chen and Woolley, 2001).

The bargaining models posit that negotiation occurs within the household and can be cooperative or non-cooperative, taking into consideration factors such as divorce threat as in social exchange theory (Manser and Brown, 1980; McElroy and Horney, 1981), or the sociological marital dependency, in which the union is not dissolved but the cooperation breaks down (Bennett, 2013; Lundberg and Pollak, 1993). Representing another class of models is the collective model, which does not specify the process of achieving outcomes but focuses on the assumption of Pareto-efficient outcomes and the intention of the couple to live together. This model allows for the inclusion of various factors, such as household production, taxes, sharing of private and public goods, and the partner's labour supply or participation (Chiappori, 1988, 1992; Browning and Chiappori, 1998).

2.2.2 Time as a resource (literally) is money

Household allocation models consider various resources, typically focusing on monetary factors such as income. However, an essential resource available to all family members is time. Becker (1965) is considered to be the seminal work in the study of time use, building a framework in which working, leisure, and non-working time categories are contrasted, breaking down the cost of time for each category. Interestingly, the non-working time category includes grey-area activities such as commuting. Becker's theory anticipated the production of time, referring to the use of technology that reduces the amount of time necessary, and its subsequent substitution and income effect. Since time can be seen as a resource, its deprivation can be considered a form of poverty.

Vickery (1977)) further explored the notion of time as a resource by incorporating it into the definition of poverty. Recognising that the standard measurement of poverty based solely on income fails to account for household needs adequately and thus any income-support program that attempts to correct it will discriminate against households with only a single adult, Vickery proposed a two-dimensional poverty threshold based on both income and time input. Specifically, they considered the threshold of 168 hours per week as the amount of time available to individuals.

Subsequent studies, such as those by Zacharias (2011); Douthitt (2000), and Harvey and Mukhopadhyay (2007), have built upon previous work, updating and adapting it to the contemporary context. These studies addressed factors like the increase in single-parent households[4], acknowledging the precariousness faced by households with fewer adults. Zacharias (2011) developed a framework that considers the time allocation of single-worker households, acknowledging the difficult allocation of their limited non-working time for necessary activities such as household production and personal care. Their proposed measure

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[3]Studies on gender-pay gaps typically argue that this phenomenon can be attributed to the choice of profession that differs between male and female, and their different characteristics such as experience and education level. The set of factors can be traced back to the social norm in which women are expected to work in more 'feminine' jobs (teacher, nurse, receptionist). This has changed in more recent times.

[4]According to US Census Bureau (2022), the number of children under 18 years old living with a single parent grew from 11.35% in 1970 to 30.22% in 2010.

for household time-income poverty assumed the availability of a non-working adult in the family, recognising the importance of non-wage-earning activities (Zacharias et al., 2014).

Douthitt (2000) emphasised the significance of time available to parents, alongside income, in assessing poverty. However, the changing dynamics of gender roles, particularly with regard to female workforce participation, necessitate a reevaluation of the traditional assumption that one parent is available to stay at home for necessary household production. Harvey and Mukhopadhyay (2007) underscored the importance of considering the availability of time in measuring time-adjusted poverty for both single and dual-income families. They acknowledged the substitution between money and time, in which a time-poor person, that is, one lacking time to produce goods and services at home, can purchase the said commodities in the market to maintain the same level of consumption. Thus, single parents, regardless of gender, are especially prone to suffering from the deficit of time. By incorporating time into poverty analysis, it would be possible to gain a deeper and more accurate view of the deprivation problem that remains outside the scope of conventional measurements.

2.2.3 Gender and time

It is evident that time is not equally valued within a family, and theories such as symbolic exchange shed light on the unequal distribution of time, particularly in relation to gender. Scholars like Berk (1980, 1985) acknowledge gender ideology bias among partners as a main culprit. It sees domestic work as a form of cultural as well as economic production with a gendered logic. This view is more pragmatic and acknowledges the discrimination that is based entirely on traditional gender roles and expectations. This usually refers to the unexplained part in the studies that conduct group comparison, which relies on the difference of profile as explanatory of the existence of the gender gap, such as years of education and experience, and field of work. For instance, Berniell, María Inés and Sánchez-Páramo, Carolina (2012) found that socio-demographic and economic factors can only explain a portion of the gender inequalities in unpaid care work, leaving a substantial portion attributable purely to discrimination. Similarly, Rizavi and Sofer (2010) discovered that women spend more than 60% of their time on unpaid household work, regardless of their employment status, income, or education level. In essence, the symbolic exchange is enforced by social institutions, such as social norms and practices, as well as both formal and informal laws, which play a role in shaping the behaviour of groups, communities, and therefore also individuals (Jütting et al., 2008).

Zhang (2021) examined societal changes in China, particularly in relation to male caregiving in elderly care. By focusing on caregiving performed by sons and husbands, Zhang offered a different perspective on the equation. As male caregiving becomes normalised, caregiving activities become less gendered. Similarly, Miller and Kaufman (1996) found that men and African Americans have a lesser perception of gender differences in caregiving for their spouses, confirming Witt's 1994 conclusion that gender roles are more a result of socialisation rather than biological determinism. These studies broadened our understanding of the dynamics of caregiving and the evolving social norms that influence the gendered division of labour within families.

2.2.4 Time, gender, and household bargaining in Sub-Saharan Africa

Kes and Swaminathan (2006) highlight the multiple roles played by both men and women in society, encompassing productive, reproductive, and community management tasks. However, women in Sub-Saharan Africa often face the burden of the 'double workday'. Unlike men, who undertake their roles sequentially, women are expected to simultaneously fulfil various responsibilities, leading to a higher level of workload intensity. Moreover, the

lack of infrastructure in the region sometimes makes simple daily activities such as fetching water or gathering firewood rather challenging. This simultaneous engagement in multiple roles forces women to make difficult choices and trade-offs, adding to their labour burden and resulting in extremely long working hours.

Arora (2015) examined the situation in Mozambique, where women engage in income-generating activities similar to men but also bear the gendered responsibilities of food production, household chores, and caring for children and the sick. In general, women work with higher intensity and have little to no leisure time. The burden of unpaid work for women in Mozambique is even greater compared to other countries in Sub-Saharan Africa, such as South Africa (Antonopoulos and Memis, 2010) and Guinea (Bardasi and Wodon, 2010). Arora also echoes Kes and Swaminathan's observations, noting that the lack of market substitutes, basic social services, and infrastructure hinders the households' ability to meet their needs, thereby placing a heavier burden on women.

The particularity of the Sub-Saharan African context lies in the large proportion of the population involved in labour-intensive agricultural enterprises, which require the involvement of every family member. Women, as traditional caretakers, are expected to take on additional unpaid activities such as caring for the elderly, sick, and children, as well as undertaking household production to ensure the family's subsistence. This includes tasks like water carrying (especially in areas without running water), gathering firewood, cooking, food preparation, and cleaning. Since the market is largely underdeveloped, and there is limited access to external providers of time-saving services, women bear the brunt of these responsibilities. As a result, the intensity of their time use increases, with several activities being performed simultaneously. Even activities that should be leisure-oriented, such as resting, become contaminated by other responsibilities. Arora notes that women often underestimate the time spent on childcare because they perceive it as an inherent part of their identity as women, rather than recognising it as work. Even when women take some time for themselves, they may still be nursing or tending to their children simultaneously.

2.2.5 Children and the perpetuation of gender roles

The reproduction of gender dynamics in time allocation adds another layer to the existing inequalities. The perpetuation of gender differences has been extensively examined, with notable studies, such as by Giménez-Nadal et al. (2019), drawing on Russian data to reveal that children tend to adopt their parents' gender roles. This phenomenon aligns with the relationship between family values and the unequal division of gender roles (Fernández et al., 2004; Fernández and Fogli, 2009; Alesina et al., 2013). The intergenerational transmission of these values and norms is evident (Bisin and Verdier, 2001; Doepke and Zilibotti, 2017). Children naturally mimic the behaviour of the first adult figure they encounter, typically their parents (Witt, 1997). Children's worldviews are shaped through parental guidance, conveying deep-rooted messages about gender roles, such as associating domestic responsibilities with females and bread-winning responsibilities with males (Miller and Kaufman, 1996; Witt, 1994). This results in the belief that certain tasks are not considered to be 'work', but are rather characteristics inherent to a specific gender, perpetuated by phrases like, '*This is not work, this is what mothers do. My mother did it too.*' (Arora, 2015). Empirical evidence, particularly from Dulla and Priyadarshini (2021), highlights how gendered parenting influences children's socialisation and marital expectations, particularly for educated and professional women, who face greater gender-related social expectations compared to their male counterparts. This is an important area of study as it has implications for women's labour outcomes (Hersch and Stratton, 2002), and carries a public cost (Tronto, 1987; Robinson, 2011; Engster, 2015).

In the context of Sub-Saharan Africa, where agricultural enterprises are widespread, children are often engaged in both chores and income-generating activities from an early

age. This blurs the line between child labour and regular chores, further reinforced by gender norms and expectations. Hedges et al. (2018) investigated the trade-offs between work and school among children in Tanzania and identified the impact of modernisation on older children's time allocation. Boys, who are typically involved in subsistence work, face challenges in combining work with schooling. This differs between younger and older boys, in which the former have a higher trade-off since they are not as productive as the latter. The onus is then put on the family, which has to make the education decision. In contrast, girls often engage in domestic tasks that can be performed outside of school hours, allowing for compatibility with schooling. Consequently, girls experience a reduction and contamination in leisure time due to their involvement in a 'double shift' of schooling and domestic work. Another study by Boyden et al. (2021) highlights the divergence between the Western conceptualisation of childhood as a time for learning and play, and the perceptions and expectations of childhood in Africa, particularly Ethiopia. They emphasised that boys' and girls' time allocation decisions are influenced by cultural norms and values, similar to the mechanism shaping the dynamics between husbands and wives in later life. These findings mirror the patterns observed among women in other literature demonstrated by studies such as Kes and Swaminathan (2006) and Rios-Avila et al. (2021). Consequently, these findings indicate that the perpetuation of gender roles is not solely due to mimicry, but also stems from broader multidimensional deprivation experienced by families, such as a lack of marketplace and infrastructure.

2.3   Research in time use

Time use measurement, however, is not as straightforward as for example that of income or consumption. One key difference is the nature of the units of measurement. While income or consumption can be measured continuously, time use is finite, restricted to 24 hours a day, 168 hours per week. Additionally, unlike income or consumption, time use often involves multitasking, especially outside of formal working hours. For instance, a mother cooking for her family may simultaneously soothe her baby to sleep, combining household production and unpaid care work at the same time. Even for clearly defined work activities, measuring time use can require additional considerations. Furthermore, the time spent on an activity does not necessarily indicate its intensity. Floro and Pichetpongsa (2010) addressed this issue by constructing a work intensity index, which highlighted differences in multitasking between genders, focusing on home-based workers in Thailand. This blurring of activity lines is particularly prevalent among women, who often engage in work concurrently with leisure or rest, resulting in what is known as 'contaminated' leisure (Bittman and Wajcman, 2000; Mattingly and Bianchi, 2003), overlapping with care provision.

Given the complexities involved, most studies exploring time use develop their own measures. For example, Zacharias (2011) defines time poverty by using households with at least one non-working adult as a benchmark. Bardasi and Wodon (2010) use the median and establish two-time poverty lines: one at 1.5 times the median of the individual working hours distribution, and another at 2 times the median. Sawo (2020) utilises the mean of working hours for individuals active in the labour force. Arora (2015), on the other hand, bases her threshold on Vickery's work 1977 of 12 hours a day (87 hours a week). Some scholars employ econometric approaches, such as Hedges et al. (2018), who use fractional multinomial logistic regression to examine the trade-off between education and other activities among children in Tanzania, or Rios-Avila et al. (2021), who employs a bivariate Tobit model to analyse the effects of spouses' decisions on their own and their partners' hours of housework in Sub-Saharan Africa.

2.4 Data and methodology

2.4.1 Time-use data and descriptive overview

Time-use data has become increasingly available in recent times, providing an opportunity for a more fine-grained study of the use of time as a resource. In general, there are two kinds of collection methods for this type of data. First is the recall method, where the individuals are asked to describe their activity on the previous day and the enumerator records the response. The downside is that relying on an individual's memory might not be entirely accurate especially if the observation goes beyond the past 24 hours. However, letting the respondent recount their activities might provide us with an insight into which activities they consider to be of higher importance. The second method is the diary method, in which the day is divided into a series of time slots, which the individuals are asked to fill with descriptions of their activities. The task of categorising then falls on the researcher. This method allows us to capture a secondary activity and approximate the intensity of the work, albeit with limited accuracy. In situations when multiple tasks are performed simultaneously, such as attending a communal gathering while preparing food, or child-nursing while working at home, it is more difficult to translate such observations to fit the traditional idea of a constraint amount of hours per day or per week, since in reality, it might exceed the limit. For example Arora's Mozambique study describes a situation where a respondent did not mention performing child care altogether despite having spent an entire day with her child while conducting other activities, simply because it was not considered to be 'work'. It is then important to consider the findings to be of the lower bound bias.

The dataset used in this study is the Integrated Labour Force Survey (ILFS) from Tanzania for the year 2006[5]. The survey contains a time-use module in the form of a time diary method. ILFS focuses on labour force participation [6]. Unsurprisingly, over half of the observations are of working-age people, with around 45% consisting of the elderly and children. The inclusion of children as young as 6 years old is especially useful in this context, since Tanzanian children from rural areas may be required to contribute work to the household quite early on. Surprisingly, the children's school attendance rate in the data is quite high, with only 14.11% having never attended school. Information on the household characteristics shows that over 50% lives in the lowest income bracket ($<$50,000 TZS[7])and the combination between the second and third lowest income brackets (50,000 - 199,000 TZS) cover 33% of the total number of respondents. Similar figures are reflected when we consider only the children. Around 70% of the children live in a household with a male head, and slightly less than 3/4 live in a household headed by an individual possessing at least some education. However, less than 1% of the children in the dataset reside in a household, whose head has a tertiary education.

Tanzania subdivides into wards as the smallest administrative unit of the country. There are three types of wards that are recognised by the state, namely, rural, urban, and mixed. 53% of the children live in rural wards, while only 13% in urban wards, and the remaining 34% in mixed wards. Considering such a wide difference, there is a big contrast in childhood experiences across the urban-rural division.

The time use survey consists of a time use diary, dividing time into 20 one-hour slots between 4 AM to 12 AM of the next day (the dataset shows 20 hours but the survey shows 18 hours beginning from 6 AM). Between one to five activities can be logged into

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[5]The collection of later Time Use Survey (TUS) data was conducted for the year 2014 and 2021. The former was not accessible to the author until very recently on November 2023 while the latter were made available only in the late 2022 during the completion of this dissertation project. The future reworking of this chapter into the a scientific publication will include the additional 2 waves.

[6]The descriptive summary can be found in Table 2.3 of the appendix

[7]The minimum wage in the country at the time was fixed at 48,000 TZS monthly.

the diary. This is due to the fact that sometimes the respondent multitasks. The data is aggregated into a weekly calculation. I decided to focus on four categories of time use, namely: chores (household production and domestic tasks), care (time spent caring for other family members), leisure (leisure and social activities), and learning (including other education activities). Table 2.1 displays the t-test result between the two groups.

	$Pr(activity) > 0$			$E(activity\|activity > 0)$		
	Male	Female	Diff	Male	Female	Diff
Core	.814	.914	-.101***	6.336	13.153	-6.816***
	(.008)	(.006)		(.158)	(.241)	
Care	.260	.391	-.130***	4.347	5.632	-1.285***
	(.009)	(.011)		(.242)	(.241)	
Leisure	.938	.913	.253**	20.697	17.818	2.879***
	(.005)	(.006)		(.345)	(.340)	
Learning	.701	.693	.006	34.218	33.795	.423
	(.010)	(.010)		(.455)	(.427)	

Table 2.1: T-test of probability and average time spent across activities

The left part of the table, marked $Pr(activity) > 0$ refer to the probability of the activity being performed at all. The latter part, marked $E(activity\|activity > 0)$ refers to the estimation of hours spent on each activity if they are performed. The two different calculation is done to avoid the contamination of the hours estimation with observations in which the activity was not done. Without such separation, the estimation of the hours spent would suffer from a underestimation bias caused by the existence of zeroes.
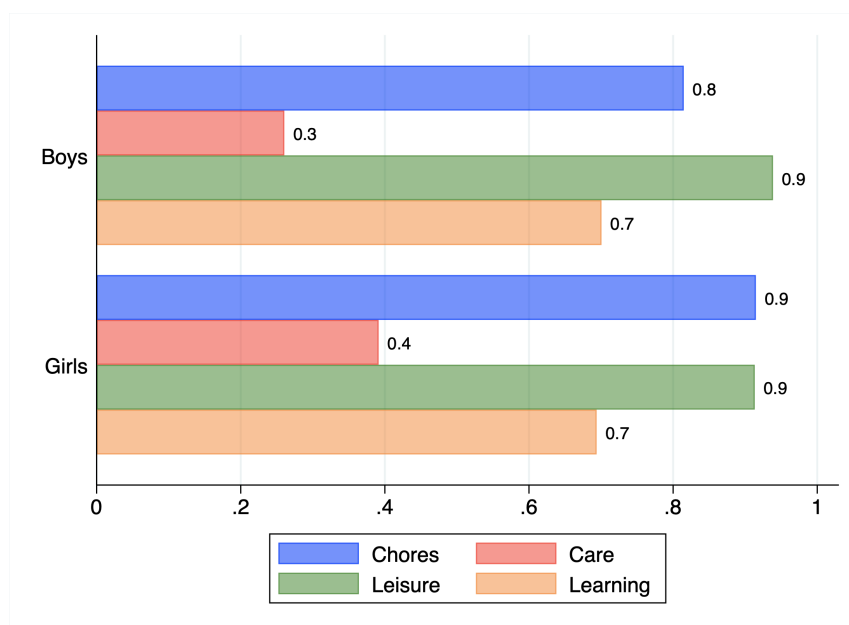
Figure 2.1: Percentage of children performing various activities

Figure 2.1 presents an overview of how many children perform various activities. There seems to be very little difference between the number of boys and girls who undertake learning and leisure activities. There is, however, quite a difference when it comes to chores and care, around 10% in each group. Remembering that the majority of children live in rural and mixed wards, it is not surprising that children of both genders are expected to help with chores. However, it is interesting to note that more girls perform the two activities compared to boys.
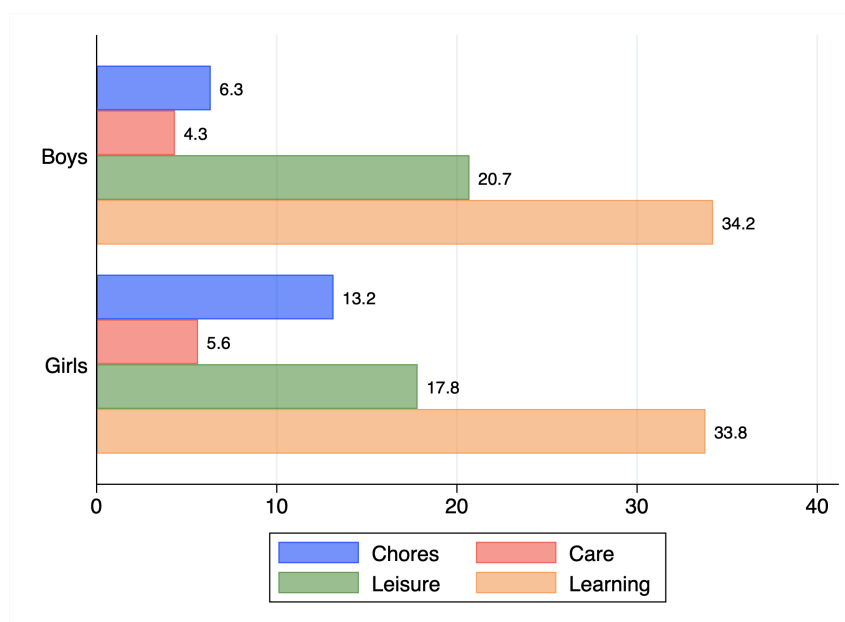
Figure 2.2: Average of hours spent by children on various activities in a week

Figure 2.2 presents a visual of how on average boys and girls spend their time across the four categories, given that they undertake the activities. For the purpose of this visualisation, I truncated the zero values from the time-use variables.

When the children perform the activities, they spend a similar amount of time learning. Girls on average spend 0.6 hours less than boys, but the difference is small enough to consider non-discrimination. However, the same cannot be said about other activities. Girls on average spend over twice as many hours compared to boys in chores while they spend almost three hours less in leisure weekly. The two categories demonstrate the difference in expectations between boys and girls. Interestingly, both groups spend minimal hours performing care-related activities in the household. However, the result shown for care activities should be met with some scepticism. As Arora noted about adult women, there is a tendency of underestimation when it comes to the performance of care-related activities. Due to having internalised the role of the main caretaker of the family, women often feel uncomfortable with the idea of considering care-related activity as work. This effect might or might not arise with girls, especially when we consider activities such as caring for younger siblings or ailing grandparents, where their involvement is considered to be a womanly duty.

The nature of activities, however, might also be misleading at times, giving rise to concepts like 'contaminated leisure': the kind of leisure that nevertheless may require considerable effort. For example, one of the activities included in the leisure category is 'community service and socialising'. It is true that socialising can take place for pure enjoyment, but it might also involve some work. For instance, a social event that requires planning, organisation, and various logistical tasks can induce stress, although technically it is categorised as a leisure activity. The same can be applied to children, especially the widespread combination between leisure and care, such as in a case where child-rearing might be combined with socialising.

Another factor to be taken into consideration is the children's age. Figure 2.3 displays the probability of performing a particular activity across the age using a simplistic probit model with only sex and age as explanatory variables while Figure 2.4 demonstrates the estimation of hours spent using OLS.

It is quite encouraging that the probability of children performing leisure is almost
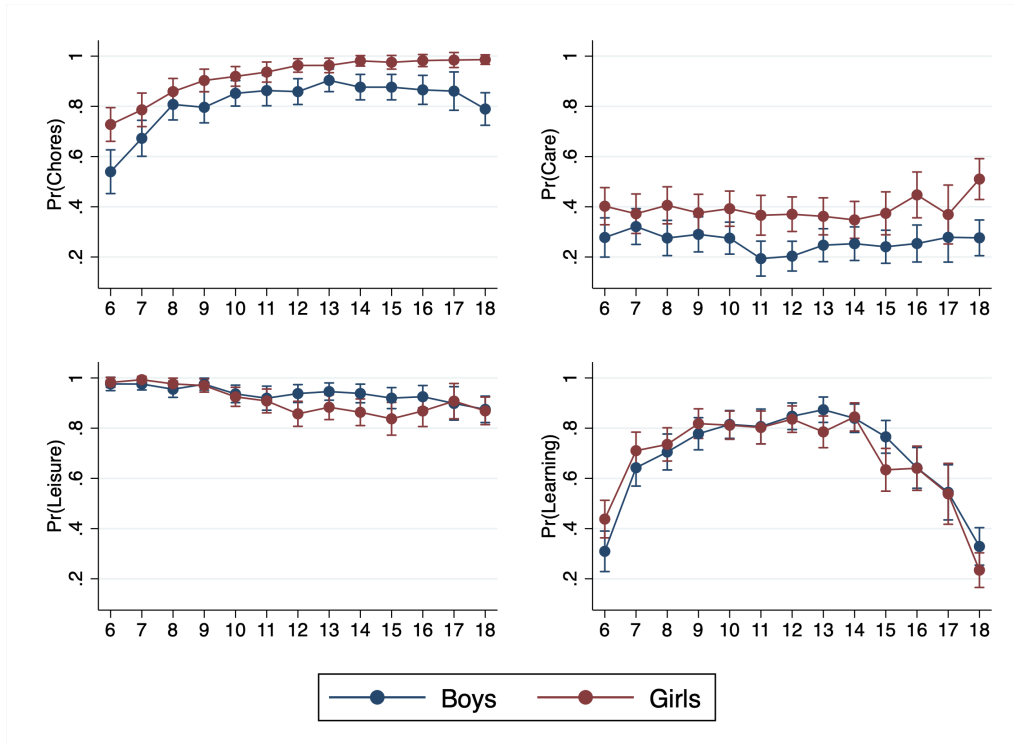
Figure 2.3: Probability of children spending time in various activities across age
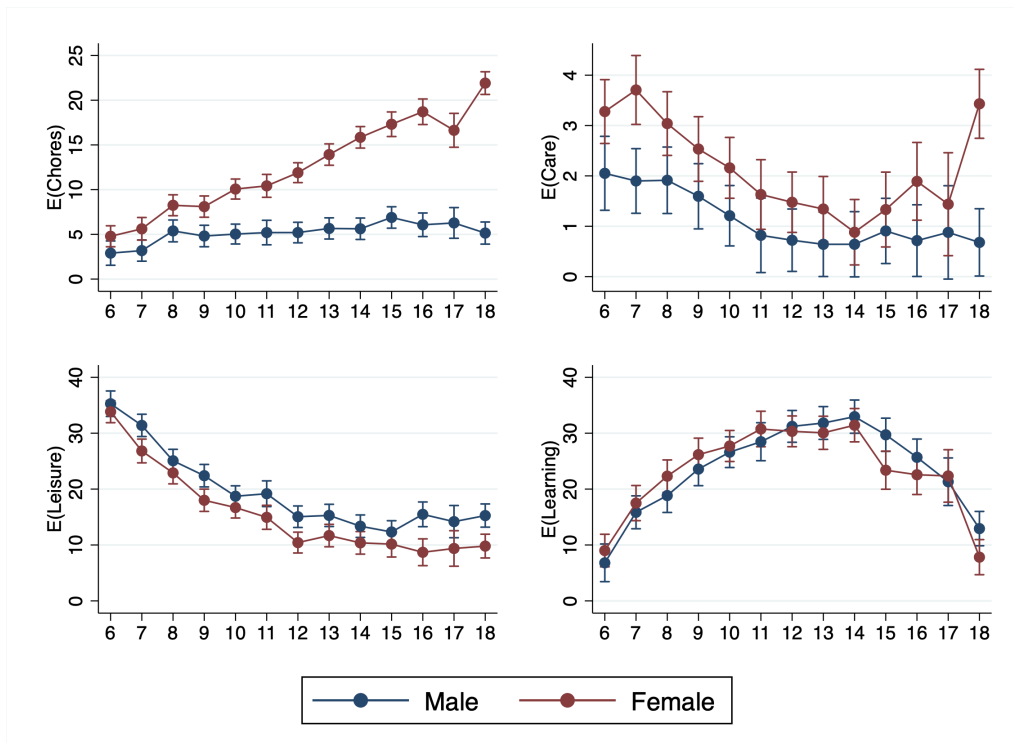
Figure 2.4: Estimation of hours spent by children in various activities across age

constantly over 80% for both genders. There is a slight decrease at the age of 10, in which the paths diverge before re-converging at the age of 17. In this 7 years gap, girls have less probability of enjoying leisure compared to boys. However, there is a steady decrease for both genders before slowing down at the age of 12. The difference between girls and boys

also becomes more pronounced, especially beyond the mark of 16 years old.

The category of learning instead shows an inverted U-shaped curve. While the steep difference between 6 and 7 years might be caused by the beginning of school year[8] that affects enrollment of children whose birthdays fall before or after a certain date, there is quite a plateau trend for both genders between the age of 7 to 14. This coincides with the duration of primary education in Tanzania which takes 7 years. Interestingly, there is a slight drop for girls at the age of 13 (6th year of primary education) and another, deeper plunge at the mark of 15 years old, which might indicate dropouts. A fact worth mentioning that the Tanzanian law used to permit girls to enter into a marriage at the age of 15[9] while boys at the age of 18, which is offers an explanation for this decline. Typically once girls are married, the family has no further incentive to encourage them to study since they are expected to focus more on the housework. Both genders show a general decline throughout what would be the secondary school years. At this age, the trade-off between education and other productive activities for children increases. If the family does not see secondary education as a good investment in their children, or simply if they happen to face a shock, this would be an intuitive cutoff point for children's education. Nonetheless, the probability of schooling between girls and boys is very similar across primary and secondary education with an exception for ages between 13 and 15. The figure for both estimation and probability look starkly similar.

Across the chores and care activities, the difference between genders is quite pronounced. Girls have a higher probability to perform than boys. In particular regarding care activities, girls show a uniform probability across ages 6 to 15, before an increase that peaks at the age of 18. The boys instead show a somewhat decreasing probability between ages 6 to 11, with a very small increment up until the mark of 18 years old. When looking at the estimation figure, the story looks quite different. While boys demonstrate a downward slope that stagnates at around age 11, girls reach their nadir at the age of 14 before the trajectory inverses.

The gap between genders seems to narrow throughout childhood before a drastic divergence begins at the age of 14. Meanwhile, for the chores, there is a steady increase for girls to almost 100% by the age of 18. For the boys instead, there is a sharp increase between ages 6 to 8, although, admittedly, the probability of a 6-year-old boy performing chores is much smaller than for a girl of the same age. The trend for boys somewhat steadily increases, peaking at 13 years old, before a decrease. The 13-year-old mark is also the zenith for the probability of boys' learning. I suspect that this might have to do with their involvement in labour or profit-seeking activities, which are not captured in these categories. The lower percentage of boys' probability of performing chores should then not be necessarily considered as preferential treatment of males but might indicate the bleak reality of childhood in a developing country.

Interestingly, the estimation shows an ever-widening gap between boys and girls. The drastic divergence begins at age 10 when girls spend an increasing number of hours in chores, while boys spend uniform hours across all age groups. If at age 6 the difference between genders was negligible, by the age of 18 girls perform over four times chores compared to the boys.

As mentioned in the previous paragraphs, the probability of both girls and boys performing any learning activities plummets after the age of finishing primary education. In that situation, the fate of children of both genders diverges greatly. When the family is facing financial difficulty, which is quite a likely scenario considering the income brackets of households in this data, boys can be sent out to work while girls have no better fate

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[8]Tanzania official school-entering age is 7.

[9]See section 13(1) of Tanzania's Law of Marriage Act of 1971. In 2016, the High Court of Tanzania ruled the law unconstitutional and increased girls' minimum age requirement for marriage to 18.

than to be married off. If that is true, then the almost certain probability of girls from the age of 14 and up performing chores might be indicative of their new roles as brides.

The overwhelming involvement of children of both genders in chores and care activities, and their early withdrawal from schooling, resonates with Kes and Swaminathan (2006), who note that the crucial deprivation worsening the between-gender time-use in Sub-Saharan Africa is mainly due to a lack of infrastructure and a suitable market. A traditional household typically requires two important roles: the breadwinner and the manager. The latter is responsible for allocating the household's collective time to ensure that a certain quality of life can be achieved through the undertaking of crucial activities such as food preparation, cleaning, and care. Thus in formalisation attempts, one of which was done by Zacharias (2011), the model sets a benchmark for drawing the time-poverty line by requiring the household to have at least one non-working adult. Zacharias built a two-dimensional poverty measure by taking into consideration the substitution relationship between monetary resources and time, consequently the bread-winning and the household manager roles. By this framework, when there is not enough time at home to fulfil the needs, such as in a case where there are no non-working adults in the household, time can then be 'purchased' from an external provider to compensate for the deficit. However, this situation poses a twofold problem for the Tanzanian household. The data shows that an overwhelming portion of families without a non-working adult[10]. This fact reveals a vulnerability to the risk of time poverty. Without a proper marketplace, where services can be purchased at an affordable price, children will be expected to carry their own weight earlier than they should.

2.4.2 Cragg's double hurdle model

The time-use data reveals twofold information on how children spend their time, namely, whether they participate in activities, and how much time they dedicate. Due to the zero-inflated nature of the dependent variable, the double-hurdle model is suitable. It is based on Cragg (1971) and provides a more flexible alternative to a Tobit model, since a corner solution exists for zero values. It allows for an approximation of both a probability of a positive outcome and the magnitude, should the first condition be fulfilled. The model thus enables the estimation of the coefficient's signs and level for the explanatory variables that differ between the probability of a positive outcome ($Pr(y > 0)$) and the magnitude ($E(y|y > 0)$). The two processes then represent a 'double hurdle' of selection and estimation.

The first 'hurdle' is the selection in which the probabilities of not performing an activity, $Pr(activity1_i = 0|x_{1i})$, and of performing at least some, $Pr(activity1_i > 0|x_{1i})$ are analysed. Both are formalised as follows:

$$Pr(activity1_i = 0|x_{1i}) = 1 - \Phi(x_{1i}\gamma) \tag{2.1}$$

$$Pr(activity1_i > 0|x_{1i}) = \Phi(x_{1i}\gamma) \tag{2.2}$$

where x_{1i} is vector of an individual's characteristics, γ is a vector of parameters to be estimated, and Φ is the standard normal probability distribution.

The second 'hurdle' is to estimate the hours spent by an individual i in each activity, given that it is not zero:

$$E(activity1_i|activity1_i > 0|x_{2i}) = x_{2i}\beta + \sigma \times \lambda(\frac{x_{2i}}{\beta}) \tag{2.3}$$

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[10]83.72% of the households have no non-working adults. 82.03% children live in such households.

where x_{2i} is a vector of individual characteristics, β is a vector of parameters to be estimated, and λ is the inverse Mills ratio, where $\lambda = \frac{\phi(x_{2i}\beta)/\sigma}{\Phi(x_{2i}\beta)/\sigma}$.

The marginal effect of the j-th explanatory variable on the probability of the i-th individual performing the activity is then:

$$\frac{\partial Pr(activity1_i > 0|x_{1i})}{\partial x_{ji}} = \gamma_j \phi(x_{1i}\gamma) \tag{2.4}$$

The marginal effect of the j-th explanatory variable of the i-th individual, conditional on $activity1$ is then:

$$\frac{\partial Pr(activity1_i|activity1_i > 0|x_{2i})}{\partial x_{ji}} = \beta_j \left[1 - \lambda\left(\frac{x_{2i}\beta}{\sigma}\right) \left\{ \frac{x_{2i}\beta}{\sigma} + \lambda\left(\frac{x_{2i}\beta}{\sigma}\right) \right\} \right] \tag{2.5}$$

The average marginal effects, which represent an average of the individual level effects, are estimated using the Delta method **?**. There are several packages in Stata for running models such as *craggit* and *dblhurdle*. For this study, I used the *churdle* package in Stata 16.

The outcome of interest in this is the time spent by children on four categories of activity: household productions (chores), caring for other family members (care), leisure, and education (learning). Chores consist of activities such as water fetching, firewood collection, house cleaning, food preparation, and to a certain extent, assisting in the family enterprise. Care consists of care-related activities performed toward ill family members, the elderly, and siblings. Leisure consists of activities such as socialising, games and hobbies, sports participation, and media consumption. Education consists of schooling and other learning activities.

The variables used to estimate the Cragg model consists of three groups of categories. The first category is the personal level characteristics: age, gender, and relationship to the household head (son/daughter, related, not related). The second is the household head's characteristics, namely, gender and education. The third is the household-level characteristics: composition of family members (numbers of non-working adults, children, adults, and elders), level of household income, and the ward type of their dwelling (urban, rural, mixed).

2.5 The double-hurdle estimation across time-use categories

Table 2.2 presents the result from the Cragg model across four categories of activity. The first two columns represent the outcomes from the model in both the first (probabity of performing the activity) and second (estimation of the hours spent) hurdle. The third column meanwhile, is the associated marginal effect. A visualisation of the marginal effect can be found in Figure 2.5.

Variable	Chores			Care			Leisure			Learning		
	Estimated coefficient		Marginal effect	Estimated coefficient		Marginal effect	Estimated coefficient		Marginal effect	Estimated coefficient		Marginal effect
	$Pr(chores>0)$	$E(chores\|chores>0)$		$Pr(care>0)$	$E(care\|care>0)$		$Pr(leisure>0)$	$E(leisure\|leisure>0)$		$Pr(learning>0)$	$E(learning\|learning>0)$	
Age	0.1009235***	2.43053***	0.7352909***	-0.0001643	-0.0705832***	-0.1184597***	-0.0726423***	-3.753811***	-1.835215***	-0.0100952*	1.594279***	0.8665896***
Is a female	0.5511843***	26.0864***	6.634166***	0.3685518***	0.1946277***	0.9761817***	-0.2345769***	-7.70992***	-3.944805***	0.0058631	0.2665656	0.2313638
Household head is a female	0.312225	-0.4710475	-0.00686795	-0.0943425*	-0.483873	-0.2432622*	0.157412**	0.8113409	0.6840241	0.0178911	-0.716806	-0.2377048
Relationship with household head (ref: Son/Daughter)												
Related	0.2292854***	3.878709***	1.311422***	-0.0669333	-0.1232006	-0.3020766*	0.2487717***	0,7080207	0.7901566	-0.0621884	-0.3371761	-0.924443
Unrelated	0.2760126	-3.187455	-0.3673551	0.151493	0.4217132**	1.319509**	0.0553585	9.501195***	4.878019***	-0.2903589**	-1,02576	-4,072779**
Household head's education (ref: No education)												
Primary	0.1436986**	-0.0045168	0.2164439	0.0086179	-0.0914304	-0.1421079	0.4370048***	-0,0276829	1.058528*	0.3096964***	0.0411453	3.786285***
Secondary	0.1595741	1.929939	0.7245925	-0.2035727**	0,0117011	-0.3523704	0.4566019***	0.4901723	1.329485	0.6420033***	2.280892	8.751168***
Tertiary	0.3403072	2.333261	1.066719	-0.1958548	0.1377409	-0.1429531	4.265641	-0,3723464	1.774106	0.902736***	-5,378876	5.107432
Household composition												
# of Non-working adults	-0.0278132	-0.774397	-0.2279417	-0.0035653	0.0210474	0.0288854	0.1210244**	-0.3778719	0.085482	-0.0203434	0.2717412	-0.0655335
# of Children	-0.0838701***	-0.9969802***	-0.3635331***	-0.016596	-0.0727167***	-0.1513026***	-0.0296434**	0.0485504	-0.0406503	0.0125847	-0.3448805*	-0.0683673
# of Adults	-0.0911702***	-1.252856**	-0.4360939***	0.008063	0.065203***	0.1235229**	-0.0287141	0.6109447	0.2133447	-0.0250391	0.1897226	-0.1698313
# of Elders	-0.1119888*	-0.2198692	-0.2164824	-0.0610068	-0.0450405	-0.1840807	-0.1400447***	-0.48908	-0.5143897	0.0529209	1,034011	1,243
Household income (ref: under 50,000)												
50,000 - 99,000	-0.0176997	-2.829634**	-0.7075592**	0.1049466**	0.0225525	0.2305588	0.0185574	-0.9189959	-0.3733894	-0.0630785	3.118969***	1,182527
100,000 - 199,000	-0.1950321***	-3.147891*	-1.046258***	-0.1509749**	0.0266102	-0.2197244	0.0288084	0.4896933	0.2842609	0.0086819	3.355852***	2.196342***
200,000 - 499,000	-0.1082045	-1.25241	-0.4728637	0.1973273**	-0.1185033	0.1398056	-0.138657	-4.117978*	-2.063024**	0.0243319	2,00756	1,520133
500,000 - 999,000	-0.4653987	-8.586692	-2.560029**	0.5485583**	-0.2549219	0.4434587	-0.0842816	0.0694571	-0.1596698	0.0106707	1,856976	1,269527
1,000,000 +	-0.622874	-10.42447	-3.147129	0.740231	-1.028313	-0.5375107	3.845399	-25.44832	-7,52997	-0.4355797	35,18318***	13,51905
Ward type (ref: urban)												
Rural	0.2491960***	-0.5333542	0.2585486	0.2108129***	0.1170929	0.5386895***	-0.20593*	-9.87317***	-5,27392***	-0.2084652***	-5.509836***	-6.001633***
Mixed	0.1407124	-0.2634091	0.1690125	0.1834037**	0.0268531	0.3350878***	-0.09027	-8.496689***	-4.433731***	-0.1400194*	-4.914107***	-4.856921***
Sigma	2,680602***			1,10105***			18,75876***			16,47846***		
Prob	0,0000			0,0000			0,0000			0,0000		
Pseudo R2	0,0484			0,0273			0,0326			0,0143		

Table 2.2: Estimated Cragg model of performing different activities and associated marginal effects among children
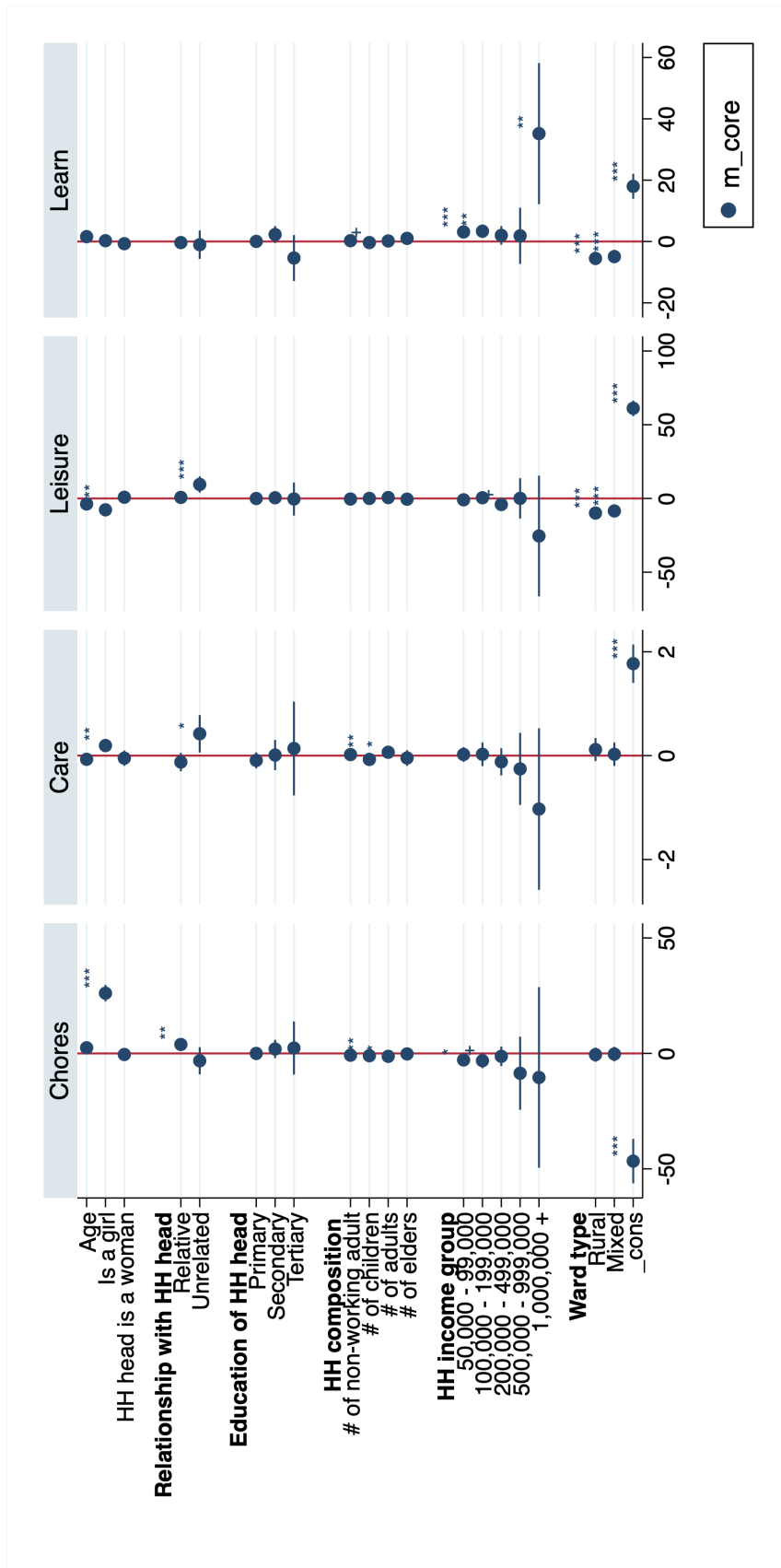
Figure 2.5: Marginal effect Cragg model for each activity

The first set of predictors contains personal-level characteristics represented by age, gender (using a dummy for females), and relationship with the household head. Age is a significant predictor in all categories except for care, however, chores are the only category in which it is positive. It is quite intuitive, that as a child grows older they become more reliable in being assigned chores. The same cannot be said about care and leisure. However, when we move to the estimation of the hours spent in each activity, all categories become strongly significant and follow the direction of the selection except for learning. The puzzle over the learning category might be described by Figure 2.3 and 2.4. The inverted U-curve relationship between age and learning might require additional treatment.

As expected, the gender predictor shows a strong significance for both the selection and estimation of chores, care, and leisure. The relationship is positive for the former two and negative for the latter. This further confirms previous graphs (Figure 2.3 and 2.4) that highlight the overall gap between the genders, and its divergence (and convergence). As expected, the result for learning is not significant since it appears both boys and girls obtain a similar level of education. An indication of gender-based discrimination is evident as girls perform more chores and care while enjoying less leisure.

Relationship with a household head is an indicator that borrows the concept of the Cinderella effect from psychology. Coined by Daly and Wilson (1999), the concept is based on the kin selection theory by Hamilton (1964). It postulates that when there is a lack of shared genetic heritage between parents and children, altruistic behaviour will be discouraged, with a more prevalent risk of mistreatment. In a clan-like living arrangement, common to non-urban areas, extended relatives often live together, forming a common household in which they share resources and responsibilities. Children are often raised together, although there is an imminent pecking order. This study assumes that when the child is the son/daughter of the household head, he/she might gain a more favourable position compared to those who are not directly related. For this reason, the relationship indicator differentiates between son/daughter, related (kin), and unrelated (non-relatives). Using the first-degree relationship as a baseline, I found that the status of being related imposes a positive effect on the probability of a child performing chores and the hours spent on the activity. However, other categories behave differently. The sign is negative for both care and learning, without any statistical significance for selection. A very weak significance is shown in the estimation of care. The non-significance of learning might indicate that mandatory primary education might be a stronger determinant of a child's likelihood of attaining it. For the leisure category, there is no significance, although the sign is positive. It might be that when the child is a relative, especially when their parents physically stay in the household, its head would take into consideration the consequences of governing other people's children beyond the communal chores that his/her own child undertakes. For the children who are unrelated, however, there is only a significance for the care and leisure categories with a positive sign in both. It might be necessary to study this further in order to understand the nature of the relationship between the child and the family: whether they are adopted (both as a child and a bride), or whether they are more of a labourer. Regardless, the non-relative status shows an interesting sign for chores as it is positive for the selection but negative for the estimation. Non-relative children have an increased chance of performing chores compared to the son/daughter, but they tend to spend less time. This might indicate that they perform other roles instead such as care (in which there is a strong positive significance on the estimation of hours). There is also a negative significance on their probability of undertaking learning, which might be a sign that they stay in the family to contribute.

The second set of variables is that of the household's head. The reasoning is that since they are typically the decision maker of the family, it is important to take their characteristics into consideration. The first factor is the gender. Although Tanzania is

still largely patriarchal, a sizeable number of households are female-headed (around 30% of children live in such a household). The intuition is that women might provide better opportunities for girls as a form of gender solidarity. However, it is important to note that the reason a household is female-headed might be out of necessity instead of choice. Widowhood or divorce are common reasons why women end up assuming the role of the head. Such a situation, especially in a patriarchal society, might indicate that the family faces increased difficulties, especially in earning subsistence. The female-head effect is correlated with the positive effect on the probability of performing all roles except for care, in which it is negative. The leisure category shows a rather strong significance, although it disappears from the estimation. The direction of estimation contradicts the selection in both leisure and learning categories with no significance.

The education level of the household head is assumed to play a role. An educated household head is expected to value education and thus children would have a higher probability of staying in school. This intuition is correct, as the learning category shows an overwhelming significance with a higher magnitude when the household head has a higher level of education. However, it does not show any significance with the estimation of chores. It might be that educational activities in Tanzania are largely based on the hours spent in school with little emphasis on extracurricular activities. Since urban families in this data are a minority, the importance of learning outside of school might be underestimated. A household head with primary school education also increases the selection probability of both chores and leisure positively, while a household head with secondary education is associated with a negative significance in the selection for care, but a strong positive significance on leisure. There is little significance from the tertiary-educated household head on the probability of three other categories (chores, care, and leisure). However, the result from this group should be taken at face value since there are very few children who live in such households (0.7%).

The third set of predictors concerns household characteristics. In this group, I focus on the composition of the household (number of non-working adults, children, adults, and elders), income bracket, and the type of ward. Since a household in itself is a working unit in which the members contribute their resources to achieve common well-being, it is not far-fetched to assume that the more hands there are in a household, the better they can fare. The composition of the household is an interesting indicator as each individual is different in the kind of contribution they can pitch into the common pool and in the kind of resources they take from it. The number of non-working adults is chosen following Zacharias's notion of how families fulfil their time requirement and the division of labour that takes place in the family. Especially in a place where infrastructure is poor and there is a lack of a good substitution market for the time deficit, it is crucial to have a supply of time from able-bodied adults. Children, on the other hand, as explained in Figure 2.3 and 2.4, pose a trade-off between productive activities and learning throughout their childhood. A younger child might not be able to help as much with chores or in toiling the land, so it does not make sense to take them out of school. In addition, they require the family's precious time as they must be reared by older family members. Similarly, the elderly can still contribute to the family by performing domestic roles and care. In short, the adults are required to perform breadwinning activities while the rest of the family members must contribute to household production and related activities (chores and care).

A positive number of non-working adults is strongly and positively associated with an increase in the probability of performing leisure among children, although the estimation shows an opposite sign albeit with no significance. They are associated with negative signs in the selection of chores, care, and learning. The number of children in the household, however, is associated with a strong negative significance for the selection of both chores and leisure. It is an interesting combination because it suggests that when there are more

children, the burden of chores is shared. The estimation of chores for the number of children is also strongly positive, and status is emulated by the number of adults and elders (albeit the latter with no significance). Indeed, the more hands there are, the less burden there is on the collective's requirement to perform chores. In the leisure category instead, the number of children is associated with a significant negative effect on selection although with a positive estimation. A very similar picture is portrayed by the elders that show a strong negative significance on selection and also a negative relationship with the estimation. The more elders in the household, the less likely it is for the children to enjoy leisure. Since the elders typically also require a certain level of care from the younger family members, this might be the culprit. However, there is no significance in selection and estimation across the care and learning categories.

The household level of income determines how likely its members compensate for the lack of time in the household, and to what extent children are involved in household-related duties. The baseline of this category is under 50,000 TZS per month. It is a very low figure remembering that the minimum wage in the country was 48,000 TZS. However, criticism against the international poverty line is applicable in this situation. Although the minimum wage might be considered to be the subsistence level designed to accommodate workers who live in places with higher living costs, i.e., urban areas, it might not be able to accurately portray the deprivations experienced by those in more rural areas. Especially in agricultural areas, farming subsistence is more difficult to calculate. Families possessing fields and livestock are able to fulfil their required calorie intake without purchasing it from the market. Furthermore, some other common expenditures in the urban setting might be superfluous in the rural context; for instance, the need for energy and water. Urban dwellers have to pay a monthly fee for running water and gas for cooking, while rural families simply send out household members to fetch water and harvest firewood nearby. However, this does not diminish or belittle the experience of deprivation among families who are in the lowest income bracket, in which some 55% of the children live. Indeed, across the brackets, there is a negative effect associated with the selection and estimation of chores, with a significance in both demonstrated by the third group (100,000 – 199,000 TZS). Interestingly income brackets between 50,000 – 999,000, representing four groups and thus almost the rest of all households, are associated with a significant positive effect on the selection of care. Only the third income group shows a negative direction.

Since care is an activity that is closely related to an emotional bond between kin, it is quite difficult to see whether the choice of children performing care is a privilege or a sign of deprivation. The substitution of care in the form of a live-in nurse and child daycare that is common in the developed world is after all an unthinkable concept in a place where several generations of relatives live under the same roof, meaning that handing over care activities to an external third party might be seen as an act of betrayal. However, there is no significance among the estimation across income groups. One would expect that the family with the highest income bracket would be able to liberate children from such a predicament, but since only 0.1% of the children in this dataset resides in such households, we should be careful in interpreting this.

The learning category yields another result worthy of attention. Although there is no significance in selection (with varying signs), there is an overwhelming positive significance in estimation. The estimation of the highest income bracket indeed shows a very high coefficient compared to other income groups. It indicates that children from well-off families might be required to spend more time learning, as their families can afford to free their time from other activities. The selection of learning, however, is largely not significant.

The geographical location of a household largely determines the experience of growing up. As mentioned earlier in this study, the model of childhood consisting of only play and learning activities, which is widely accepted in developed countries, is something that

is uncommon in the more rural part of the world where children are integrated into the family's household production activities. By using Tanzanian households located in the urban wards as a baseline, this study aims to highlight children's experiences in the rural majority of the country. Indeed, across four categories the rural classification indicates significance in selection with two positives (chores and care) and two negatives (leisure and learning). The estimation is associated with a strong negative effect on leisure and learning. As discussed previously, the positive association with chores and care should not raise an alarm because they are just a part of family involvement. However, the learning activities should be of concern. With infrastructure problems that plague the country and little perceived return on education among children beyond primary education, it is not surprising to find that being in a rural household has a strong negative association with learning.

Mixed wards show a strong negative correlation in the estimation of time spent on leisure and learning, although not on the selection of chores. Mixed wards represent a combination of urban and rural characteristics, which might also pose challenges unique to each ward type, putting mixed wards at risk of disadvantage.

2.6   Children in Tanzania and their time use

This study aims to explore the gender difference in time use among children in Sub-Saharan Africa. By taking into consideration the cultural particularity of a largely agrarian society, this study specifically looks into factors that determine the selection and estimation of time spent by children in four distinct categories: chores, care, leisure, and learning. Cragg's double hurdle model is used to perform the analysis, applied to the novel time-use module provided by the Tanzanian ILFS survey.

In the first part of this study, I portray the aggregate gender difference in time use, finding out that there is a similar likelihood for both boys and girls to learn and enjoy leisure, although with discouraging results concerning children's attainment of education in general. The time spent across two categories largely follows the same trajectory with a minimal, if not negligible difference in selection. However, a more pronounced difference can be found in chores and care activities. Although the trajectory of selection in both genders is quite similar (notwithstanding the different levels), the estimation shows a different story. Girls spend an exponential amount of hours compared to boys when it comes to chores, ending up with over three times as much time spent on chores towards the end of their childhood. In care instead, although boys and girls spend a decreasing number of hours until they almost converge at age 14, their trajectories soon diverge, with girls spending over three times more time compared to boys.

Although on the surface this can be taken as a sign of pure discrimination, one must take into account the country-specific nature of experiencing childhood, whereby children are integrated into household activities instead of being passive recipients of resources. The divergence of chores between girls and boys over the entire childhood also shows how girls increasingly assume domestic roles, while boys instead might be sent out to work upon completing their primary education.

The second part of this study explores the influence of three sets of variables in determining both the selection and estimation of children's performance in each category. Age and gender of the child remain the strongest predictor, indicating that both genders are expected to perform, albeit in different roles: girls in domestic work, and boys in other out-of-the-house affairs. Surprisingly, the household relationship shows some significance across different categories, when considering the relative and non-relative status with respect to the household head. The suspected Cinderella effect might take place, although we should further investigate the reason why is there a non-related child in the household

in the first place: are they a servant, a bride, or an adopted child? The effect of the relative child is also mixed, as there is an indication that although the household head has domain over other members, there is still in place a certain dynamic in which the natural parent of the child has a say. Nonetheless, remembering that children are largely expected to work, this should not be taken as a clear sign of discrimination over the degree of blood separation from the household head.

The household composition poses an interesting result. The female-head effect is not as positive as expected because although there might be more compassion for the plight of girls, the circumstances that force the woman to assume the role of a household head (i.e., widowhood, divorce) might put the entire family in a rather deprived condition compared to male-headed households. The educational background of the household head indeed plays a great role in the selection of learning across different educational attainments, indicating their acknowledgement of its importance.

Characteristics of the household reveal rather fascinating findings. The number of non-working adults in the family indeed imposes a more favourable condition on the children, although it seems that they are in the minority. The number of children also reveals a similar result. The higher number of children in the household is negatively associated with the selection of the first three categories. It means that when there is a sufficient supply of children for performing domestic tasks, the family can then be more selective in choosing the most efficient performer, i.e., the older children, to bear the burden of work. The only positive relationship between leisure and family members is with non-working adults. They perform domestic roles better than children, so when there is a supply of non-working adults, it encourages children to use the time for themselves. Interestingly, there is no strong effect of any family members on the learning selection and estimation among children. It seems that the decision to undergo schooling is largely free from the influence of factors other than the household head's own education level for the selection, and the income bracket of the household for the estimation. The household income bracket plays a significant role in increasing the hours spent on care by children except for the third income group. As care is a less demanding type of domestic task compared to chores, it might indicate that families with a better financial situation allocate their children from chores to care, as the selection of chores is uniformly negative.

Finally, the ward indicator is very important as it highlights the Tanzanian case as a country that is largely agrarian, with a mostly rural population. The rural indicator positively predicts the selection of chores and care and negatively predicts leisure and learning. This suggests that the childhood experiences of children in urban and rural areas are distinct, although it does not necessarily means that one trumps another. The results from the mixed wards are quite similar to those from the rural wards, possibly indicating that they are characteristically closer to the rural wards than the urban ones.

Nonetheless, I noticed that care measurement might be a culprit. Time measurement is notoriously difficult to calculate due to its flexible nature and occurrences of multitasking that are difficult to properly enumerate. Not to mention that the perception of certain tasks such as child-rearing as 'not work' might lead to under-reporting. When working with children, it is especially more difficult since they are often not capable of maintaining their own time record and thus rely on their parents who might misreport. Thus, I think it is safer to consider the result of care-related activities as possibly downward bias. Studies should make use of qualitative analysis to provide a better explanation of time-use differences between children.

The experience of childhood between girls and boys is largely similar in the leisure and learning categories, where there is little discrimination seen. However, the gap between gender in chores and care might cause concern. It sets up a potential future opportunity to study the broader context of time use among children, such as the prevalence of child

labour and child marriage that is rife in such societies. The figure shown for learning activities is quite alarming, as it indicates a drop in both selection and estimation post the completion of primary schooling. Nevertheless, the household characteristics' role in determining time use is complimentary with the personal characteristics of the children. To this effect, it would be interesting to perform a decomposition analysis between genders to accurately estimate the degree of discrimination, should it exist.

2.7 Appendix

2.7.1 Demographic description

The time use module in the survey consists of 10,302 individuals in 3,146 households. The demographic description of the dataset is as follows:

	All			**Children**	
	Total	**Percent**		**Total**	**Percent**
Sex					
Male	4,923	47.79%		1,954	50.22%
Female	5,379	52.21%		1,937	49.78%
Age group					
Children (5-18)	3,891	37.77%	Younger children (5-13)	2,594	66.67%
Adults (19-60)	5,663	54.97%	Older children (14-18)	1,297	33.33%
Elders (61+)	748	7.26%			
Education					
None	2,812	27.30%	Completed	404	10,38%
Primary	6,514	63.24%	Attending	2,938	75.51%
Secondary	900	8.74%	Never attended school	549	14.11%
Tertiary	74	0.72%			
Household's Income group					
\textless 50,000	5,607	54.43%		2,141	55.02%
50,000 - 99,000	2,858	27.74%		1,102	28.32%
100,000 - 199,000	1,223	11.87%		421	10.82%
200,000 - 499,000	544	5.28%		203	5.22%
500,000 - 999,000	53	0.51%		20	0.51%
1,000,000 +	17	0.17%		4	0.10%
Household head					
Male	7,651	74.27%		2,721	69.93%
Female	2,651	25.73%		1,170	30.07%
Household head's education					
None	2,812	27.30%		1,016	26.11%
Primary	6,514	63.24%		2,527	64.94%
Secondary	900	8.74%		321	8.25%
Tertiary	74	0.72%		27	0.69%
Household ward					
Rural	5,180	50.28%		2,056	52.84%
Urban	1,585	15.39%		488	12.54%
Mixed	3,537	34.33%		1,347	34.62%

Table 2.3: Tanzanian demographic characteristics for both the entire population and the children

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Chapter 3

Trajectories of mental distress during the COVID-19 pandemic in the United Kingdom: the role of loneliness and job security

Abstract

The COVID-19 pandemic has had a profound impact on various aspects of society, including the mental well-being of individuals. This study examines the trajectories of mental distress in the United Kingdom during the pandemic, with a specific focus on the role of loneliness and job security. Utilizing the UK Household Longitudinal Study (UKHLS), I employ population mean comparison and latent class analysis to identify distinct trajectories of mental health distress. Building upon prior research by Ellwardt and Präg (2021) and Pierce et al. (2021), I analyse the socio-economic and health factors associated with these trajectories. The findings reveal the existence of four distinct trajectories of mental health distress experienced by the population. Furthermore, I employ multinomial logit regression to predict individuals' assignment to specific trajectories based on their socio-demographic profiles. This research contributes to a deeper understanding of the complex interplay between individual experiences and broader societal factors during the COVID-19 pandemic.

Keywords: *subjective well-being, mental illness, loneliness, job security, trajectory analysis, latent class models, group-based trajectory modelling*

3.1 Introduction

The COVID-19 pandemic incited a widespread disruption in many aspects of society's quotidian life. One of its defining features was the global consensus on putting forward a predominantly homogeneous lockdown policy to stop the virus' transmission. Its effects on both public and personal spheres have been thoroughly documented, with studies such as by Banks and Xu (2020), Fujiwara et al. (2020), and Daly and Robinson (2022) describing the negative effects of the lockdowns on the population's mental health and psychological well-being. Although there is a population-level detriment in mental well-being, on the individual level this varies greatly. Each person's capability to respond and cope with the situation is based on their unique set of personal characteristics. Thus, an a priori expectation of every individual's health outcome can be misleading. For instance,

some ex-ante characteristics might play a greater role in determining how one performs during an extended period of social contact deprivation and uncertainty. Although socio-economic characteristics are often used to segment expectations of various outcomes, they might not be able to fully explain the resilience that comes out of factors such as social capitalMcKenzie et al. (2002).

One of the notorious aftermaths of the lockdown policy is the physical and social isolation it caused. While some individuals were able to stay together with their loved ones, many were not. In addition, with the economy coming to a halt, most commercial enterprises ceased their activities. Jobs that did not require physical presence soon migrated to the so-called 'work from home (WFH)' or 'remote working' environment. Workers that stayed in the physical workplaces ended up being divided into those considered to be 'essential' and/or 'frontline' workers, and those who were not[1]. The UK government quickly introduced two schemes: the Coronavirus Job Retention Scheme (CJRS) for salaried employees, and the Self-Employment Income Support Scheme (SEISS) for self-employed individuals. The subtle difference in determining who was eligible for benefits under the schemes meant that the representatives of two distinct types of employment would experience the perception of job safety differently. The relationship between job insecurity and the negative consequences on workers' well-being and mental health has been well established (Cheng and Chan, 2008; De witte et al., 2016; Lee et al., 2018). At the same time, uncertainty and extended state of isolation were found to exacerbate preexisting mental health problems Banerjee and Rai (2020); Hards et al. (2022); Vissink et al. (2021).

3.2   Previous studies

Understanding the ability of individuals to respond and cope with a crisis is a complex task, often challenging to measure. The COVID-19 pandemic occurred during a time of significant societal shifts, impacting various aspects of our lives, including social values and mechanisms. Therefore, it is essential to reevaluate the mental health stressors and their link to a priori expectations at the population level.

Country-level explorations have been done in countries such as France (Lu et al., 2022), Germany (Ahrens et al., 2021), Italy (Sani et al., 2020), USA (Zhou et al., 2020). A meta-analysis done by Xiong et al. (2020) and Robinson et al. (2022) attempted to further generalise the dynamics of mental health development across countries by drawing results from various studies. Xiong et al. found relatively high rates of anxiety, depression, post-traumatic stress disorder, psychological distress, and stress in eight countries studied. They further defined the risk factor of those affected by the pandemic the most: characteristics included being female, under 40 years old, having chronic or psychiatric illnesses, being unemployed, being a student, and, interestingly, frequently exposed to social media or news about COVID-19. Drawing from a larger body of studies, Robinson et al. found that the overall mental health symptoms increased especially among those with a physical health condition although none among samples with a pre-existing mental health condition. A link between gender, loneliness, and happiness during this period was explored by Lepinteur et al. (2022) who found a gender gap in loneliness in which the increase was greatly demonstrated by women. However, since COVID-19 was experienced by everyone, it is difficult to assign the blame to the pandemic. Moreover, the dramatic fall of life satisfaction of women between 2007-2020 might have produced a sufficient level of penalty which exacerbate their feeling of loneliness.

This research is built on two particular works that studied mental health distress throughout the pandemic on the population level, namely Pierce et al. (2021) and Ell-

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[1]A more detailed account can be found in Blau et al. (2021) who identifies the profile of essential and frontline workers from March 2020 and December 2020 that saw an addition of the education sector.

wardt and Präg (2021). The earlier work by Pierce et al. utilised the first six waves of the UK Household Longitudinal Study (UKHLS) COVID-19 module to study the trajectory of subjective mental distress, presenting a mean comparison across age, group, and sex. It allowed for a more intimate observation of a population subset, while still capturing general public tendencies. Ellwardt and Präg followed suit by investigating the heterogeneity in socio-economic characteristics to further break down the various predictors of an individual assignment to a particular trajectory. By incorporating two additional waves of data, they painted a more comprehensive picture of the UK, paralysed by the second and third national lockdowns.

With the latest inclusion of wave 9 of UKHLS COVID-19 module data, it became possible to get a grasp on how the UK population fared throughout the one-and-a-half years of the pandemic. This time frame coincided with the end of government support, as businesses returned to their usual operation. Consistent with the two predecessors, this study hypothesises that socio-economic and demographic characteristics are good predictors of an individual assignment to a particular mental health trajectory. I am in particular interested in assessing the factors of loneliness and job security as additional predictors.

The choice of loneliness as a predictor is based on the well-established consensus of its association with a higher level of depression and a reduction in life satisfaction (Borg et al., 2006; Golden et al., 2009). It is a phenomenon observed in various cultures, which thus indicates its universality (Cacioppo et al., 2006; Losada et al., 2012). With the recent development in technology, digital communication channels have increasingly become the norm in lieu of traditional forms of communication, such as in-person interaction. However, it cannot entirely replace the benefit of the direct interaction of a face-to-face meeting Teo et al. (2019). The lack of feeling of companionship is especially tied to mental distress. Studies by Shevlin et al. (2013) and Hawkley and Cacioppo (2010) demonstrated how loneliness exacerbates mental distress. The COVID-19 pandemic imposed a situation in which social distancing policies further disrupted the ability to fulfil the need for social contact, worsening mental health problems Bu et al. (2020).

Job security is selected as a predictor due to its prominence alongside social distancing policies as a crucial consequence of the pandemic. Business closures, in particular those requiring a physical presence, have affected numerous workers. Although the UK government was quick to provide forms of support for those whose jobs were affected, the experiences have varied. Cheng and Chan's meta-analytical study of the detrimental effects of job insecurity found its negative effect on health outcomes, especially for those with longer tenure and older workers (Cheng and Chan, 2008). De witte et al. (2016) reviewed 57 longitudinal studies published within a 30-year period, finding that there is strong evidence for normal causation in which job insecurity influences both psychological well-being and somatic health. Similar to the issue of loneliness, technological development greatly affected the conceptualisation of work in more recent years. With the trends of offshoring, automation, and changing landscape of the job environment, especially regarding abolition and creation of new forms of job, it is crucial to study how it affects one's well-being (Lee et al., 2018). COVID-19 forced us to rethink the future of jobs, as we saw a part of the working population was able to move their job to a remote setting, while those who did not either became essential workers, were furloughed, or lost employment altogether.

3.3 Data and methods

3.3.1 Preliminary study design

This study utilises UKHLS Understanding Society panel survey data (University Of Essex, 2021, 2022) to conduct the analysis. The mainstage longitudinal data consists of the Harmonised British Household Panel Survey (BHPS) between 1991-2009 and the Un-

derstanding Society panel survey from 2009-2021. It includes households from England, Scotland, Wales, and Northern Ireland, with participants aged 16 years old and above. To account for immigration, the survey collected information on the respondents' ethnic backgrounds. Beginning in April 2020 an additional module focusing on the COVID-19 pandemic was added to the survey. It involved a small survey administered through web-based platforms and telephone interviews, capturing respondents' personal circumstances, well-being status, and various work-related information throughout the different lockdown policies.

To address the research question posed by this study, several key pieces of information were used. I employ the General Health Questionnaire (GHQ) to measure the level of mental health distress. Specifically, I use the GHQ-12[2] as a subjective measure of well-being to detect current psychiatric distress (Goldberg and Blackwell, 1970). The use of GHQ to detect distress is considered to be reliable and consistent (Pevalin, 2000). More detailed information on the survey questions can be found in the appendix. The 12 questions are answered with a response in the form of a Likert-type scale of four levels where the lower numbers indicate an absence or a lesser level of distress. The results are typically dichotomised into 1 or 0 to indicate the existence of stress, resulting in 0-12 scales or the entire questionnaire. However, based on Goldberg and Williams (1988), this can be further summarised into the so-called caseness of distress with a cutoff point of 4 out of 12. In other words, respondents who reach the cutoff will be considered as suffering from mental health distress in a clinically relevant sense. This situation is then referred to as 'caseness'. In total, the COVID-19 module consisted of 9 waves[3]. In order to ensure the quality of data, only respondents who completed at least three waves were included (N=6667).

This study especially focuses on the pre-pandemic level of loneliness as an indicator, based on the survey question 'How often do you feel lonely?' with three levels of response: 1) hardly ever/never, 2) some of the time, and 3) often. It is used alongside various socio-economic indicators obtained from the Understanding Society main survey prior to the lockdown, recorded in Wave 10 of the UKHLS main survey conducted between 2018 and 2019. Additional covariates include age group, ethnicity, sex, family life indicators (such as partner status, children, and single parenthood), and health-related information (prior health status and whether they suffered from COVID-19).

One significant disruption that took place during the pandemic was the halt of economic activities. To capture this information, this study focuses on several indicators: status and type of employment pre-pandemic (employed or self-employed), earnings loss (and subsequently, the loss of income), and any form of government support (CJRS for furloughed employees, and SEISS for the self-employed). In particular, the socio-economic status adheres to the official UKHLS classification system based on the official National Statistics Socio-Economic Classification (NS-SEC)[4] on the respondent's profession.

3.3.2   Technical approach

To study the population-level mental health distress, I use two main approaches, namely, the population-level changes in mean GHQ-12 score, and the group-based trajectory model (GBTM).

The first approach is descriptive in nature and aims to superficially compare the level of mental health distress in the population through the use of mean GHQ-12 scores. It is called the Likert approach approach, in which the responses from GHQ-12 questions

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[2]Others are: GHQ-28 (or Scaled GHQ), GHQ-30, and GHQ-60. They are used in a more specific clinical setting.

[3]The data were collected in April, May, June, July, September, and November 2020, then January, May, and September 2021.

[4]Further breakdown can be found in the appendix.

are recoded to 0-3 instead of 1-4 which results in a scale ranging between 0 (the least distressed) to 36 (the most distressed). An alternative approach would follow the intuition suggested by Goldberg and Blackwell (1970) called the caseness. In this case, the valid answer from the GHQ-12 questions are recoded to a single binary scale by converting the response 1 and 2 to 0, while 3 and 4 to 1. The recoded response is then summed up, generating a scale that runs between 0 (the least distressed) to 12 (the most distressed). This research opt for the former (Likert approach) because the resulting mean difference provides a simple indicator that allows for a quick comparison between groups over time, including their pre-COVID-19 state.

The second approach is a specific type of group-based trajectory model, the latent class mixture modelling, which allows us to identify clusters of individual trajectories of variable changes without having any prior expectation of its distribution (Collins and Lanza, 2010; Jones and Nagin, 2013). In short, we put no assumption into the clustering process, and the model groups the observations into their respective trajectories based on the choice of k class. Then a follow-up analysis is made through the use of a multinomial logit model, in which the average marginal effects (AMEs) are visualised to display the contribution of each covariate toward an individual's assignment to a certain trajectory. Further theoretical elaboration on the model can be found in the appendix.

3.4 Discussion

3.4.1 The evolution of COVID-19 policies stringency

Figure 3.1: The development of COVID-19 policy stringency in the UK between January 2020 - September 2021. Source: Hale et al. (2021)

When discussing the evolution of mental health distress during the pandemic, it is important to consider the stringency of the policy at the time. The stringency index was

developed by Hale et al. (2021), presenting a composite measure based on nine indicators which can be studied in Figure 3.1. After the initial response in March 2020, the regulations remained strict throughout the pandemic with a slight easing up from summer 2020 before the new an ascension that peaked after the new year of 2021. The year 2021 saw a constant decline in the stringency, which also coincides with the availability of vaccination.

Formally, there were three national lockdowns: on March 2020, November 2020, and January 2021. Each was followed by a series of policy relaxation that governed schooling, work, and social gatherings. Following the first lockdown, the first sign of the restriction being eased came into effect on June 2020. Schools were partially opened, as well as non-essential shops. In addition, the social distancing rule was eased. On July 2020, although a local lockdown came into place in Leicester and Leicestershire, a further restriction easing took place with the opening of pubs, restaurants, and hairdressers. On September 2020 more businesses were allowed to reopen included indoor theaters, bowling alleys, and soft plays. Following the second lockdown, an eased regulation was allowed only by the Christmas period. This was followed by the third lockdocwn on January that saw the gradual easing up beginning March, where the school reopening took place, until July where most of the social distancing rule was removed.

3.4.2 Overall mean change
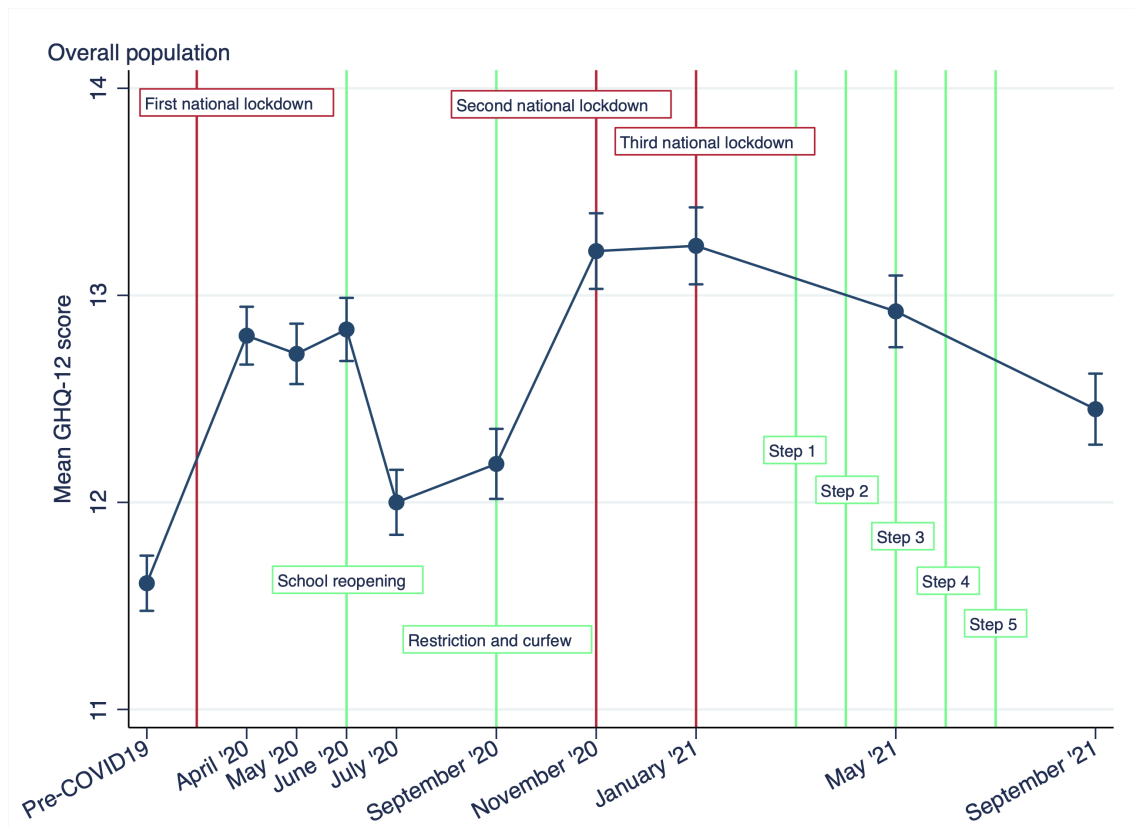
Figure 3.2: Overall mean GHQ-12 score across time using the Likert approach. Red lines indicate the adoption of national lockdown policies while green lines indicate the loosening of restrictions. The 'restriction and curfew' policy was largely tightening but balanced it out with some reopening of businesses.

As such, the analysis of the overall mean GHQ-12 score on the population level indicates an increase in mental health distress during the pandemic, with the ebb and flow that corresponds to the implementation of various policies.

Notably, the last observation in September 2021, coinciding with the end of the pandemic, recorded a distress level higher than the pre-pandemic period. The initial national lockdown had a significant impact on distress levels, which persisted until a slight decrease was observed following the reopening of schools. The introduction of restrictions and curfews in September 2020, accompanied by some business openings, led to a slight increase in distress, although the effect was not drastic. The second national lockdown, however, brought distress levels to a new high, and there was a further slight increase during the third national lockdown in January 2021. The holiday season of Christmas and New Year, traditionally associated with family and friends, may have exacerbated feelings of isolation due to the implemented policies. Starting in 2021, the distress level steadily decreased, reaching a point slightly lower than during the initial national lockdown but still higher than in the summer of 2020, which saw schools and businesses reopen. It would be intriguing to explore how long it will take for the population's mean score to return to its pre-pandemic level.
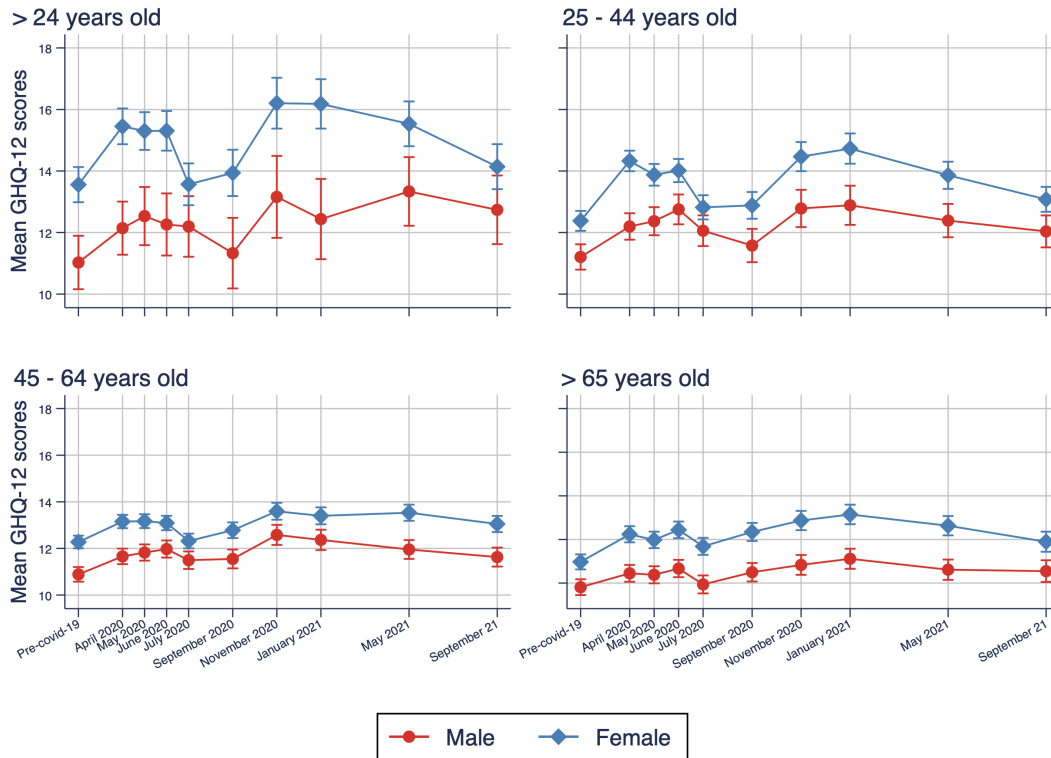
Figure 3.3: Mean GHQ-12 scores across age groups, sex using the Likert approach

Figure 3.3 represents the categorisation of respondents into four groups based on their age: below 24 years old, 25-44 years old, 45-64 years old, and over 65 years old. The first group encompasses students and early career workers, while the second and third groups represent those in their productive age, albeit at different stages of personal and professional life. The last group consists of retirees. During the initial phase of the pandemic and the first national lockdown in April 2020, the first group experienced the most significant increase in distress levels. As schools and shops reopened and restrictions eased throughout the summer, distress levels gradually decreased until August 2020. However, the introduction of restrictions and curfews in September 2020 led to a notable increase in distress among females, whereas males in both groups under 45 years old exhibited the

opposite trend[5]. The peak observed in November 2020 coincided with the second national lockdown. Subsequently, a downward trend in distress levels was observed for most groups, except for males below 24 years old, who experienced a peak in May 2021, coinciding with the implementation of Step 3 of the national reopening.

When comparing between groups, the retirees seem to show the least change in distress levels, if any. While their initial level was already relatively low compared to the other groups, they show a minimal overall increase at the end of the series.

The third and fourth groups demonstrate a very similar trend for female respondents, while their male counterparts in the third group show a slightly higher level of distress compared to the retirees, although still lower than females in both groups. In contrast, the second group shows more fluctuation at the higher level of distress compared to the third and fourth groups. The widest gender gap is observed within the first group. The under 24 years old males exhibited a comparable level of distress with the second group, while females scored almost 1 point higher compared to the other groups with a greater fluctuation. When comparing to the population-level mean, it is evident that the dynamic is experienced similarly across groups, albeit with a different intensity.
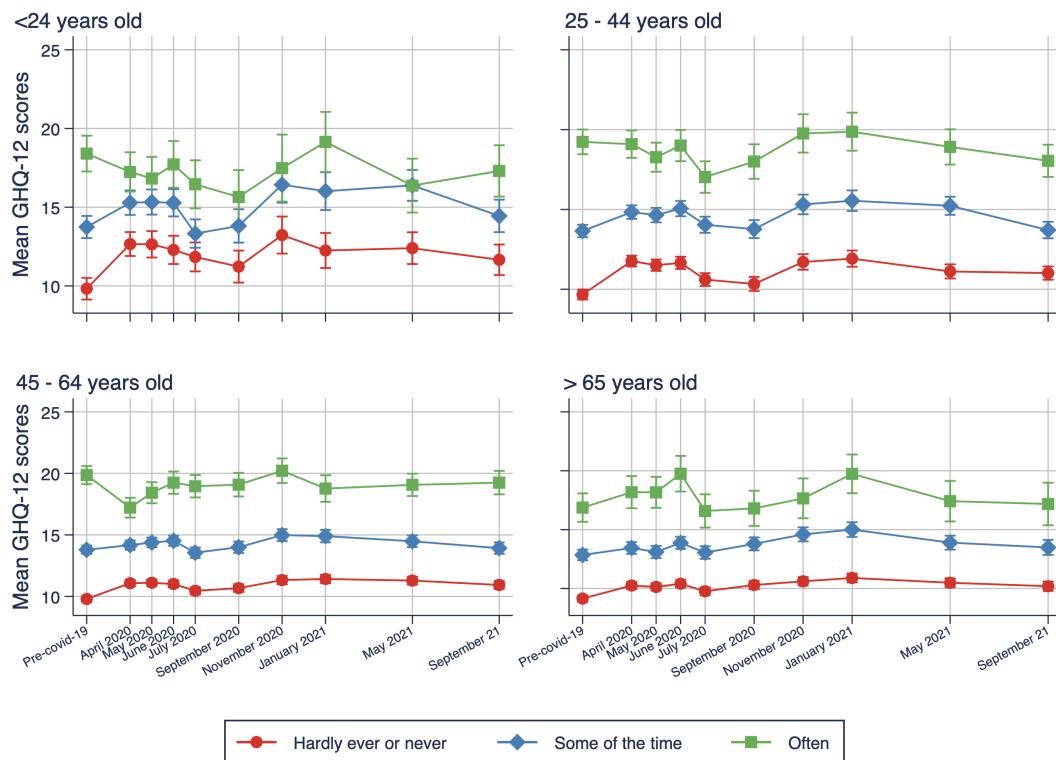
Figure 3.4: Mean GHQ-12 scores across age groups, loneliness using the Likert approach

The loneliness indicator, on the other hand, shows a pretty consistent trend across the observations. Figure 3.4 reveals that in almost all age groups, those who often feel lonely have the highest level of distress, while those who never feel lonely tend to experience a lower level of distress. In fact, the latter group demonstrates an exceptionally low level of distress, with most age groups starting at 10 points or even slightly lower. This persistently low level of distress is comparable to the mean score of male retirees in the previous series. Another intriguing finding pertains to the group which often feels lonely. Their mean

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[5]This increase in female distress could be attributed to factors such as the work-from-home policy, as women often face challenges in balancing childcare and other responsibilities.

distress level is consistently high and reaches 20 points quite often as exhibited by the third age group. Interestingly, unlike the previous series, the lonely youngsters exhibit slightly lower levels of distress compared to other groups, albeit marginally. This observation may potentially be explained by the fact that younger respondents are often considered digital natives, who sometimes prioritise the use of electronic media to connect with their peers. The group which experiences loneliness some of the time exhibits a similar level of distress across age groups with a slightly higher level observed among the youth.
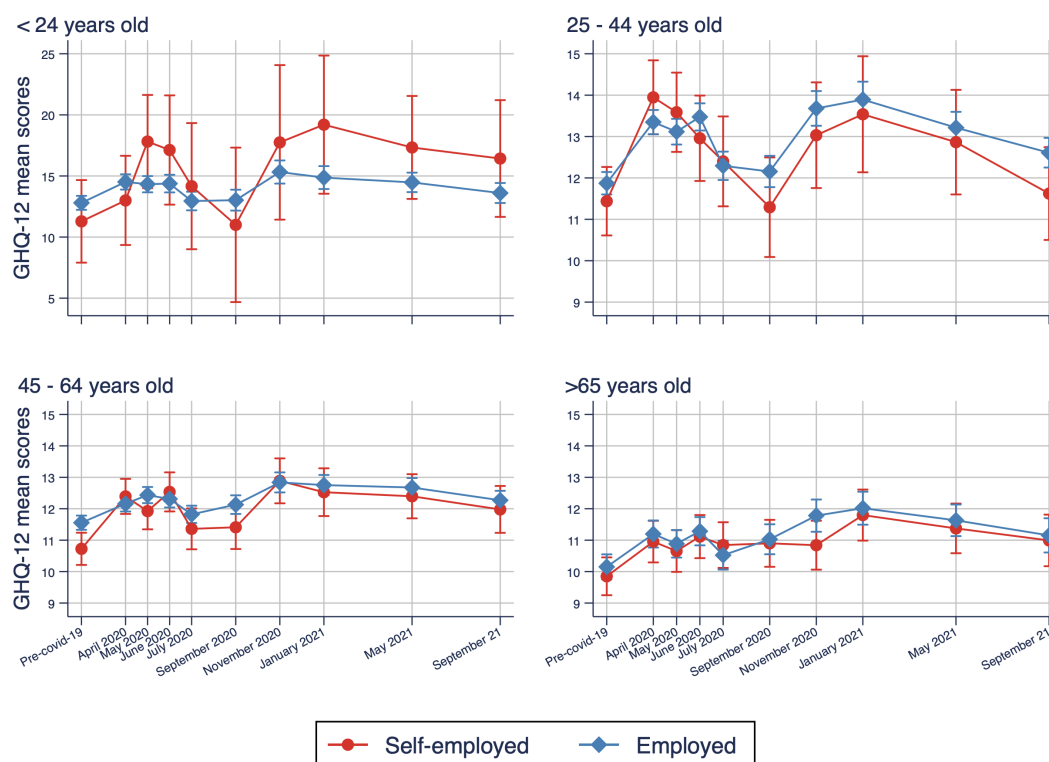
Figure 3.5: Mean GHQ-12 scores across income loss, employment using the Likert approach

Another hypothesis explored by this study is the possibility of self-employment status as a predictor of trajectory assignment. The underlying intuition suggests that self-employed individuals face additional stressors related to job security. Figure 3.5 presents a visualisation of distress levels for the employed and self-employed across different age groups. Rather counterintuitively, the factor of self-employment only contributes to a noticeably higher level of distress among the young. Notice the different scale presented between the youngest group and the rest, in which the range is wider (5-15 instead of 9-15). For age groups above 25 years old, the dynamic between employed and self-employed individuals is very similar. The third and fourth age groups fluctuate between 10-13 and 10-12 points respectively, with the employed group showing slightly higher distress. The second age group shows greater variation, ranging between 11-14 points, which is one point higher than the lowest level of distress among the third and fourth age groups. Notably, a significant change occurs between the implementation of the first national lockdown and the subsequent spike in distress following the summer of 2020, coinciding with the second lockdown.

The first group, however, demonstrates remarkable fluctuations of distress levels among the self-employed, averaging between 10 to 20 points. While the dynamic is comparable to the second age group, the sheer magnitude of distress experienced is astonishing. Moreover,

their mean distress score does not fully recover but rather plateaus around 16 points, approximately 5 points higher than their pre-pandemic level. Additionally, we can observe an interesting reversal of trends. Initially, the employed group exhibited a higher level of distress, but by the end of the series, the opposite was true. It seems that the gap between the self-employed and employed respondents is most evident in this group.
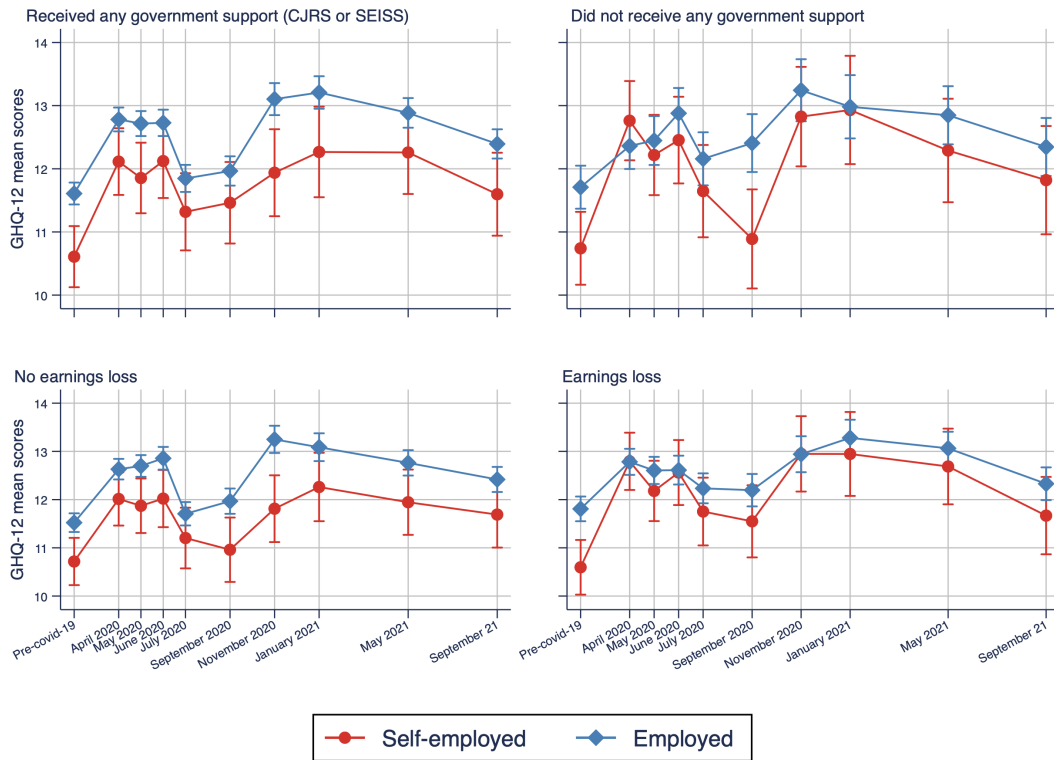
Figure 3.6: Mean GHQ-12 scores across government support and income loss using the Likert approach

To further investigate the divergence between the employed and self-employed groups, I compared the mean GHQ-12 scores based on whether individuals received government support or experienced earnings loss during the pandemic. Surprisingly, the results presented a contrast with the previous findings. Figure 3.6 illustrates that, across almost all four cases defined by the presence of government support and earnings loss, the employed group fared worse than the self-employed group.

Among those who received government support and did not experience earnings loss, the change and level of distress were very similar between the two employment groups. For individuals who experienced earnings loss, both employed and self-employed individuals exhibited elevated levels of distress that were almost identical across employment types. However, by the end of the pandemic, their distress levels had returned to the same level as those who did not experience earnings loss. A similar trend can be observed among those who did not receive any government support, with the employed group showing higher levels of distress peaking around the summer of 2020 and reaching a new high during the second national lockdown in September 2020. Eventually, their distress levels decreased to match those of government support recipients by the end of the pandemic. In contrast, the self-employed group without government support displayed a more volatile trend. They initially started with a lower level of distress but quickly surpassed their employed counterparts at the onset of the pandemic. This trend continued to decrease, reaching a level comparable

to their pre-pandemic baseline just before the second lockdown. However, their distress levels increased significantly during the second lockdown in November 2020, similar to the levels observed during the first national lockdown. This trend persisted until the beginning of 2021 before further decreasing. At the end of the pandemic, their distress levels were slightly higher compared to the self-employed individuals who received government support.

In this context, government support refers to the CJRS scheme (commonly known as furlough) for employed individuals and the SEISS scheme for the self-employed. While the mechanisms of these support schemes differ slightly, they cover almost the same period. The CJRS scheme covers 80% of the employee's salary, initially fully funded by the government and later with around 20% of the contribution paid by the employer. On the other hand, the SEISS scheme was implemented in five rounds and based on 80% of a 3-month average of profits, capped at £7,500. Overall, individuals under the SEISS scheme had the potential to earn less than those under the CJRS scheme. However, it is important to note that other factors such as industry, level of earnings (and thus social class), and individual circumstances may contribute to the level of distress experienced, rather than solely relying on a simplified dichotomy between employed and self-employed status.

3.4.3 Group-based Trajectory Analysis

The GHQ-12 questionnaire, which this study utilises as a subjective measure of well-being, is further elaborated in the appendix. Two different approaches have been demonstrated by Pierce et al. (2021) and Ellwardt and Präg (2021) to employ this measure. As explained in the previous section, the questionnaire consists of 12 items with 4 response options ranging from 0-3, resulting in scores ranging from 0 to 36 where higher scores indicate a greater level of distress. Pierce et al. used this measurement to observe changes in the mean of the general population as well as the assignment of trajectory. On the other hand, Ellwardt and Präg used a different approach known as 'caseness', which yields a binary response ranging from 0 to 1 (also outlined in the previous section), indicating the presence or absence of mental distress. This method is more suitable for detecting such disturbances and has been discussed in psychiatric literature (Goldberg and Blackwell, 1970).

The construction of the latent class mixed model to identify the distinct trajectories is done through the use of the *traj* command in Stata 16[6]. The specification of the logit distribution for $p(\cdot)$ was based on the optimal number of trajectories or latent classes, denoted as k. This is done through the use of goodness of fit statistics in which the model is sequentially compared starting with $k=1$ until the ideal number is achieved.

	BIC	AIC	LL	$k=1$	$k=2$	$k=3$	$k=4$	$k=5$
Trajectory 1	-33038,61	-33024,40	-33020,40	100				
Trajectory 2	-26898,13	-26876,82	-26870,82	68,79	31,21			
Trajectory 3	-26431,65	-26392,58	-26381,58	53,96	30,22	15,82		
Trajectory 4	-26263,10	-26263,10	-26190,26	51,09	7,46	25,21	16,25	
Trajectory 5	-26216,99	-26142,40	-26121,40	25,73	30,53	23,36	4,86	15,53

Note: Goodness of fit statistics and class prevalence for k latent trajectories model
BIC: Bayes Information Criterion, AIC: Akaike Information Criterion, LL: Log Likelihood

Table 3.1: Fit statistics and percentage of assignment to each trajectory.

Table 3.1 presents the fit statistics for different values of k based on three measures: BIC (Bayes Information Criterion), AIC (Akaike Information Criterion), and LL (Log Likelihood). Additionally, it provides the assignment probabilities to each trajectory without assuming any prior distribution of the data. The analysis reveals that the optimal fit is

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[6]The documentation can be found in Jones and Nagin (2013).

achieved at $k = 4$, although there is a possibility of choosing $k = 5$ as well. While there is a partial improvement in fit between $k = 4$ and $k = 5$, the posterior probability rates and entropy measures decrease[7]. However, since no discernible visual heterogeneity beyond this point can offer an interesting interpretation, this study will adopt the $k = 4$ fit.
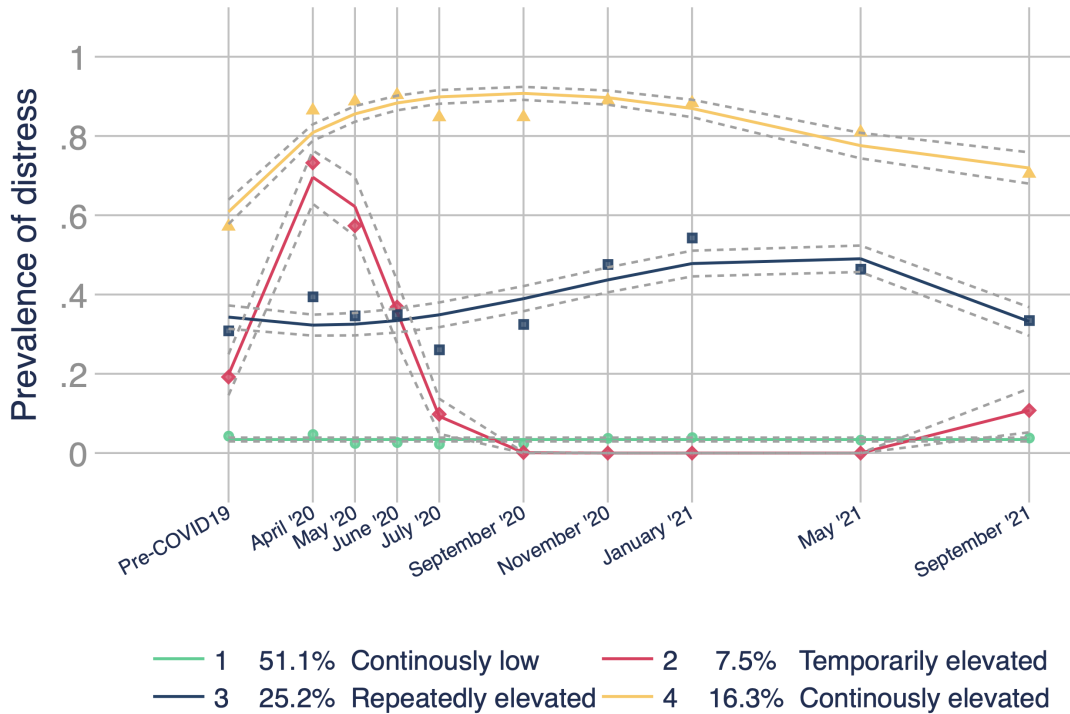
Figure 3.7: Trajectories of mental distress throughout the COVID-19 pandemic.

The trajectories are visualised in Figure 3.7. The highest prevalence of distress is observed in the 4th trajectory, affecting 16.3% of the respondents. This trajectory initially exhibited a high prevalence, which steadily increased throughout the first national lockdown. It then reached a plateau before showing signs of slight improvement only in 2021. The final observation is slightly higher than the pre-pandemic prevalence but lower than the peak. On the other hand, the 1st trajectory displays the lowest prevalence, accounting for 51.1% of the respondents. This group exhibited consistently low prevalence throughout the pandemic with minimal variation.

The most interesting trajectories, however, are the 2nd and 3rd. The 3rd trajectory started and ended at almost the same level of prevalence but showed noticeable dynamics during the pandemic. It exhibited a slow increase only after the summer of 2020 when the initial easing measures were introduced. June 2020 saw the reopening of schools and non-essential shops which continued well into July and August 2020. In September 2020, curfew and work-from-home policies were implemented, followed by the announcement of the 2nd national lockdown in November 2020. This trajectory reached its peak in January 2021 during the 3rd national lockdown and remained stable until May 2021 before returning to its pre-pandemic level by September 2021. Approximately 25.2% of the respondents were assigned to this trajectory.

The last trajectory is the 2nd group, which exhibits a peculiar dynamic. It experienced

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[7]For the curious reader, the trajectories for $k = 5$ are visualized in the appendix, along with a brief explanation of their main differences.

a significant spike in prevalence during the first national lockdown. However, this quickly decreased to a level even lower than the pre-pandemic level by July 2020. Interestingly, from September 2020 to May 2021, there appears to be no prevalence of distress whatsoever, until it increased again to the July 2020 level by September 2021.

These findings are consistent with other similar studies that employed latent class analysis (Pierce et al., 2021; Ellwardt and Präg, 2021; Lu et al., 2022). Among all the trajectories, only the 4th group shows no indication of recovery and experiences worse distress levels than their pre-pandemic period. The remaining trajectories either demonstrate improvement (2nd group) or no significant change (1st and 3rd groups).

3.4.4 Multinomial logit

The analysis utilises multinomial logit regression to examine the connection between individual-level characteristics and trajectory assignment. Specifically, it explores a range of covariates that could potentially explain an individual's placement within a particular trajectory. The covariates and their associations are illustrated in Figure 3.8.
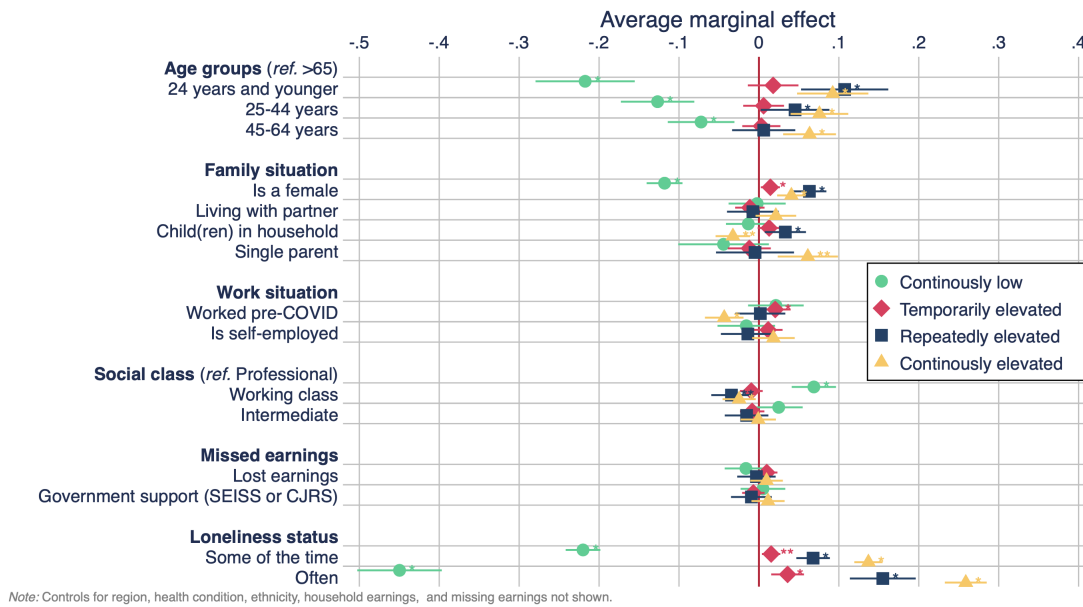
Figure 3.8: Coefficient plot of Average marginal effects of multinomial regressions of belonging to either trajectory.

The age group serves as a significant negative predictor, particularly for the continuously low trajectory. This implies that individuals younger than 65 are significantly less likely to be assigned to the continuously low class. Similarly, the age group predicts assignment to the repeatedly elevated or continuously elevated classes. However, no age group appears to predict assignment to the temporarily elevated class. Nevertheless, this finding confirms the overall mean comparison, which suggests that individuals over 65 years old demonstrate the least mental distress.

Moving on to family-related covariates, female status significantly predicts a negative assignment to the continuously low class. This aligns with the overall mean comparison, indicating that females experience higher levels of mental distress across almost all age groups compared to their male counterparts. The female status also predicts a positive assignment to the other three classes, although with a lower average marginal effect on the temporarily elevated class. Living with a partner or having child(ren) in the household shows a minimal average marginal effect, albeit with statistical significance for the latter in

the continuously low and stable neutral classes. Conversely, single-parent status predicts a somewhat stronger and more significant assignment to the continuously high class. It would be interesting to study the interaction between female status, living with a partner, and having children in the household to assess whether female individuals with children fare better in terms of mental health outcomes when they have a partner or not.

The work situation is a key area of interest in this study. Pre-pandemic employment status significantly predicts a negative assignment to the continuously high class and a positive assignment to the continuously low class. Both findings indicate that being employed prior to the pandemic is an indicator of lower levels of mental distress. Meanwhile, self-employment status does not seem to yield any significant results, with very negligible average marginal effects on all classes. Among employed individuals, compared to professionals, being part of the working population is positively correlated with continuously low mental health distress. There is a slightly negative average marginal effect on assignment to both the stable neutral and continuously high classes. Conversely, the intermediate category does not show any significant relationship with an assignment to any of the trajectory classes.

Another aspect related to job security and work status is the impact of missed earnings, defined as experiencing lower earnings compared to pre-pandemic levels. To address this issue, the government implemented the Job Retention Scheme (CJRS) for employees affected by job loss and a cash assistance program for self-employed individuals (SEISS). Interestingly, neither of these factors seems to predict assignment to any of the trajectory classes.

One intriguing finding of this study pertains to the extent to which loneliness status predicts assignment to a particular trajectory. Using the absence of loneliness as a reference point, it significantly predicts a positive assignment to the continuously low trajectory and a negative assignment to the temporarily elevated, stable neutral, and continuously high trajectories. This confirms the results of the overall mean comparison, indicating that the absence of loneliness is associated with a lower level of mental health distress that remains stable throughout the pandemic, albeit at a higher level compared to pre-pandemic levels. On the other hand, individuals who often experience loneliness demonstrate higher levels of distress, particularly among the age groups of 25-44 and 45-64.

3.4.5 Predicting group-based trajectories with covariates

The distribution of individual-level characteristics across the classes can be observed in Table 3.2, which presents the ex-post classification of individuals into latent classes based on their assigned mental health trajectories. For example, individuals in the continuously low mental distress class are more likely to belong to the 45-64 years old age group, live with a partner, and rarely experience loneliness. The indicator for single parents, defined as individuals who do not live with a partner and have children in the household, appears to be most prevalent in the continuously elevated group. When this indicator is divided into living with a partner and having child(ren) in the household separately, the former indicates a slightly higher assignment to the continuously low class, while the latter is associated with both the temporarily elevated and repeatedly elevated classes. This suggests that the presence of children and a partner may have different implications for assignment to different trajectories. Interestingly, the female factor shows the lowest assignment to the continuously low trajectory. Overall, considering family and personal characteristics, it appears that single-parent women are more prevalent in being assigned to the continuously elevated trajectory.

Regarding health and work-related covariates, we gained further insights into the likelihood of being assigned to the continuously low and continuously elevated trajectories. COVID-19 symptoms are most commonly observed in the continuously elevated group,

while individuals without any health conditions are more likely to be assigned to the temporarily elevated trajectory, followed by the continuously low class. Pre-pandemic working status indicates the strongest assignment to the temporarily elevated class, which aligns with the trajectory visuals as they initially experience a spike before returning to a very low level of distress. Interestingly, among the employed and self-employed individuals, the former is more strongly associated with the continuously elevated trajectory. On the other hand, the self-employed group divides fairly evenly into the three other trajectories, with slightly higher means observed in the repeatedly elevated group. However, the p-value of 0.4 suggests that employment type may not be the most reliable indicator. Similarly, individuals who experienced earnings loss are more prevalent in the temporarily elevated class, followed by the continuously low and repeatedly elevated classes. However, their mean levels of distress appear to be relatively low across all trajectories.

One of the main focuses of this study is to explore the effect of government support, specifically CJRS and SEISS, on predicting assignment to a particular trajectory. The mean values for both government support factors are relatively low and uniform across all trajectories, with a p-value of 0.842. This suggests that neither employment types nor government support serves as strong indicators in predicting assignment patterns. On the other hand, loneliness yields surprising results. Individuals who report rarely experiencing loneliness are predominantly present in the continuously low trajectory. The group reporting occasional loneliness demonstrates a relatively strong prediction of the continuously elevated class. Similarly, individuals who frequently experience loneliness are also more prevalent in the continuously elevated group, although their overall mean levels of distress across trajectories are quite low.

Out of the three covariates of particular interest in this study, the loneliness indicator is the only statistically significant predictor of mental health distress trajectories, alongside age groups, family and personal characteristics (excluding ethnicity), and health status.

| | Trajectories | | | | | |
	Continuously low	Temporarily elevated	Repeatedly elevated	Continuously elevated	Chi-2 test	p-value
Age groups					154.4976	0.000
24 years and younger	.0503656	.09375	.1034704	.1054159		
25 - 44 years old	.3059843	.3828125	.3856041	.3588008		
45 - 64 years old	.4865963	.4375	.4113111	.4487427		
65 years and older	.1570539	.0859375	.0996144	.0870406		
Family and personal characteristics						
Non-white	.1337666	.1432292	.1336761	.1615087	5.6530	0.130
Female	.5028432	.6588542	.6683805	.6924565	203.6082	0.000
Living with partner	.779583	.6979167	.6966581	.639265	100.4456	0.000
Child(ren) in household	.4042784	.4895833	.4691517	.4158607	25.7561	0.000
Single parent	.0500948	.0885417	.094473	.1189555	72.5452	0.000
Health						
Reported COVID19 symptoms	.2247495	.3098958	.2994859	.3462282	79.0109	0.000
No health condition	.5792039	.609375	.5443445	.4661509	47.1261	0.000
Work						
Worked pre-COVID19	.8020579	.8671875	.8161954	.7746615	16.9592	0.001
Employed	.1586786	.1510417	.127892	.4932302	8.3369	0.40
Self-employed	.8413214	.8489583	.872108	.1972921		
Earnings						
Earnings pre-COVID	7.539355	7.545582	7.448342	.8549323	31.0231	0.000
Lost earnings	.3782832	.4401042	.3946015	.2475822	6.1282	0.106
Received any govt support (CJRS or SEISS)	.241538	.2395833	.2326478	.2475822	0.8316	0.842
Loneliness					922.1501	0.000
Hardly ever or never	.7516924	.5286458	.5109254	.3094778		
Some of the time	.2282697	.3854167	.3939589	.4932302		
Often	.0200379	.0859375	.0951157	.1972921		

Table 3.2: The proportion of covariates by trajectories

3.5 Discussion

The combination between the overall mean change and multinomial logit offers a more comprehensive explanation of the group-based trajectory model. Since the trajectory itself is built without any prejudice of the group characteristics, the multinomial logit is then able to provide us with an insight into whether certain covariates are able to predict one's assignment toward a certain trajectory. However, it is still difficult to discern any subtle nuance without knowing the context. The use of overall mean change can provide us with a glimpse, albeit minor, to explain the multinomial logit result.

The most typical demographic characteristics used to divide the population are the age group and sex. Indeed, both covariates provide us with a good predictor of how diverse parts of the population fared throughout the pandemic. The younger people, we learn, are more prone to high levels of distress. This is not surprising, since they are relatively inexperienced and might not be as advanced in their careers compared to their older counterparts, either employed or self-employed. Instead, the older groups, especially the retirees, display a lower level of distress which might be caused by the absence of job-related stress. Meanwhile, there appears a very stark contrast in comparing the age groups based on gender. Across all groups, women experience more mental health distress than men. Having children at home instead is associated with around a 4% higher chance of being in the stable neutral prevalence of distress.

When compared to the overall mean comparison, the result of these covariates seems to shed more light on the issue. As Figure 3.5 indicated, the only noticeable difference between the self-employed and employed was detected among the under 24 years old group. This might reveal the precariousness of self-employment among the younger group who might not yet have a stable enough stream of income. The development of GHQ-12 means that score in the same group for the employed instead mimics other age groups, indicating that they are under better protection through the furlough scheme, or, perhaps, their classification as 'essential workers', who were unaffected by the job loss. The opposite is true when we instead focus on government support and recorded earnings losses: in the four categories derived from the two factors, we repeatedly see employed people suffer from a higher level of mental health distress.

The earnings losses suffered by the individuals should be expected to worsen the mental health distress. Indeed, compared to their non-earning losing counterparts, those who suffered earnings losses have a slightly higher level of distress compared to those who did not (Figure 3.6). Interestingly, they have a slightly higher average level of distress between June 2020 to January 2021 in which those who did not suffer earnings losses seemed to fare worse. The difference between those who were employed and self-employed is also not so pronounced, although those employed unexpectedly appeared to display a higher level of distress. It might have to do with the more specific incidence of income during this period. Since earnings losses consider all categories of income, including those of CJRS and SEISS, which is roughly 70-80% of the pre-pandemic income, they might reflect the furloughed more significantly than those who simply lost their jobs. On the other hand, the group experiencing no earnings losses might include a large portion of essential workers who had to work under a greater strain of stress.

The SEISS grants, which ran for five rounds, were claimed at least once by 2.9 million individuals. The average value of the claims ranged between £2,300 and £2,900 per round[8]. However, there was a notable contrast between the higher and lower grant. For example, in the last round, out of the 1.3 million individuals whose claims were successful, 29% received an average of £1,100, while 71% received an average of £2,700. This disparity means that the total average should be taken with a grain of salt. On the other hand, the

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[8]Each round, the grant is based on between 70-80% of an individual's 3 months' average trading profits.

CJRS scheme was more widespread, with a cumulative total of 11.7 million jobs supported by the government. Towards the end of the pandemic period, by 30 September 2021, only 410,000 employers totaling 1.14 million jobs were still supported under the furlough scheme, based on provisional figures. The figure 3.6 shows a comparison of those who received at least one grant, either CJRS or SEISS, compared to those who received no grant at all. Of the two groups, those who received support show a much more similar dynamic to that of the general population. Those who did not receive any support instead demonstrate a more nuanced trajectory. For instance, the distress level of the employed appeared to peak only in June and November 2020, slightly later than their support-receiving counterparts.

The self-employed interestingly exhibit a much greater variance: during the first months of the pandemic, their average mean score jumped by around two points, before recovering to almost pre-pandemic levels by September 2020. It jumped again in November 2020 to the level of its previous peak and worsened still in January 2021 before recovering towards the end of the pandemic. It can be argued that based on the nature of self-employment, in which there is a greater need to plan for unexpected expenditures, self-employed individuals might be better equipped with financial means, making them more resilient. In addition to the CJRS and SEISS, an alternative form of support for those who lost their jobs came from Universal Credit, which is not explored in this study.

Loneliness emerges as the most influential variable in predicting trajectory assignment. With the exception of individuals under 24 years old, who demonstrate a partial convergence of distress levels among certain groups, there is a clear and pronounced difference across age categories. Consistently, the group reporting hardly ever or never feeling lonely displays very low levels of distress, while the often lonely group maintains a relatively stable mean score of 15-20 points on the GHQ-12 scale. As this indicator represents pre-existing loneliness status, it indicates that those with a more positive outlook on life consistently fared better throughout the pandemic, without experiencing any drastic spikes in distress. This holds true for almost all age groups, except for those under 24 years old, who still exhibit a somewhat more nuanced development, as evident in other indicators as well. Nonetheless, among the indicators of job security and loneliness, the latter demonstrates greater potential as a stronger and more significant predictor of trajectory assignment.

3.6   Concluding remarks

This study builds upon earlier works by Pierce et al. (2021) and Ellwardt and Präg (2021), but it differs in several aspects. Firstly, it encompasses a larger number of observations and covers a longer time span. Pierce et al. examined the six earliest waves of the pandemic, while Ellwardt and Präg included an additional two waves, totaling eight. In contrast, this study utilises the data from all nine waves, providing a comprehensive picture of the pandemic from its onset to the early phase of returning to normality. Notably, this study aligns with Ellwardt and Präg's approach, employing the Group-Based Trajectory Model (GMTB) (i.e., `traj` by Jones and Nagin (2013)), while Pierce et al. employed the Generalized Linear Latent and Mixed Model (GLLAMM) (i.e., *gllamm* by Rabe-Hesketh et al. (2002)). Furthermore, the list of covariates used in this study differs from those used by Pierce et al. and Ellwardt and Präg. Pierce et al. incorporated additional factors such as the Index of Multiple Deprivation, prior mental illness, NHS-shielded patient status, and key-worker status, in addition to demographic data. Ellwardt and Präg, on the other hand, focused on socio-economic indicators including social class and earnings loss during the pandemic. In this study, we expanded the investigation by examining the predictors of trajectory assignment, specifically focusing on loneliness and job security status.

By incorporating additional data, this study expands upon Pierce et al.'s observation of the overall mean GHQ-12 score throughout the pandemic. Through a more detailed group

comparison, we find a general deterioration in mental health. Family-related characteristics, such as living with a partner and having children, as well as single-parent status, prove to be significant predictors of assignment to specific trajectories. Distress levels are consistently higher among women and individuals who reported experiencing loneliness prior to the first national lockdown. Interestingly, those who did not report experiencing loneliness fare better throughout the pandemic, which is not surprising considering their initial distress levels were significantly lower than the general population. Male pensioners demonstrate similarly low levels of distress and seem to cope well during the pandemic. Examining the difference between employed and self-employed individuals, we find negligible differences between the two groups, except for self-employed individuals under 24 years old who started the pandemic with lower distress levels compared to their employed counterparts but experienced higher levels as a result of the various policies introduced.

The updated trajectory analysis produces results largely consistent with Ellwardt and Präg (2021), albeit with slight differences in the probabilities of assignment to each trajectory. The optimal number of trajectories remains at $k = 4$. However, the multinomial regression model for trajectory membership shows slight variations due to the inclusion of additional variables. Self-employment status, government support, and earnings loss do not demonstrate significant effects, but the introduction of the loneliness factor reveals unexpected significance. The absence of loneliness positively predicts assignment to the continuously low trajectory and negatively predicts the other three trajectories with higher levels of distress. This effect is almost as strong as the age group indicator, particularly in terms of predicting negative assignment to the continuously low trajectory compared to the oldest age group.

This paper contributes additional evidence to highlight the heterogeneity in mental health distress among different demographic groups. The trajectory analysis reveals that while many individuals remained largely unaffected throughout the pandemic, it is crucial to focus on the over 40% of the population that experienced consistently elevated levels of distress. Particularly noteworthy is the concentration of distress among the young and lonely. The experience of physical isolation during uncertain times can significantly impact one's mental well-being. Just as our healthcare system should enhance its preparedness for future events, it is equally important for society to prioritise mental health distress and combat loneliness as crucial components of overall well-being.

3.7   Acknowledgements

3.8 Appendix

3.8.1 GHQ-12 module of UKHLS

Concentration

Have you recently been able to concentrate on whatever you are doing?

1. Better than usual

2. Same as usual

3. Rather more than usual

4. Much more than usual

Loss of sleep

Have you recently lost much sleep over worry?

1. Not at all

2. No more than usual

3. Rather more than usual

4. Much more than usual

Playing a useful role

Have you recently felt that you were playing a useful part in things?

1. More so than usual

2. Same as usual

3. Less so than usual

4. Much less than usual

Capable of making decisions

Have you recently felt capable of making decisions about things?

1. More so than usual

2. Same as usual

3. Less so than usual

4. Much less than usual

Constantly under strain

Have you recently felt constantly under strain?

1. Not at all

2. No more than usual

3. Rather more than usual

4. Much more than usual

Problem overcoming difficulties

Have you recently felt you couldn't overcome your difficulties?

1. Not at all

2. No more than usual

3. Rather more than usual

4. Much more than usual

Enjoy day-to-day activities

Have you recently been able to enjoy your normal day-to-day activities?

1. More so than usual

2. Same as usual

3. Less so than usual

4. Much less than usual

Ability to face problems

Have you recently been able to face up to problems?

1. More so than usual

2. Same as usual

3. Less so than usual

4. Much less than usual

Unhappy or depressed

Have you recently been feeling unhappy or depressed?

1. Not at all

2. No more than usual

3. Rather more than usual

4. Much more than usual

Losing confidence

Have you recently been losing confidence in yourself?

1. Not at all

2. No more than usual

3. Rather more than usual

4. Much more than usual

Believe worthless

Have you recently been thinking of yourself as a worthless person?

1. Not at all

2. No more than usual

3. Rather more than usual

4. Much more than usual

General happiness

Have you recently been feeling reasonably happy, all things considered?

1. More so than usual

2. Same as usual

3. Less so than usual

4. Much less than usual

3.8.2 Socio-Economic Status

The socio-economic statuses in UKHLS survey are typically grouped into 8-classes, 5-classes, and 3-classes classifications based on the official National Statistics Socio-Economic Classification (NS-SEC)[9].

8-classes		
1		Higher managerial, administrative and professional occupations
	1.1	Large employers and higher managerial and administrative occupations
	1.2	Higher professional occupations
2		Lower managerial, administrative and professional occupations
3		Intermediate occupations
4		Small employers and own account workers
5		Lower supervisory and technical occupations
6		Semi-routine occupations
7		Routine occupations
8		Never worked and long-term unemployed
5-classes		
1		Higher managerial, administrative and professional occupations
2		Intermediate occupations
3		Small employers and own account workers
4		Lower supervisory and technical occupations
5		Semi-routine occupations
	*	Never worked and long-term unemployed
3-classes		
1		Higher managerial, administrative and professional occupations
2		Intermediate occupations
3		Routine and manual occupations
	*	Never worked and long-term unemployed

This study follows the 3-classes classification, although I renamed the routine and manual occupations into the working class for brevity. The classification is as follows:

- **Professional**: Employers in large establishments, higher managerial and administrative occupations, higher professional employees (traditional or new), higher professional self-employed (traditional or new), lower professional or higher technicians employees (traditional or new), lower professional or higher technicians self-employed (traditional or new), lower managerial and administrative occupations and higher supervisory occupations.

- **Intermediate**: Intermediate clerical and administrative occupations, intermediate sales and service occupations, intermediate technical and auxiliary occupations and intermediate engineering occupations, employers in small establishments, own account workers in non professional occupations, own account workers in agriculture.

- **Working class**: semi routine service, sale, operative, agricultural clerical and childcare operations; routine sales and services, production, technical, operative and agricultural operations.

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[9]Further information can be found on: https://ons.gov.uk

3.8.3 Group-Based Trajectory Model formalisation

The GBTM allows to identify clusters of individual trajectories of changes in a variable without having a prior expectation of its distribution (Collins and Lanza, 2010; Jones and Nagin, 2013). The estimation of this technique is based on the maximum likelihood estimation that is consistent and asymptotically normally distributed. The result consists of the shape of trajectory defined by a polynomial function of time, and a probability of trajectory group membership. It is intended to provide a flexible method for identifying distinctive clusters of individual trajectories within the population and for profiling the characteristics of individuals within clusters. This method is based on Jones and Nagin (2013).

The elaboration of the model is as follows. Formally, let $Y_i = y_{i1}, y_{i2}, ..., y_{it}$ denote the vector of longitudinal sequence of measurements of individual i's mental distress over T periods, where $T = 10$. Let $P(Y_i)$ be the probability of Y_i. The objective of the group-based trajectory modelling is to estimate a set of parameters β that maximise the probability of Y_i, $P(Y_i)$. β defines the shape of the trajectories and the probability of class memberships. The shape of the trajectories is described by a polynomial function of time, which we specify as a third-order polynomial. The model assumes that individual differences in trajectories can be summarised in a finite set of different polynomial functions of time and each set corresponds to a trajectory class k. Additionally, let $P(Y_i|k)$ be the probability of Y_i given the membership in class k, and let π^k be the probability of a randomly chosen individual of belonging to class k (essentially, a memberships probability). π^k is unknown and has to be estimated.

The likelihood function requires the aggregation of the K conditional likelihood functions $P(Y_i|k)$ to form the probability of the data Y_i. In other words $P(Y_i)$ is the sum across the k classes of the probability of Y_i given i's membership in classes k weighted by the probability of membership in class k. The equation reads as follows:

$$P(Y_i) = \sum_{k=1}^{K} \pi^k P(Y_i|k; \beta^k) \tag{3.1}$$

where

$$P(Y_i|k; \beta^k) = \prod_{t=1}^{T} p(y_{it}|k; \beta^k). \tag{3.2}$$

Here, $p(.)$ is the distribution of y_{it} conditional on membership in class k. We specify the distributional form of $p(.)$ to be a binary logistic distribution, as mental distress is measured as a dummy of the presence or absence of distress, hence $y_{it} = [0, 1]$. For any class k, conditional independence is assumed for the sequential realisations of the elements in Y_i, y_{it}, over T.

Finally, since one of the purposes of latent class analysis is to assign individuals to latent classes, we point out that the probability of each individual's belonging to either latent class K, given his response vector Y_i is obtained by a Bayes rule. The most common classification rule is the modal assignment, which amounts to assigning each individual to the latent class with the highest posterior probability (Magidson and Vermunt, 2004).

$$(\pi^k|Y_i) = \frac{\pi^k \times P(Y_i|k; \beta^k)}{P(Y_i)} \tag{3.3}$$

3.8.4 Choice of k number of trajectories

The choice of k number of trajectories is based on the fit statistics. There was a very close result between the fit statistics between $k = 4$ and $k = 5$. The decision to choose $k = 4$ is purely based on the fit statistics result, however, there might be merit in showing the visualisation of $k = 5$ that can be found in Figure 3.9.
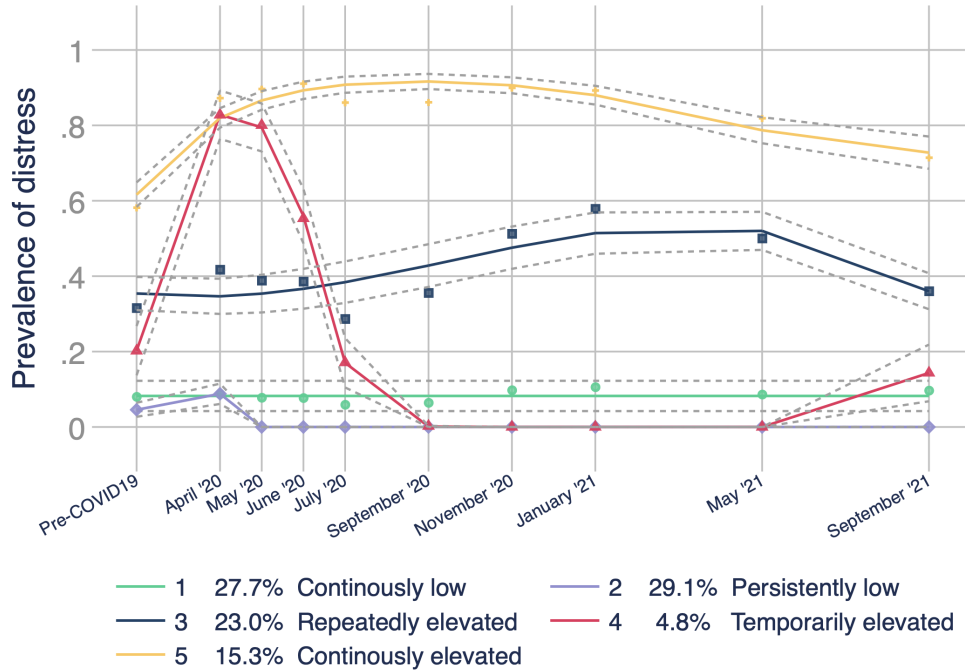
Figure 3.9: Trajectories of mental health throughout COVID-19 ($k = 5$)

With an introduction of an additional trajectory, we now observe another class (number 2) with a persistently low rate of distress almost throughout the entire period. Aside from an initial spike, yet at a level that is almost negligible compared to the others, there seems to be no disturbance detected. With five trajectories, the composition of the probability of being assigned to each trajectory changes, as explained in Table 1. The newly introduced class exhibits a 29.9% probability. To accommodate an extra trajectory, the attribution to the continuously low trajectory decreases from 51.1% to 27.7%, the temporarily elevated from 7.5% to 4.8%, the repeatedly elevated from 25.2% to 23%, and the continuously elevated from 16.3% to 15.3%. This means that the only majorly affected trajectory is that of continuously low, while others experience only a slight adjustment. Since the two trajectories of the continuously low and the persistently low prevalence of distress are remarkably similar, this paper will focus on the choice of $k = 4$.

3.8.5 List of covariates and their respective assignment percentages

Covariates	Trajectories								Total	
	1		2		3		4			
	3693	55,79%	384	5,80%	1556	23,51%	1034	15,62%	6619	100%
Age										
24 years and younger	171	4,63%	34,00	8,85%	155	9,96%	104	10,06%	464,00	7,01%
25-44 years	1124	30,44%	147,00	38,28%	596	38,30%	370	35,78%	2237,00	33,80%
45-64 years	1795	48,61%	168,00	43,75%	638	41,00%	461	44,58%	3062,00	46,26%
65 years and older	580	15,71%	31,00	8,07%	155	9,96%	90	8,70%	856,00	12,93%
Race										
White	3185	86,24%	325,00	84,64%	1337	85,93%	859	83,08%	5706,00	86,21%
Non White	485	13,13%	55,00	14,32%	207	13,30%	166	16,05%	913,00	13,79%
Sex										
Male	1824	49,39%	131	34,11%	513	32,97%	314	30,37%	2782,00	42,03%
Female	1846	49,99%	249,00	64,84%	1031	66,26%	711	68,76%	3837,00	57,97%
Living with partner										
No	795	21,53%	113,00	29,43%	465	29,88%	366	35,40%	1739,00	26,27%
Yes	2875	77,85%	267,00	69,53%	1079	69,34%	659	63,73%	4880,00	73,73%
Child(ren) at home										
None	2187	59,22%	193,00	50,26%	817	52,51%	599	57,93%	3796,00	57,35%
Yes	1483	40,16%	187,00	48,70%	727	46,72%	426	41,20%	2823,00	42,65%
Single parent										
No	3494	94,61%	347,00	90,36%	1399	89,91%	905	87,52%	6145,00	92,84%
Yes	176	4,77%	33,00	8,59%	145	9,32%	120	11,61%	474,00	7,16%
Worked pre-covid										
No	725	19,63%	49,00	12,76%	282	18,12%	231	22,34%	1287,00	19,44%
Yes	2945	79,75%	331,00	86,20%	1262	81,11%	794	76,79%	5332,00	80,56%
Reported COVID-19 symptoms										
No	2851	77,20%	262,00	68,23%	1081	69,47%	670	64,80%	4864,00	73,49%
Yes	819	22,18%	118,00	30,73%	463	29,76%	355	34,33%	1755,00	26,51%
No health condition										
No	1548	41,92%	150	39,06%	705	45,31%	546	52,80%	2949,00	44,55%
Yes	2122	57,46%	230,00	59,90%	839	53,92%	479	46,32%	3670,00	55,45%
Lost earnings										
No	2276	61,63%	211,00	54,95%	935	60,09%	628	60,74%	4050,00	61,19%
Yes	1394	37,75%	169,00	44,01%	609	39,14%	397	38,39%	2569,00	38,81%
Social class										
Working Class	1075	29,11%	100	26,04%	436	28,02%	298	28,82%	1909,00	28,84%
Intermediate	861	23,31%	85	22,14%	348	22,37%	252	24,37%	1546,00	23,36%
Professional	1734	46,95%	195	50,78%	760	48,84%	475	45,94%	3164,00	47,80%
Employment status										
Self-employed	584	15,81%	58	15,10%	196	12,60%	149	14,41%	987,00	14,91%
Employed	3086	83,56%	322,00	83,85%	1348	86,63%	876	84,72%	5632,00	85,09%
Received any government support (CJRS or SEISS)										
No	2781	75,30%	289,00	75,26%	1185	76,16%	772	74,66%	5027,00	75,95%
Yes	889	24,07%	91,00	23,70%	359	23,07%	253	24,47%	1592,00	24,05%
How often do you feel lonely?										
Hardly ever or never	27760	751,69%	201,00	52,34%	791	50,84%	319	30,85%	29071,00	439,21%
Some of the time	837	22,66%	146,00	38,02%	609	39,14%	505	48,84%	2097,00	31,68%
Often	73	1,98%	33,00	8,59%	144	9,25%	201	19,44%	451,00	6,81%

Table 3.3: Distribution of trajectory assignment across covariates

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Chapter 4

Economic Growth and Income Inequality in Indonesia: An Exercise in Cointegration

Abstract

This study aims to expand the empirical evidence on the relationship between economic growth and income inequality by focusing on a less-studied region, specifically Indonesia. While the relationship between these two variables has been extensively studied in developed countries, there is a need to explore their dynamics in the context of developing economies. By utilising comprehensive time-series data from 1965 to 2021, this research examines the long-run relationship between GDP per capita and the Gini index in Indonesia. Through a cointegration analysis, the findings suggest a somewhat weak presence of cointegration between the two variables, implying a potentially spurious relationship. To further investigate causality, the study employs the Granger test. By elaborating on these relationships in the context of a developing country, this research contributes to a broader understanding of the dynamics between economic growth and income inequality.

Keywords: *economic growth, income inequality, cointegration analysis, exogeneity, Granger causality test, Indonesia*

4.1 Introduction

A significant number of studies have explored the relationship between economic growth and income inequality. Among the earliest approaches would be the seminal work by Kuznets (1955) that prevailed well into the 1970s. He explored the relationship between income distribution and economic growth, a study that culminated in the famous inverted U-shaped Kuznets curve. It hypothesises that inequality tends to be relatively lower at the early and later stages of economic development. Recently, we have seen an increasing interest among economists in inequality studies (for example, Piketty (2014)).

Scholars typically distinguish four transmission channels of growth into inequality, neatly summarised by Neves and Silva (2014). The first one is the classical theory of the saving rate channel, which can be traced back to the ideas of Kaldor, Keynes, and Smith. It postulates that economic growth depends mainly on the rate at which it accumulates productive resources and thus follows the aggregate saving rate. In other words, the higher income inequality (more income for the capital owners and lower wages for the

labour force) leads to an increase in saving and investment rates, which improves capital formation, thus being beneficial for economic growth. The second channel is the credit market imperfection that sees the uneven distribution of wealth, making access to loans to invest in both physical and human capital prohibitive due to the high cost and the often unavailability of collateral, negatively affecting economic growth. Galor and Zeira (1993) elaborated this approach well, especially concerning human capital. The third channel concerns fiscal policies, especially regarding the redistribution of benefits that would require an increase in the tax burden on investment return and can lead to reduced economic growth. The last one is the socio-political instability through which inequality decreases economic growth due to its negative effect on investment. Without the protection of property rights, investment would be discouraged and thus, the relationship between inequality and growth would inverse (Alesina and Perotti, 1996).

The increasing interest in the study of inequality has motivated empirical research establishing the relationship between income distribution and growth, especially in an attempt to either explore the existence of the Kuznets curve or disprove it. Fields (2015) conducted a literature survey exploring the existence of the Kuznets curve and found that it is not a necessary feature for explaining the relationship between growth and inequality. A more recent study by Desbordes and Verardi (2012) further explored the hypothesis using a semi-parametric model and found that although there was observational evidence of the curve, the causality could not be confirmed. This is true, especially when accounting for endogeneity. However, a survey by Neves and Silva (2014) showed that there was no singular global pattern and that the relationship has to be established on a national or regional level.

Brida et al. (2020) clustered countries into groups with shared similarities concerning their income distribution-related variables and showed how countries could be clustered into two groups: the advanced economies (growing or stagnated with low-income inequality) or developing countries (growing or not, with high-income inequality). Although there is a constant pursuit of exploring a relationship between inequality and growth, a significant variance emerged based on the type of data and methodology used, the measures chosen, and the countries included in the study. Many works attempted to establish causality or merely detect the existence of the curve. However, as Neves and Silva (2014) stated, there seems to be no singular global pattern nor an established causality between inequality and growth. Instead, attention should be given to the national or regional level study without attempting to generalize the findings on a global scale.

4.1.1 Cointegration analysis

Because of the abundance of empirical literature on this strand of research, the majority of studies utilize standard cross-country panel data or multi-country time-series data and regression analysis. However, this approach has faced criticism, as pointed out by Herzer and Vollmer (2012). First, it relies on assumptions such as the implied common economic structure among countries and that inequality affects growth, without considering the other direction of the relationship. Second, there are technical econometric issues that can arise, including problems of omitted-variable bias Pesaran and Smith (1995), or the use of time-averaged data that eliminates the effects of business cycles. Various studies, such as those conducted by Ericsson et al. (2001); Nair-Reichert and Weinhold (2001); Wan et al. (2006); Attanasio et al. (2000), argue against the use of time-averaged data.

Cointegration analysis provides an alternative approach, allowing us to effectively overcome the limitations and address the criticisms. Several studies have explored this approach in the context of a single country. For instance, Gobbin and Rayp (2008) employed Johansen's cointegration methodology to investigate the relationship between inequality and growth in Belgium, the US, and Finland. Subsequent studies have followed suit, examin-

ing countries such as the US (Frank, 2009), Mexico (Risso et al., 2013), Portugal (Simões et al., 2013), Pakistan (Ali, 2014), South Africa (Akanbi, 2016), and Tunisia (Khemili and Belloumi, 2018). By focusing on a single country, these studies avoid data comparability issues and mitigate problems associated with panel and cross-sectional studies. Moreover, employing a bivariate cointegrated vector autoregressive (VAR) approach allows for avoiding parameter heterogeneity, omitted variable bias, and endogeneity, as highlighted by Knowles (2005).

In line with these considerations, this paper will adopt a cointegration exercise using Johansen's method (1990), with a specific focus on a single country, Indonesia. By employing this approach, the paper aims to address the limitations of previous studies and provide valuable insights into the long-run relationship between inequality and growth in the Indonesian context.

4.1.2 A brief overview of the Indonesian economy

Indonesia is the world's fourth most populous country in the world[1]. Formerly known as the Dutch East Indies, Indonesia gained independence from the Netherlands in 1945. Since then, it has experienced numerous crises and economic booms. The archipelago consists of around 17,000 islands, spanning 5,120 km in the equator, and possesses abundant natural resources. Time-series surveys measuring Indonesia's growth and inequality began in the 1960s, during the transition from the so-called *Old Order* (1950-1965) to the *New Order* (1966-1998) (Booth, 1998). The decade began with rampant inflation, measuring 27% in 1961, 174% in 1962, and 600% in 1965. Associated political turmoil culminated in a regime change, and the new administration managed to place inflation under control, from the maximum of 636% recorded in 1966 to around 10% in 1969, and as low as 2% in 1971 (McLeod, 1997). The beginning of the *New Order*, which would last for the next 32 years, saw a growth of 10.9% in 1968 and a real rate of 7% between 1967-1995 (Piazolo, 1996). Furthermore, income inequality showed a sharp decline between the 1960s to 1990s (van Leeuwen and Földvári, 2016).

However, this positive shock brought by the oil boom was overturned in the 1990s due to the political reform preceded by the 1980s oil glut and the 1997 Southeast Asian economic crisis. 1998 saw negative economic growth and an increase in inequality that persisted well into the 2000s. The *reformation* period initiated a massive structural adjustment, which helped the country recover. By the beginning of the 2000s, Indonesia experienced quite a stable growth hovering around 3-5% annually. The demographic boom further helped the country by supplying the labour force when the labour demand shifted to the Asian countries. From the early 2000s to 2020, the Indonesian economy has steadily grown into an upper-middle-income country with a sharply declining poverty rate. As shown by Figure 4.7, Indonesia successfully reduced its poverty rate from around 30% in the early 2000s to below 10% in 2020.

4.2 Data and empirical results

4.2.1 Dataset

The dataset used in this study consisted of two main variables: the annual GDP per capita as a measure of economic growth and the Gini index as a measure of income distribution inequality. The GDP per capita measure with the constant 2017 US dollars was obtained from the World Development Indicators (WDI) provided by the World Bank database. Meanwhile, the Gini index was obtained from the Standardised World Income Inequality Database (SWIID) version 9.4 by Solt (2019). It is worth noting that SWIID is an

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[1]As of 31 December 2022, Indonesia's population was estimated at 277,749,853.

imputation-based dataset, meaning that the Gini index is calculated using a multiple imputation methods based on a group of microdata based source (Such as SEDLAC[2] and LIS[3]) and secondary sources (ALG[4]). In addition, the imputation follows the LIS definition of income as a standard. The benefit of using SWIID is the size and coverage of the dataset that provides an opportunity to perform a longitudinal study, which might not be available through other dataset. However, as outlined by Ferreira et al. (2015), there are certain caveat to be taken into consideration when deciding which data is to be used. Various datasets portraying indicators such as Gini demonstrate variations that arose from the different method of imputations and the underlying definition of key concepts such as income. Both Ferreira et al. (2015) and Jenkins (2015) describe in detail differences between Gini Indices provided by various dataset. Their discussion implies that the nature of SWIID, caused by its multiple-imputation method and the use of secondary datasets, can affect the year-to-year variation. Ferreira et al.. Figure 4.1 displays the differing trend lines for Indonesian Gini measure based on 4 datasets: WDI[5], ATG, SWIID, WIID[6].
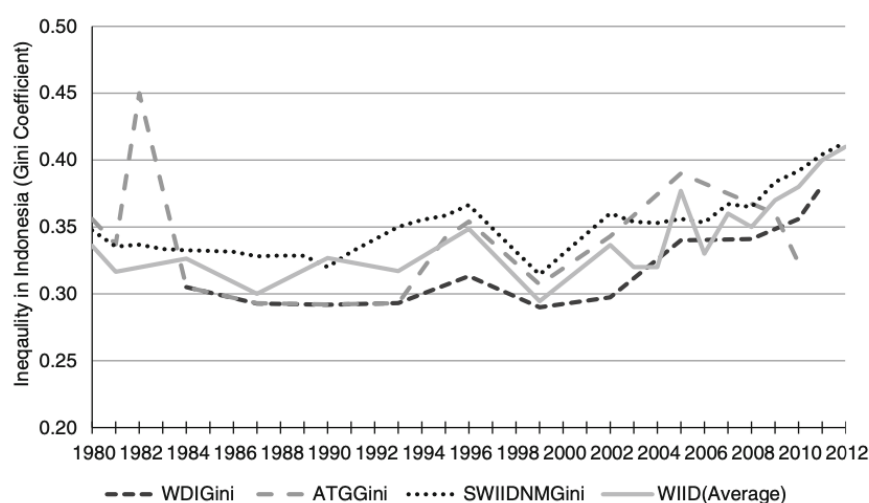

Figure 4.1: Differing Trend Lines in Indonesia. Notes: WDI Gini is the Gini coefficient reported in the World Development Indicators. ATG Gini is All the Ginis GiniAll. SWIIDNMGini is the mean Net Market Gini reported by SWIID. The WIID(Average) series includes all WIID Gini coefficients, and averages coefficients together where more than one source exists in a given year. Source: Ferreira et al. (2015)

Note the peak in 1996, in which ATG showed a 20% increase while SWIID only 5%. On the latter part, between 2005-2012, ATG instead showed a decreasing trend of inequality while 3 other datasets showed an increase. The decision to use SWIID data for this study thus, is based on the coverage of the data especially in an environment where the complete data at the national level is not sufficient, such is in the case of Indonesia.

Both series, the GDP per capita and Gini index, began in 1965 and ended in 2021. The data are plotted to provide a visual cue (Figure 4.2).

The figure follows the findings of previous studies by McLeod (1997); Piazolo (1996); van Leeuwen and Földvári (2016) regarding the economic situation in Indonesia beginning in the 1960s. According to a classification of the political and economic change in Indonesia by Dick (2001), the beginning of the series in 1965 coincides with the end of *Guided*

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[2]Socio-Economic Database for Latin America and the Caribbean
[3]Luxembourg Income Study
[4]All the Ginis
[5]World Development Indicator
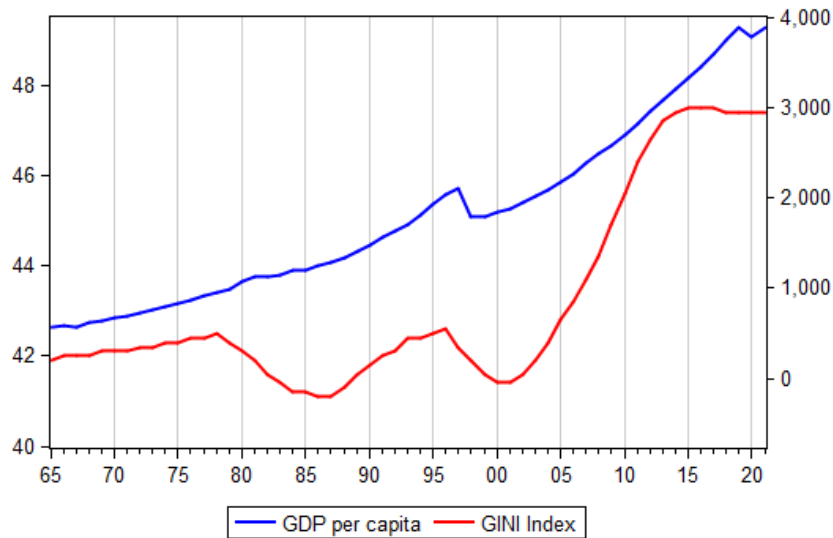[6]World Income Inequality Database

Figure 4.2: Gini index and GDP per capita across time in Indonesia

democracy period characterised by economic stagnation and decline. From the point of view of the economy, the period between 1966-73 was a time of economic recovery. By imposing a certain discipline through various austerity measures, the new administration, the *New Order* regime, was able to bring the inflation rate under control. The following period between 1974-98 saw rapid development in the economies that coincided with both the global oil boom and the oil glut period. A severe downturn was experienced nationwide following the Southeast Asian financial crisis that began in Thailand in 1997 and rippled throughout the region. The increase following 1997 is most likely due to the market liberation followed by the country's undergoing a significant reformation. Since then, the Indonesian economy has experienced steady growth with a minor interruption during the COVID-19 pandemic in 2020.

The level of inequality followed a similar trajectory to that of GDP per capita, until notable dips set the two series apart in 1977, and later 1997. The first might be related to the global events that took place between 1974-1981. Indonesia experienced two oil booms: first in 1973/1974 when OPEC decided to reduce its supply and thus quadruple the price; then in 1979/1980 when the Iraqi oil industry closed following the toppling of the Shah's regime, causing oil prices to double. However, this period ended in 1982 as the global oil market weakened and Indonesia's oil export suffered Thee (2012). Throughout this period, there was a constant downward trend in the Gini measure indicating an improvement in the national income inequality.

The second dip took place in 1997, as explained in the previous paragraph. It is exhibited during the reformation period, preceding and following the Southeast Asian financial crisis. The latter was followed by a change of regime with Suharto stepping down from his office after spending 32 years as president. Along with the shift of power, the undertaking of numerous reforms caused a temporary economic downturn. By the early 2000s, the economy somewhat stabilised and Indonesia saw a significant increase in GDP per capita, but also a tremendous growth in inequality. Thanks to the demographic boom and the shift of production from China to Southeast Asia, Indonesia was able to exploit opportunities for further growth. Interestingly, the inequality measure reached a plateau that began in 2012 and has remained somewhat stable while the GDP per capita continues to increase.

4.2.2 Empirical strategy

This study aims to establish the existence of a long-run relationship between GDP per capita and the Gini index in Indonesia through the use of a cointegration exercise. In addition, a small part of this study will be dedicated to the causality between the Gini index and GDP per capita.

I begin the first part of this study by conducting a unit root test to establish the stationarity of the series. Next, I will perform two cointegration tests: Johansen and Engle-Granger. Upon obtaining the results, I will decide whether to reject the null hypothesis of no-cointegration or not. For the second part, a simple regression will confirm a relationship between the two variables. An impulse response figure will be generated to visualise Gini's response to a positive GDP shock.

4.3 Empirical result

4.3.1 Unit roots

The first step is to study the stationarity of the series through the use of Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS). Table 4.1 shows the tests in both the level and first difference of the series logarithmic form.

Variables			ADF		KSPP	
			t-stat	p-val	LM-stat	CV 5%
ln_gini	Level	Trend & intercept	-2.553270	0.3026	0.201273	0.146000
		Intercept	-1.289050	0.6285	0.598903	0.463000
		None	0.618373	0.8470		
	1st difference	Trend & intercept	-2.141738	0.5116	0.067707	0.146000
		Intercept	-2.054534	0.2635	0.261720	0.463000
		None	-1.967539	0.0478		
ln_gdp	Level	Trend & intercept	-2.537128	0.3099	0.128933	0.146000
		Intercept	-0.759770	0.8224	0.869816	0.463000
		None	7.762436	1.0000		
	1st difference	Trend & intercept	-5.834496	0.0001	0.061608	0.146000
		Intercept	-5.829683	0.0000	0.098657	0.463000
		None	-6.637607	0.0010		

Table 4.1: Stationarity test result for Indonesian GDP per capita (2017 US$) and Gini Index. Both variables are expressed in their respective logarithmic form.

ADF and KSPP are typically used together and are considered to be complementary. They are tested differently, but with a similar result of detecting stationarity. In ADF's case, the null-hypothesis of unit root can be rejected when the *p-value* is <5%. The rejection of $H0$ indicated stationarity. For KPSS instead, the null-hypothesis of stationarity is rejected when the critical value (CV) is greater than the Lagrange Multiplier statistics (LM-stat). Thus, stationarity is indicated when we cannot reject the $H0$.

On the table, the two test performed on the residual of ln_gdp indicates stationarity with KSPP[7] and ADF[8]. In this particular case, the KSPP detect stationarity on the un-transformed data (level) while ADF on the differenced data (first difference). For ln_gini, ADF indicates an existence of unit roots and thus non-stationarity, while KPSS shows

---

[7]Intercept at level shows a LM-stat higher than the CV.

[8]The specification labelled 'none' that indicates stationarity without any assumption of deterministic trend and/or intercept, has a *p-value* lower than 5%. Thus, the $H0$ of unit root is rejected.

that on 1st difference it fails to reject the null hypothesis of stationarity, indicating that it is stationary. Since KPSS tests for stationarity around deterministic trends, it means *ln_gini* is then considered to be stationary with a trend. In such situations, ADF is typically considered to be a weaker test compared to KPSS, especially when the test statistics are less than 1. It is then possible to consider that both series are integrated processes of the first order or I(1).

4.3.2 Cointegration

There are several commonly used cointegration tests. In this study, I will use Engle-Granger and Johansen.

Johansen cointegration test

This test was proposed by Johansen (1988). It requires an estimation of Vector Error Correction, a VAR with a long-term relationship that shows how variables return to equilibrium after suffering a shock. The first step is to obtain an optimal lag. The result can be found in Table 4.2. The SIC has a tendency to offer a lower number of lags compared to other criteria. Typically there is an unequivocal consensus regarding the lag choice. However, when a situation in which criteria offer different numbers arises, the one with the lowest parameter is chosen. In this case, I choose two lags, as suggested by SIC.

Lag	AIC	SIC	HQ
0	-2.750912	-2.673695	-2.721616
1	-11.46998	-11.23833	-11.38209
2	-12.68541	-12.29932*	-12.53893
3	-12.75498*	-12.21446	-12.54991*
4	-12.73966	-12.04470	-12.47599
5	-12.69970	-11.85031	-12.37744
6	-12.60448	-11.60065	-12.22363
7	-12.51978	-11.36152	-12.08034
8	-12.41923	-11.10653	-11.92119

Table 4.2: Optimal lags according to Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Hannan-Quinn Information Criterion (HQ)

Using the chosen lag, the next step is to perform the Johansen cointegration test that results in both trace and maximum eigenvalue statistics. I provide test results for two types of test specifications. The first is that of unrestricted constant, where the level data possess a linear trend but the cointegration equation only has an intercept. The second is that of the restricted trend, where both level data and cointegration equations have linear trends. The result can be found in Table 4.3.

The first specification results in the rejection of the null hypothesis of no-cointegration at the 5% level, suggesting that there is a cointegration relationship. However, there is a conflicting result between the trace test and the maximum eigenvalue. When such a situation emerges, Johansen and Juselius (1990) suggests that the trace test trumps the maximum eigenvalue. When the specification assumes trends, trace test and maximum eigenvalue reach a consensus of rejection of the no cointegration null hypothesis in both 1% and 5% levels. The Johansen cointegration test suggests that there is a cointegration relationship between the two-time series.

Specification	Hypothesis	Eigenvalue	Statistic	5% Critical Value	1% Critical Value
			Trace		
	None	0.205180	15.45254	15.41*	20.04
Intercept (no trend) in CE	At most 1	0.054951	3.051994	3.76	6.65
and test VAR			**Maximum Eigenvalue**		
	None	0.205180	12.40055	14.07	18.63
	At most 1	0.054951	3.051994	3.76	6.65
			Trace		
	None	0.427717	39.27979	25.32*	30.45*
Intercept and trend in CE	At most 1	0.155729	9.141208	12.25	16.26
- no intercept in VAR			**Maximum Eigenvalue**		
	None	0.427717	30.13858	18.96*	23.65*
	At most 1	0.155729	9.141208	12.25	16.26

Table 4.3: Johansen cointegration test (trace test and maximum eigenvalue) with critical value defined by Osterwad-Lenum

Engle-Granger cointegration test

The Engle-Granger cointegration test 1987 is a two-step procedure for cointegration analysis. It is especially useful when the model is not multivariate. The first step in this approach is to first estimate the long-run model as follows:

$$y_t = \beta_0 + \beta_1 x_t + u_t \tag{4.1}$$

The residual of the OLS model is the measure of disequilibrium:

$$\hat{u} = y_t - \hat{\beta}_0 - \hat{\beta}_1 x_t \tag{4.2}$$

The cointegration is determined by the unit root test of the residual. When the null hypothesis of the unit root is rejected, indicating stationarity, then we can move forward to the second step.

The next part of this approach is then done through the estimation of the Error Correction Model (ECM):

$$\Delta y_t = \beta_1 \Delta x_t + \beta_2(\hat{u}_{t-1}) + \nu_t \tag{4.3}$$

where

$$\hat{u}_{t-1} = y_{t-1} - \hat{\tau} x_{t-1} \tag{4.4}$$

in this case, β_2 is the error correction term. To begin the test on the series, the following is the cointegrating regression model (i.e. the long-run relationship):

$$
\begin{aligned}
ln\_gini_t &= \delta_0 + \delta_1 ln\_gdp_t + u_t \\
&= 3.301273 + 0.063012 \, ln\_gdp_t + u_t \\
&\quad {\scriptstyle (0.057183)} \quad\quad {\scriptstyle (0.007758)}
\end{aligned}
\tag{4.5}
$$

The unit root test of the residual is presented in Table 4.4.

The ADF result fails to reject the null hypothesis in both $t - stat$ and the MHM $p - value$. There is an indication of stationarity from the $p - val$ only when no trend and no constant are included in the equation. The KSPP results are instead mixed. When considering an intercept in the equation, the critical value indicates non-stationarity. Meanwhile, the equation with trend and intercept indicates stationarity. Nevertheless, results generated by ADF (none) and KSPP (trend & intercept) are consistent and present the same story. We cannot reject non-stationarity, and thus there is no indication of cointegration at 1% level.

Variables			ADF		KSPP	
			t-stat	p-val	LM-stat	CV 5%
		Trend & intercept	-2.554994	0.3018	0.212074	0.146000
$\hat{u}_t$	Level	Intercept	-2.573399	0.1047	0.211900	0.463000
		None	-2.586424	0.0106		

Table 4.4: Stationarity test result for the residual of Engle-Granger's long-term regression

The second step of the test involves the error correction model (i.e. the short-term relationship) by using the residual obtained in the previous step. Following is the equation:

$$
\begin{aligned}
\Delta \, ln\_gini_t &= \alpha_0 + \alpha_1 \Delta ln\_gdp_t + \gamma \hat{u}_{t-1} + \nu_t \\
&= \underset{(0.001124)}{0.000183} + \underset{(0.024094)}{0.058889} \, \Delta ln\_gdp_t - \underset{(0.023623)}{0.012398} \, \hat{u}_{t-1} + \nu_t
\end{aligned}
\tag{4.6}
$$

The Error Correction Term (ECT) is indicated by γ. The negative sign indicates the rate at which the equation will reverse toward the equilibrium after 1 period. However, it does not seem to be significant, which suggests that even though there might be a possibility of a long-run relationship between the variables, the evidence for cointegration is weak or inconclusive.

Equilibrium Correction Model (ECM)

4.3.3 Granger causality test

The cointegration tests do not indicate a causal relationship. When two series are cointegrated and individually I(1), a causal relationship will exist at least in one way (Engle and Granger, 1987). Toda and Yamamoto (1995) suggest testing the Granger causality test by applying a VAR model with an extra lag, however, this might not be necessary according to Lütkepohl (2005). Since the model presented in this work is bivariate, I will use the VAR model with no additional lag. The result is reported in Tab;e 4.5:

VAR Granger Causality/Block Exogeneity Wald Tests			
Null Hypothesis	Chi-square	df	Prob
$ln\_gini \overset{G}{\nrightarrow} ln\_gdp$	2.878940	2	0.2371
$ln\_gdp \overset{G}{\nrightarrow} ln\_gini$	10.91290	2	0.0043

Table 4.5: Granger causality test

From the result, we can reject the null hypothesis of $ln\_gdp \overset{G}{\nrightarrow} ln\_gini$ at both 1% and 5%. Meanwhile, the null hypothesis of $ln\_gini \overset{G}{\nrightarrow} ln\_gdp$ cannot be rejected. The result suggests that there is an unidirectional causality from ln_gdp to ln_gini.

4.3.4 Impulse response function

The impulse response analysis allows us to figure out the impact of one variable on another in a system. The following figure shows the effect of ln_gini to a positive shock of ln_gdp.

The impulse response showed a tremendous spike at the beginning of the series before decreasing significantly between 5th and 15th years. I reversed its course, albeit slower than the first cycle, peaking on the 27th year. The impulse declined again before showing a relatively stable plateau beginning with the 37th year until the end of the series. It indicates that the trend converges into a constant after around 37 years. It follows the
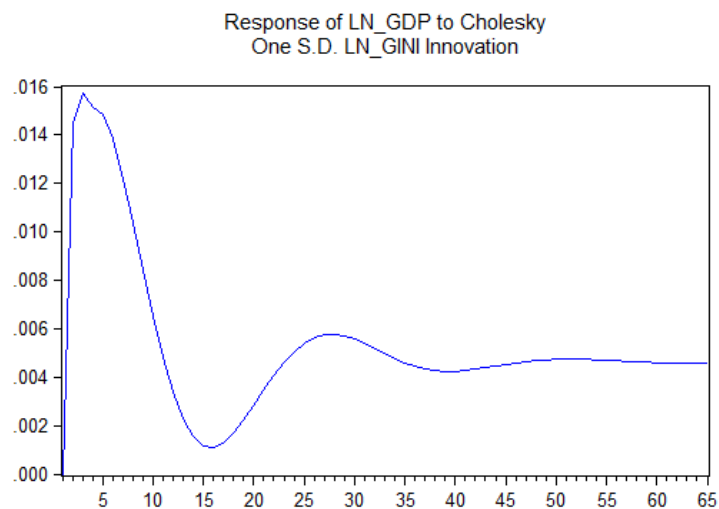
Figure 4.3: Response to Cholesky one S.D innovations. A response of ln_gini to ln_gdp

political situation in the country that began to recover in the early 2000s after the great turmoil of the late 1990s.

4.4 Discussion

There are three key findings from this study: First, there is a long-term, albeit shaky, relationship between income inequality and economic growth. Second, the relationship is positive, indicating that a higher level of inequality is associated with higher economic growth. Third, the analysis confirms a unidirectional causality running from GDP per capita to income inequality.

The initial part of the series up to 1997 aligns with findings by McLeod (1997), Piazolo (1996), and van Leeuwen and Földvári (2016), particularly in terms of the political economy perspective. During the early years of Suharto's regime, Indonesia experienced economic stabilization following a crisis in the early 1960s, leading to a decline in inequality over time and an increase in GDP per capita. However, the country faced challenges such as human rights violations and high inflation. Furthermore, global phenomena like the oil boom and subsequent glut significantly impacted Indonesia's economy. Despite the following financial catastrophes in the region, Indonesia underwent significant structural reforms and market liberalization. However, these reforms were not accompanied by suitable redistribution policies, resulting in a significant increase in inequality despite improvements in GDP per capita during the 2000s.

However, the findings reveal several noteworthy points. First, the study confirms the existence of a weak long-run relationship between inequality and growth. The impulse response analysis of GDP per capita to income inequality shows a conversion, indicating the potential for positive outcomes if the government focuses on redistribution policies. The latest data from the Standardized World Income Inequality Database (SWIID) also suggests a plateau in Indonesian Gini coefficients on disposable income, which is a positive sign. Second, the study indicates a unidirectional causality from GDP per capita to income inequality, which is an interesting finding considering that much of the literature focuses on the causality from inequality to growth.

The relationship established through this study is thus very limited, and there is a significant possibility of a spurious relationship stemming from the cointegration between a stationary and a non-stationary series. Mixed results from both the Johansen and Engle-Granger tests do not agree on the existence of any cointegration, further casting doubt on the relationship. Although there is some causality relationship as established by the Granger causality test, the results should be taken with a grain of salt. This opens up opportunities for further investigation into this causal relationship in future studies.

4.4.1 Other explanations: Institutions?

As discussed by Brida et al. (2020)), it is unwise to generalize the bivariate model without considering other crucial factors, such as democratic experiences and different welfare regimes associated with institutional systems, which can provide valuable insights into the relationship between inequality and growth. The empirical findings of the same study revealed that the cluster of advanced and developing economies is distinct. Even when considering a more similar group of countries such as the OECD, Ille et al. (2017) found a non-monotonic relationship between inequality and democracy. Instead, an inverted U-shaped relationship was found between the Gini index and Unified Democracy Scores (UDS) (respectively, a proxy for inequality and democracy). They postulate that a small amount of inequality benefits democratisation, but when it reaches a high level, the cost of social movements will decrease, thus leading to a higher risk of destabilising democracy, rendering it unsustainable. Social changes, often encouraged by economic growth and innovation in production, have an impact on democracy by maximising the level of equality. On a similar note, the institutional system and the subsequent welfare regime are good candidates to study the channel in which the two factors interact with one another.

Following Esping-Andersen (1990) welfare regime typologies, the government plays a significant role in redistribution, contributing to an attempt to create a more equal society. Thus, the ability of economic growth to significantly affect the level of inequality depends on the experience of democracy, which is closely related to the institutional system. The consensus on the welfare regime is then crucial for determining the equalisation process and reflects both the population's and the government's appetite for the level of inequality.

The choice of welfare regime decides upon the type of social protection programs that are available to individuals. It also affects their ability to achieve their earning potential, which manifests in the national level of income distribution. By taking into consideration socio-economic heterogeneity, social spending then becomes a key piece in the redistribution channel. The concept of equality of opportunity by Roemer (1998) and the capability approach by Sen (2001) portray the importance of considering the point of departure of individuals but also highlight the importance of the state in providing an opportunity to level the playing field somewhat. By providing public services such as education and health, the government acts as a channel of redistribution to share the fruits of progress with the rest of society. On the other hand, the government can also take a more *laissez-faire* approach and wait for trickle-down economics to kick in. Whichever stance is taken, this demonstrates the importance of institutional factors in determining how economic growth translates to the level of inequality.

In the context of Indonesia, the country did not truly experience democracy during the majority of the time series, as Suharto was the *de facto* leader of the country between 1966 and 1998 (Liddle, 2000). This long rule allowed him to develop long-term planning such as the six phases of *REPELITA*[9] and ensure its execution. As such, he had significant power in enforcing policy changes without any meaningful opposition. During his rule, Indonesia underwent significant economic reforms in response to various challenges, including hyperinflation in the early 1960s, the oil boom and subsequent glut in the early 1980s, and the slowing down of non-oil exports in the mid-1990s (Resosudarmo and Kuncoro, 2006).

There were three notable economic reforms that took place during Suharto's rule. The first one took place when he assumed power in the early 1960s and brought down hyperinflation through a string of austerity measures. The second followed the oil glut and the subsequent worldwide recession in the early 1980s, which forced him to diversify the non-oil sector in the economy. The last one occurred in the mid-1990s to address concerns about the apparent slowing down of non-oil exports (Resosudarmo and Kuncoro, 2006). The last two reforms manifested in the evident change of course in the inequality measure. On a larger scale, it was relatively stable between 41-43, which was not without reason. Indonesia experienced what was called the Weberian concept of patrimonialism (Crouch, 1979) during both Sukarno and early Suharto's era, in which the masses were depoliticized, and the power remained within the elite emanating from the ruler. Suharto's *New Order* regime later expanded the circle to include economists/technocrats (a group of Western-trained University of Indonesia economists), tech/economic nationalists (mostly engineers and economists who supported the infant industry argument), and patrimonialists (military personnel, elite bureaucrats, and ruling party members). However, this system would change in the early 1990s to a patrimonial oligarch state[10] in which power shifted from the fractious elites to the oligarchs (Winters, 2011). Interestingly, this type of patrimonialism continued well into the post-Suharto era (Fukuoka, 2012).

Thailand's economic crisis exacerbated problems caused by changes in political influence that took place at the beginning of the 1990s. The impact of the crisis was felt only in 1998 and resulted in the IMF intervention. The economic reform oversaw the financial restructuring, and both trade and foreign investment liberation. In 1998, high levels of un-

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[9] *Rencana Pembangunan Lima Tahun*: 'The Five Year Development Plan'.
[10] based on Hutchcroft (2019) typology of state and capitalism.

employment and high price increases were observed. Although it was largely regarded as a result of the IMF's intervention, Suharto soon became the target of protests. It eventually ended his rule and saw the installation of B.J. Habibie as a somewhat interim president.

Following Pemstein et al.'s measure of the Unified Democracy Score (UDS) visualised in Figure 4.4, it is possible to see Indonesia's progression from autocracy, which was somewhat stable before 1995, and the eventual increase in 1997-1998 before eventually breaching into democracy in the early 2000s. Interestingly, the UDS follows a similar trajectory to the Gini measures. This might agree with an intuitive proposition by Ille et al. (2017) regarding the positive relationship between democratization and inequality, although further exploration has to be done to determine the critical point at which the inverted U curve changes course.
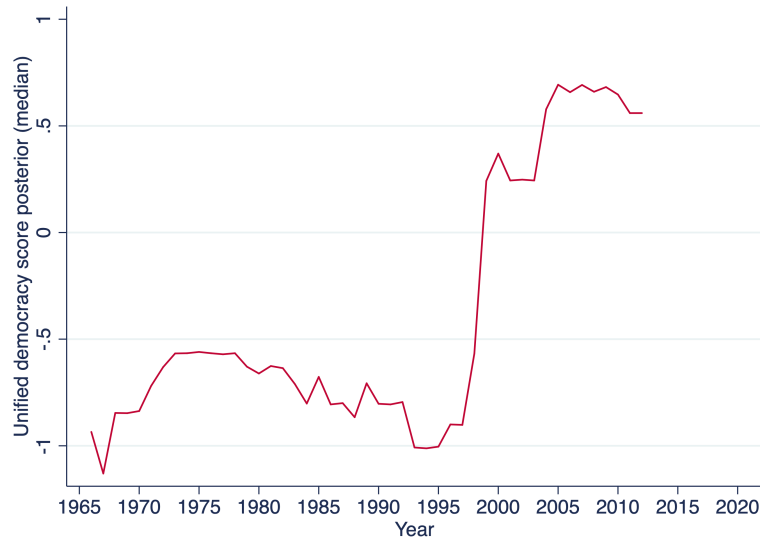

Figure 4.4: The Unified Democracy Score (UDS) of Indonesia over time (Source: Coppedge et al. (2023))

By 2004, the country was on track for recovery. The series shows an upward trend for both indicators well into the mid-2010s when the inequality measure plateaus while GDP per capita continues to grow. Hill (2021) explains that the flattening of the inequality measure was caused by a severe decline in poverty. Although the majority of the population is still poor, the poverty incidence has fallen rapidly as living standards rose more or less commensurately with economic growth. They suggest that this is the result of six broad areas where policies have impacted inequality and poverty reduction: the labour market, education policy, trade and commercial policy, explicit price and market interventions, major decentralization, and the role of social policy, taxes, and transfers. Policy plays an important role in controlling the level of inequality, as noted by Nolan (2009); Wildowicz-Szumarska (2022) and Kammer et al. (2012). Social protection programs ensure that individuals are provided with a safety net to help them improve their personal circumstances, allowing them to have a better chance of earning well. On the macro level, such improvements can accumulate into a significant effect on income distribution. The redistribution approach uses tools such as taxes and transfers to tackle income inequality (Joumard et al., 2012), and countries can be classified based on the mechanisms they choose. One notable example is Esping-Andersen (1990) welfare regime typologies. There have been efforts to fit Indonesia into this framework, although the consensus seems to agree that it remains characteristically productivist. This type of regime is characterised by selective provisions in social policy to ensure labour production, human capital, and sustained economic growth (Holliday, 2000). These social policies are not intended to promote

social protection or redistribution but rather to promote economic productivity. However, Yuda and Kühner (2023) notes a shift in more recent times towards a different approach in the country, moving away from the previously practised clientelism-driven approach. The introduction of healthcare and various social programs, as elaborated by Hill (2021) has contributed to stalling inequality while economic growth continues.

Another significant post-Suharto change in Indonesian institutions is the subsequent decentralisation. Several empirical studies have suggested that decentralisation plays a role in mediating inequality and growth by creating between-group inequalities. Three empirical studies from the developed world explore the effect of fiscal decentralisation on inequality at different levels. The first study on 20 OECD countries by Stossberg and Blöchliger (2017) found a weak but significant negative effect at the country level. When further broken down, the effects vary. Decentralisation of economic affairs has a small inequality-decreasing effect, while education demonstrates the opposite. The second study on 17 OECD countries by Canaleta et al. (2004) found a strong negative correlation at the regional level, with a positive influence of decentralisation on regional convergence. The last study by Tselios et al. (2012) focused on Western European countries using individual-level data in the EU. It found that a higher level of fiscal decentralisation is associated with lower interpersonal income inequality, but as regional income rises, further decentralisation is connected to a lower decrease in inequality. The intuition follows that by delegating power and resources to sub-national entities, the policy enables more targeted initiatives that address the specific needs of the region, thus decreasing overall inequality in the country. At the regional level, there is a risk of inter-regional inequality due to different resource endowments, economic opportunities, governance capacities, and historical factors. The individual level is more nuanced, depending on factors such as socio-economic status, access to services, and geographical location. Although decentralisation allows sub-national entities to be more precise in tackling certain issues, it does not necessarily addresses the underlying social and economic disparities that contribute to inequality. In the case of Indonesia, Resosudarmo and Kuncoro (2006) note a centralisation of governance during Suharto's time that extended to corruption and various rent-seeking activities. Although it ensured the stability of economic performance, such a system is not sustainable, especially when considering the patrimonialism that characterised the government at the time. The decentralisation of rule and the increase in regional autonomy that followed in the early 2000s allowed regions to be more agile in managing their resources and eventually affect the national measure of inequality.

4.4.2 Other explanations: Inflation?

The institutional perspective offers an opportunity to scrutinise the relationship between inequality and growth by taking into consideration the redistribution mechanisms that took place, be it through social programs, decentralisation of autonomy, or democracy. However, further interesting insights can be acquired by considering the choice of economic policies undertaken by the government.

Inflation is a phenomenon that touches upon many economic concepts. The combination of fiscal and monetary policy can affect the level of inflation, but at the same time, they can be used to control it. The effects of inflation can be observed in various aspects of economies, such as the redistribution of wealth, labour market dynamics, the level of saving and investment, access to credit, and macroeconomic stability. Literature exploring paired relationships like inflation-inequality and inflation-growth is quite abundant, although there are few studies that explore the three (inflation-inequality-growth) simultaneously. Models proposed by Jin (2009) and Chang et al. (2022) might offer a good theoretical framework to empirically test the three-way relationship. An attempt by Li and Zou (2002) furthered the approach of linking inflation to income distribution by

considering inflation as one of the transmission channels. This was followed by studies focusing on singular countries, such as Yue (2011) in South Korea, Ali (2014) in Pakistan, and Acharya and Mia (2020) in South Asian countries. Although economic models provide an opportunity to understand the dynamics between different factors, the empirical results are often mixed when applied to different countries. For instance, the paradoxical relationship between economic growth and income inequality is found to be negative in East Asia and South America but positive in the USA and France (Shin, 2012). Thus, it is important to consider the context of each country's political economy.

In the context of Indonesia, hyperinflation took place very early in the series. Although inflation is often understood as an increase in the price level, it can also mean a decline in the value of money. Indonesia's case was the latter, caused by rapid monetary expansion. The 'Guided Democracy' period announced by Sukarno in 1959 practically eliminated the system of checks and balances. Governmental spending on both military expansion (first to quell the Sumatran Rebellion in the late 1950s, and later for the West Irian campaign in the early 1960s) and ambitious development projects were coupled with harmful policies such as the forced nationalisation of foreign enterprises (Widodo, 2006). This expansion was further exacerbated by price increases caused by drought in 1961 and other issues such as a decline in tax revenue, forcing the government to finance the deficit by creating money (Aghevli and Khan, 1977). This process spiralled further and resulted in hyperinflation.
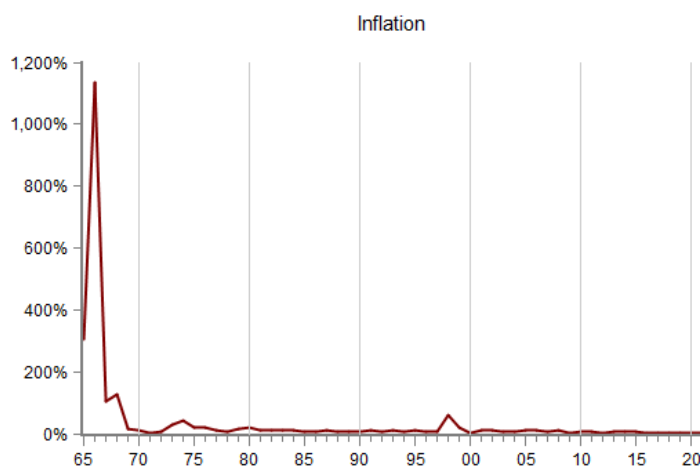

Figure 4.5: Historical annual inflation rate in Indonesia.

The *New Order* period that began in 1967 was successful in bringing much-needed economic stability to the country. With some discipline in government spending through the austerity policy and a large infusion of foreign aid, the economy stabilised. An increase in inflation was observed in the early 1970s due to expansionary fiscal policies and peaked due to the rising global oil prices and the second oil shock in the mid-1970s. Indonesia's heavy reliance on oil export, continued expansionary fiscal policies, and rising global commodity prices kept the inflation high well into the early 1980s, at which point the government decided to implement import substitution industrialisation policies which led to increased domestic production cost and price pressures. In order to control inflation, the government introduced various stabilisation measures, such as reducing budget deficits and increasing interest rates in the 1980s. The effort had limited success and inflation remained high. It persisted well into the 1990s, when expansionary fiscal policies, corruption, and cronyism continued to contribute to inflationary pressure.

The high level of inflation witnessed in 1997 was a result of various events, notably the Southeast Asia crisis that depreciated the Indonesian Rupiah significantly against the

US Dollar. It was accompanied by the high level of unemployment and the high price of commodities, as well as the already high inflation level from the previous decades. Suharto's administration was not able to keep the situation under control and the institutional shifts that had weakened his power further exacerbated the situation. Reluctantly, the country invited IMF to intervene. A series of economic and political reforms took place, including changes in monetary and fiscal policies. It took a couple of years before the country's inflation level stabilised below 10%. 1999-2000 saw a still relatively high level of inflation as the country struggled with economic instability and structural challenges. However, there followed a decline that continued well throughout the 2000s. With further economic and structural reforms, financial consolidation measures, and improved monetary policy frameworks, the economy stabilised and inflation declined. Despite the global subprime mortgage crisis of 2008, Indonesia's inflation rate remained relatively under control. It further declined up until 2020 and remained low in spite of the global COVID-19 pandemic.
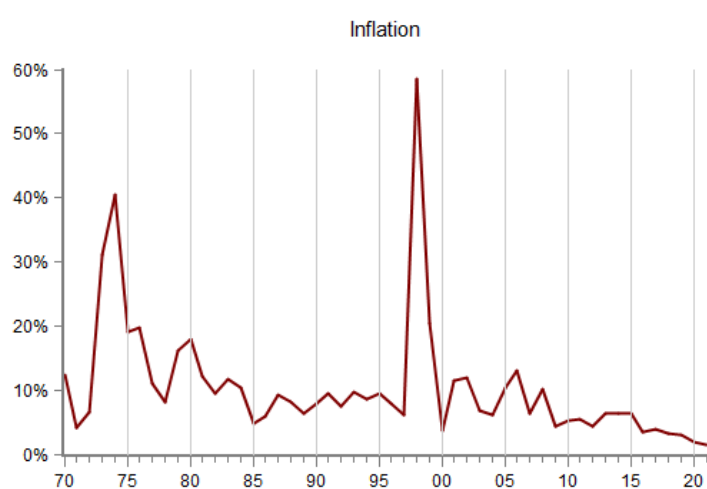

Figure 4.6: Historical annual inflation rate in Indonesia from 1970 (Source: IMF)

4.4.3 Concluding remarks

This study sets out to explore the simplified relationship between inequality and economic growth in Indonesia through the use of a time-series econometrics approach. However, there was no satisfying answer regarding their long-run relationship. The metrics show that they are related, albeit very weakly. In such a case, there is a possibility of a spurious relationship. Following the suggestion of Brida et al. (2020) to explore beyond bivariate analysis, I attempted to study the economic history of the country to offer possible explanations. I offered two sets of possible factors that might serve as transmission channels between inequality and growth. The first factor was the institutions, including the level of democratisation, choice of welfare regime, and decentralisation. These factors are closely related to the redistribution mechanism and offer an explanation of the organisation of prosperity sharing. The second factor was inflation, which unifies monetary and fiscal policies into a confounding factor between growth and inequality as they affect the macroeconomic conditions of the country.

Regardless of the turmoil that the country has faced in the past half-decade, it has witnessed a constant decline in the poverty level. It took Indonesia 25 years to bring the figure from 70% down to an amazingly low 8.5%. The present study is indicative of the need for further investigation into the country's remarkable economic development.
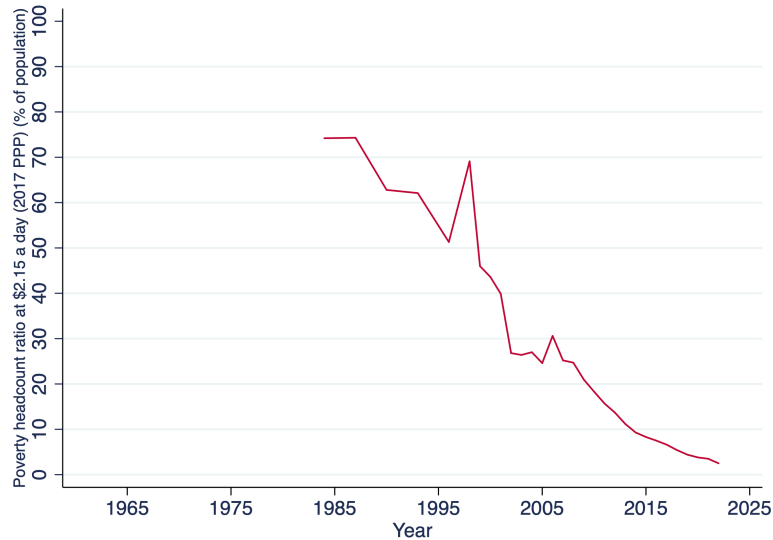
Figure 4.7: Historical poverty rate in Indonesia (Source: The World Bank).

4.5 Appendix

4.5.1 Unit roots

Prior to the test, it is imperative to assess the stationarity of the variables. For the purpose of this work, I conducted the Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. The null hypothesis of the ADF test is that the process is non-stationary, whereas the KPSS test assumes stationarity as the null hypothesis. Both tests agree that in terms of level and intercept, both processes are integrated of order 1 or $I(1)$. However, there is a disagreement between the two tests regarding the first difference of the series ln_gini. The ADF test indicates non-stationarity, while the KPSS test suggests stationarity. It is important to note that the ADF test has lower power when the true value is close to, but less than, 1. Thus, in this case, the KPSS test is considered more trustworthy.

4.5.2 Tests

There are several classic assumption tests that can be used alongside least square regression. This section presents tests performed on the residuals, including the normality test and the serial correlation test.

Normality test - JB

The test of goodness-of-fit is based on Jarque-Bera test, proposed by Jarque and Bera (1980). This test detects whether the data follows a normal distribution or not. The results of the test are shown in Figure 4.8.

Serial correlation test

The null hypothesis of the Breusch-Godfrey test is that there is no serial correlation in the residuals. However, the test result indicates the presence of serial correlation. The detailed results of the test can be seen in Table 4.6.
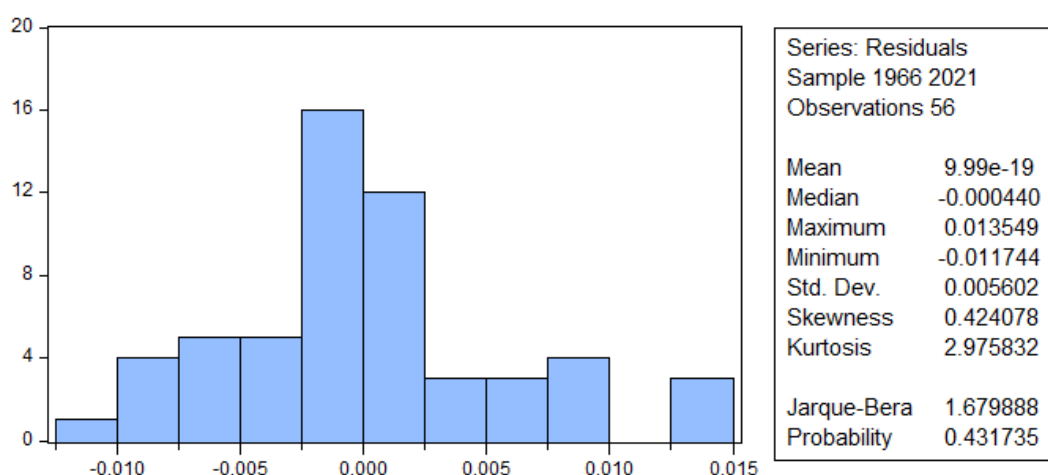
Figure 4.8: Jarque-Bera normality test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	59.30289	Prob. F(2,51)	0.0000
Obs*R-squared	39.16095	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/07/23   Time: 17:04
Sample: 1966 2021
Included observations: 56
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001503	0.000645	2.328574	0.0239
D(LN_GDP)	-0.044884	0.014183	-3.164606	0.0026
RESID_LT(-1)	-0.031200	0.013759	-2.267690	0.0276
RESID(-1)	0.550832	0.118343	4.654541	0.0000
RESID(-2)	0.413847	0.118676	3.487200	0.0010
R-squared	0.699303	Mean dependent var	9.99E-19
Adjusted R-squared	0.675719	S.D. dependent var	0.005602
S.E. of regression	0.003190	Akaike info criterion	-8.572558
Sum squared resid	0.000519	Schwarz criterion	-8.391723
Log likelihood	245.0316	Hannan-Quinn criter.	-8.502448
F-statistic	29.65145	Durbin-Watson stat	1.758734
Prob(F-statistic)	0.000000		

Table 4.6: Breusch-Godfrey serial correlation LM test

Heteroscedasticity test

The null hypothesis of the Breusch-Pagan-Godfrey test is that there is no heteroscedasticity in the model. The test result indicates that the model does not exhibit heteroscedasticity. The detailed results of the test can be seen in Table 4.7.

Breusch-Pagan-Godfrey heteroscedasticity test

F-statistic	0.964179	Prob. F(2,53)	0.3879
Obs*R-squared	1.965980	Prob. Chi-Square(2)	0.3742
Scaled explained SS	1.739702	Prob. Chi-Square(2)	0.4190

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/07/23 Time: 17:05
Sample: 1966 2021
Included observations: 56
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.42E-05	8.61E-06	2.815112	0.0068
D(LN_GDP)	0.000189	0.000185	1.022362	0.3113
RESID_LT(-1)	-0.000193	0.000181	-1.066980	0.2908

R-squared	0.035107	Mean dependent var	3.08E-05
Adjusted R-squared	-0.001304	S.D. dependent var	4.37E-05
S.E. of regression	4.37E-05	Akaike info criterion	-17.18444
Sum squared resid	1.01E-07	Schwarz criterion	-17.07594
Log likelihood	484.1643	Hannan-Quinn criter.	-17.14237
F-statistic	0.964179	Durbin-Watson stat	0.694296
Prob(F-statistic)	0.387882		

Table 4.7: Breusch-Pagan-Godfrey heteroscedasticity test

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Chapter 5

Afterword

We are citizens of the richest and most fortunate nation in the history of the world...We have never lost sight of our goal: an America in which every citizen shares all the opportunities of his society, in which every man has a chance to advance his welfare to the limit of his capacities. We have come a long way toward this goal. We still have a long way to go.

The distance which remains is the measure of the great unfinished work of our society. To finish that work I have called for a national war on poverty. Our objective: total victory.

There are millions of Americans – one fifth of our people – who have not shared in the abundance which has been granted to most of us, and on whom the gates of opportunity have been closed.

What does this poverty mean to those who endure it? It means a daily struggle to secure the necessities for even a meager existence. It means that the abundance, the comforts, the opportunities they see all around them are beyond their grasp. Worst of all, it means hopelessness for the young.

The young man or woman who grows up without a decent education, in a broken home, in a hostile and squalid environment, in ill health or in the face of racial injustice–that young man or woman is often trapped in a life of poverty. He does not have the skills demanded by a complex society. He does not know how to acquire those skills. He faces a mounting sense of despair which drains initiative and ambition and energy...

We must also strike down all the barriers which keep many from using those exits. The war on poverty is not a struggle simply to support people, to make them dependent on the generosity of others. It is a struggle to give people a chance. It is an effort to allow them to develop and use their capacities, as we have been allowed to develop and use ours, so that they can share, as others share, in the promise of this nation.

<div align="right">

–Lyndon B. Johnson, 1964

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In his 1964 State of the Union address, US President Lyndon B. Johnson declared a war on poverty. His words encapsulated the promise of progress: 'an America in which every citizen shares all the opportunities of his society, in which every man has a chance to advance his welfare to the limit of his capacities.' This is a goal our society should strive for. However, there are many forces in play that not only cause poverty but perpetuate it into an unending vicious cycle. Johnson's war on poverty eventually met its end in 1996. Deregulation, growing criticism of the welfare state, and an ideological shift to reducing federal aid to impoverished people in the 1980s and 1990s culminated in the Personal Responsibility and Work Opportunity Act of 1996, which President Bill Clinton claimed, 'ended welfare as we know it.'

Poverty and Well-being

Poverty and well-being respectively represent the problem that we seek to eliminate, and the objective we seek to achieve as a species. We want to build a society in which no one is hungry and everyone can afford a dignified lifestyle, but more importantly to live well and be fulfilled enough to achieve their full potential. This objective, although noble, is not easy to achieve. Poverty is like a mycorrhizal network that permeates every corner of our society's building blocks, lurking for an opportunity to emerge whenever possible. It is a complicated issue to approach, primarily because there seems to be barely any consensus on what is poverty in the first place. Like a shapeshifter, it evolves alongside mankind in an endless game of whack-of-mole.

In this study, I have outlined a fraction of the issues we face as a society: how do we define poverty, does the inequality start in the family, how critical are psychological deprivations in determining our well-being, and do we as a society strive to share the fruits of progress? I realise that I barely scratched the surface of the poverty issue, but just like with tackling any other complex issue, it needs to be reduced into smaller elements that we can deal with one by one. And, although I also realise that this is an issue that does not have an ultimate solution, this should not prevent us as the human race from at least giving it a try to find one.