Understanding Universal Health Coverage success through Qualitative Comparative Analysis

by

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Declaration

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Abstract

Goal 3 of the United Nations Sustainable Development Goals (SDGs) is to "Ensure healthy lives and promote well-being for all at all ages". More specifically, this goal is to "Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all". In 2016 all the UN member states agreed to attempt to achieve universal health coverage (UHC) by 2030.

For many countries, achieving UHC is a daunting task, for which they will have to transform their whole health system. It is therefore crucial for policy-makers and participants in the implementation of UHC to understand which conditions in a country influence the success of UHC outcomes.

The aim of this study is to contribute to the research on how better to implement UHC in a country through understanding the conditions that influence UHC outcomes by using a structured engineering approach.

This was done by first determine which methods can help in this understanding of universal health coverage, and then selecting the most appropriate comparative causal research method – which in this case was found to be Qualitative Comparative Analysis (QCA). The QCA methodology is then described step-by-step; and in order to show QCA's capability each step is also applied to an example. In applying the QCA method, country conditions were used as model condition variables and UHC service coverage index were used as model outcomes.

Results from the QCA example indicated that that the combination of high employment to population ratio, high health spending as a percentage of GDP, and being a highly developed country is sufficient for a positive UHC outcome.

The results are cross-validated in two steps: applying regression analysis on the raw data to understand the predictive power of the conditions on the UHC service coverage index. This was followed by doing within case investigations on countries showing strong links between the condition variables (those presented in the findings of the QCA analysis) and UHC outcomes.

The regression analysis highlighted that a high employment to population ratio and a more developed country classification are good predictors of UHC outcomes.

The within-case investigations indicated that the countries included in the findings of the QCA were mostly high-income European countries with high GDP per capita. The case investigations also highlighted that these countries mostly had compulsory and statutory health systems, and that revenue was often raised by some form of income taxation. It also highlighted that hospitals were mostly publicly owned, that primary health facilities were mostly owned privately, and that most countries included in the study still had some level of out-of-pocket expenditure (OOP). From the application of the example it is suggested that the QCA method proposed in this research inquiry could be useful to provide decision support to policy makers of UHC in countries.

Opsomming

Doelstelling 3 van die volhoubare ontwikkelingsdoelstellings van die Verenigde Nasies (VN) is om "Gesonde lewens te verseker en welsyn vir almal van alle ouderdomme te bevorder". Meer spesifiek sluit hierdie doelwit die volgende in: "Bereik universele gesondheidsdekking, insluitende finansiële risikobeskerming, toegang tot kwaliteit noodsaaklike gesondheidsorgdienste en toegang tot veilige, effektiewe en bekostigbare noodsaaklike medisyne en entstowwe vir almal van aanvaarbare kwaliteit". In 2016 het alle VN-lidlande ooreengekom om teen 2030 universele gesondheidsdekking te probeer bereik.

Vir baie lande is die implementering van universele gesondheidsdekking ’n uitdagende taak siende dat dit van lande vereis om hulle hele gesondheidstelsel te transformeer. Dit is dus noodsaaklik vir beleidmakers en deelnemers aan die implementering van universele gesondheidsdekking om te verstaan watter toestande in ’n land die uitkomste van universele gesondheidsdekking positief kan beïnvloed.

Die doel van hierdie studie is om, met die gebruik van ’n gestruktureerde ingenieursbenadering, ’n bydra te lewer tot die liggaam van kennis m.b.t. die verstaan van die invloed wat spesifieke toestande het in ‘n land op die uitkomste van universele gesondheidsdekking.

Die studie het eers ‘n opname gemaak van die moontlike metodes wat gebruik kan word om hierdie tipe probleem op te los. Daarna was die mees toepaslike metode gekies, naamlik Kwalitatiewe Vergelykende Analise (KVA). Na n stapsgewyse beskrywing van die KVA metode, is die metode se vermoë ook gedemonstreer met die toepassing daarvan op ‘n relevante voorbeeld. Die voorbeeld het KVA toegepas deur landtoestande aan te wend as kondisie-veranderlikes en die universele gesondheidsdekking-indeks te beskou as die model uitkoms-veranderlike.

Die resultate was eerstens gevalideer deur middel van n regressie-analise van die rou data. Daarna was die lande wat sterk verbande gewys het tussen landstoestande en hulle universele gesondheidsdekking uitkomste in diepte ondersoek deur middel van gevalle studies.

Die regressie analise het daarop gewys dat ‘n land se indiensnemings persentasie en ekonomiese klassifikasie goeie aanduidings kan wees van n land se universele gesondheidsdekking-uitkomste.

Die lande wat ingesluit was in die gevalle-studies was meestal hoë-inkomste Europese lande wat hoë bruto binnelandse produk per kapita gehad het. Die lande het ook meestal verpligte en statutêre gesondheidstelsels gehad, en fondse was dikwels deur ‘n vorm van inkomstebelasting ingewin. Die studie het ook gevind dat dié lande se hospitale hoofsaaklik in staatsbesit was, dat primêre gesondheidsfasiliteite meestal in privaat besit was, en dat die meeste lande steeds ‘n koste las op individue het wanneer hulle gesondheidsdienste gebruik.

Acknowledgements

Firstly, I would not have been able to complete this project if it hadn't been for the support of my family and my best friend who believed in me.

I genuinely appreciate the support of my sister who read and edited this document.

Lastly, I am grateful to my study leaders for partnering with me in completing this thesis.

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LIST OF ACRONYMNS

Abbreviation	Description
AC	Antenatal coverage
ART	Antiretroviral treatment
BP	Non-elevated blood pressure
CovN	Necessity coverage
CovS	Raw coverage equation for sufficiency
CovU	Unique coverage equation
csQCA	Crisp set QCA
DG	Director-General
DTP3	Child immunisation coverage
EFC	Evidenced formal coverage index
EFCOOP	Evidenced formal coverage index with out-of-pocket expenditure
FP	Family planning
FPG	Non-elevated blood glucose
fsQCA	Fuzzy set QCA
GDP	Gross domestic product
Hosp	In-patient admission rate
HWD	Health worker density
IHR	International health regulation
InclN	Necessity inclusion
InclS	Fuzzy sufficiency inclusion / consistency
ITN	Insecticide-treated bed net
MDG	Millennium Development Goals
mvQCA	Multi-value QCA
NDP	National Development Plan
NHI	National Health Insurance
NHS	National Health System
OECD	Organisation for Economic Co-operation and Development
OOP	Out-of-pocket expenditure
OWG	UN General Assembly Open Working Group
Pneum	Care-seeking pneumonia
PRI	Proportional Reduction in Inconsistency equation
QCA	Qualitative comparative analysis
RoN	Relevance of necessity
SDG	Sustainable Development Goals
TB	Tuberculosis coverage
TFR	Totally fuzzy and relative
tQCA	Temporal QCA
UHC	Universal health coverage

Abbreviation	Description
UN	United Nations
WASH	Improved water and sanitation
WHO	World Health Organization
Y/N	Yes or No

LIST OF BOXES

1 INTRODUCTION

This chapter introduces the necessity for the research document, and provides a summary of the contextual background to the study. The background is followed by the problem statement that leads into the aims and objectives of what this research study aims to achieve. A proposed research design and the expected structure of the research inquiry are discussed, concluding with the scope and limitations of conducting this research.

1.1 BACKGROUND

At the Millennium Summit in September 2000, a gathering of world leaders adopted the UN Millennium Declaration, committing their nations to a new global partnership to reduce extreme poverty, and setting out a series of time-bound targets, with a deadline of 2015 (United Nations, 2000). These targets, known as the Millennium Development Goals (MDGs), are listed in Table 1. In 2012, following the Millennium Summit, the United Nations Conference on Sustainable Development was held to continue the momentum generated by the MDGs beyond 2015. In 2014, the UN General Assembly Open Working Group (OWG) put forward supplementary goals, known as the sustainable development goals (SDGs), based on agreement reached in the United Nations Conference on Sustainable Development. One of the SDGs (World Health Organization, 2015) is especially relevant to this study:

"Goal 3: Ensure healthy lives and promote well-being for all at all ages."

In addition, a specific aim of Goal 3 (World Health Organization, 2015) is to "Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all".

Table 1: Millennium development goals (World Health Organization, 2015)

Goal 1:	Eradicate extreme hunger and poverty
Goal 2:	Achieve universal primary education
Goal 3:	Promote gender equality and empower women
Goal 4:	Reduce child mortality
Goal 5:	Improve maternal health
Goal 6:	Combat HIV/AIDS, malaria and other diseases
Goal 7:	Ensure environmental sustainability
Goal 8:	Develop a global partnership for development

The question arises: How seriously committed are countries to achieve universal health coverage (UHC)? Perhaps the best way to understand this level of commitment is to look at major commitments made by countries, such as legislation passed to achieve UHC. Stuckler, Feigl and Basu (2010) performed a study that exposed that 23% of countries worldwide had legislation in place to give effect to UHC implementation by 2010, and that by 2016 all the UN member states (193 out of the 196 countries in the world) had agreed to attempt to achieve UHC by 2030 (World Health Organization, 2018). These figures indicate a significant global commitment towards achieving UHC.

UHC is briefly defined as "access to key promotive, preventive, curative and rehabilitative health interventions for all at an affordable cost, thereby achieving equity in access" (World Health Assembly, 2005).

For many countries that do not currently meet the above-mentioned aims, this implies a major health systems reform. Evans, Beyeler and Beith (2015) defined typical steps that such a health system reform has to include (Box 1).

(1) Setting and expanding guaranteed services.

(2) Developing health financing systems to fund guaranteed services and ensure financial protection.

(3) Ensuring high-quality service availability and delivery.

(4) Improving governance and management of the health sector.

(5) Strengthening other aspects of health systems to move closer to UHC.

Box 1: The "what" of UHC implementation (Evans, Beyeler and Beith, 2015).

Evans, Beyeler and Beith (2015) provide more detail on each of these steps, which are summarised in the paragraphs below. These details are mentioned to indicate the complexity of implementations of this kind, and to highlight the great need for decision support in this environment.

Setting and expanding guaranteed services concerns the scope of health services and how they are provided, the main concern being which population to cover. For example, should a specific country cover fewer services for a larger portion of the population, or more services for a smaller, needier, portion of the population? And what are the nuances between the former and the latter? Setting guaranteed services also concerns which services to guarantee, and is mainly driven by ensuring that the budget is sustainably allocated. Once there is an understanding of how much sustainable funding is available (taking potential resource capacity/limitation into consideration), commitments about the scope of services that will be covered can be made.

An integral part of setting guaranteed services is ensuring that value for money is optimised. This refers to the constant decision support that decision-makers require, in the form of economic viability evaluations, to understand which trade-offs are more suitable for the population. Lastly, managing the potential fragmentation of guaranteed services is also important when setting guaranteed services. Fragmentation in this application implies that policy-makers can decide to allow different populations to be covered for different services, requiring different contributions. Fragmentation adds complexity to the management of the health system, but may be unavoidable as a result of economic constraints.

Constructing health **financing systems to fund guaranteed services and ensure their financial protection** implies the raising and pooling of funds and the centralisation of purchasing. Funds could be raised from one of the following sources: (i) out-of-pocket funding (excluding catastrophic expenditure), (ii) insurance premiums, (iii) taxes, and (iv) increased health spending from public money. Funds that are raised need to be pooled to spread risk and to be used by all. Centralised purchasing should then ideally be performed with the pooled funds to leverage the benefits of economy of scale of the pooled funds.

Ensuring high-quality service delivery is about ensuring that the required health services are available, are of good quality, are safe, and are utilised by the populations that required them. There should also be continuity of care across health conditions at different locations and across time. Barriers to access such as cost, accommodation, and transport should be monitored and eradicated as far as possible.

Improving governance and management of the health sector is a cornerstone of nationally managed services. This requires the implementation of governance mechanisms and rules by which health systems are administered, controlled, and managed. These rules and mechanisms should also include how responsibility and accountability is allocated, and what incentive structures exist between the different actors in the health system.

Other implementation aspects typically include insufficient or incorrectly allocated human resources, medicines, and infrastructure. In addition, services not only need to be safe and of good quality, but should also be perceived as such by the population – a perception that needs to be intentionally managed.

In addition to these steps, Evans, Beyeler and Beith (2015) note that the success of UHC implementation is attributed not only to system configuration (such as that mentioned in Box 1), but also to contextual conditions such as (1) a country's historical background, (2) its historical and current epidemiological profile, (3) the population's will power, and (4) the political climate. These conditions are often outside the policy-maker's control.

1.2 PROBLEM STATEMENT

For many countries, UHC programmes are transformational (Cotlear *et al.*, 2015), because they fundamentally change how their health systems work. To support this task, it is argued that it will be helpful to understand which contextual conditions and health system organisational configurations contributed to positive UHC outcomes in different countries. This will support decision-making in countries trying to achieve UHC.

It is envisaged that, from such insights, a country's policy-makers could gain additional perspectives that will assist in understanding which contextual conditions to influence or manage intentionally, and which health system organisational configurations to select when implementing UHC in their specific country. This leads to the problem statement of this research inquiry:

There is a need to understand how to identify the underlying causal links that influence the success of a UHC implementation in a country. Alongside this, traditional probabilistic methodologies used for these types of inquiries might be somewhat lacking as a result of an inability to identify causal linkages based on both qualitative and quantitative conditions, and also the configurations of multiple such conditions.

Addressing this problem statement could have value for countries that are considering or are in the process of implementing UHC themselves. Cotlear *et al.* (2015) note that studies that simply determine whether a multifaceted UHC programme affected some of the UHC outcomes do not prove useful, and that causal links between specific programme components and outcome will be more valuable.

In addition, Cotlear *et al.* (2015) conducted a review of 42 pieces of literature on UHC, and found that a small number of studies provide additional evidence on the key contextual conditions leading to the success of UHC outcomes.

1.3 AIM AND OBJECTIVES

The aim of this study is to contribute to the efforts of evaluating how to implement UHC with increased effectiveness. The primary aim of this study is methodological in nature: to identify a methodology that can be used to determine the conditions that impact the success of UHC outcomes in an analytical, transparent, systematic, structured, and repeatable manner. The contribution will include the application of this methodology by determining which health system conditions contribute to the success of UHC outcomes, and specifically whether they are organisational, political, social, or economic conditions. In essence this research inquiry will then identify a method and explain that method through an application of an example.

The following logical processes are set as a guide to achieve the above-mentioned aim and are visualised in Figure 1 and Figure 2 below.

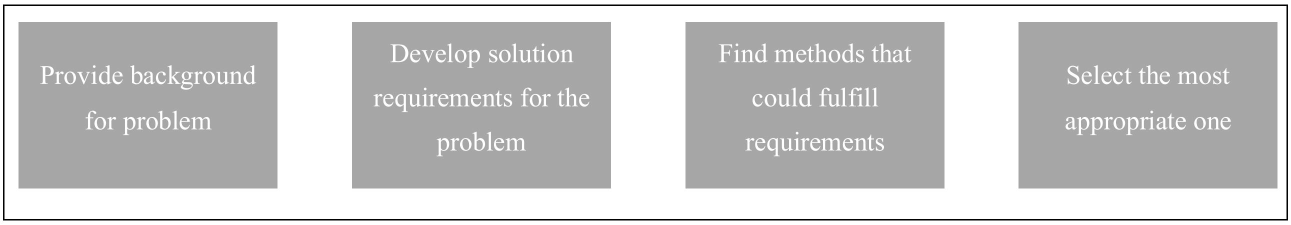


Figure 1: Process to fulfil the main aim

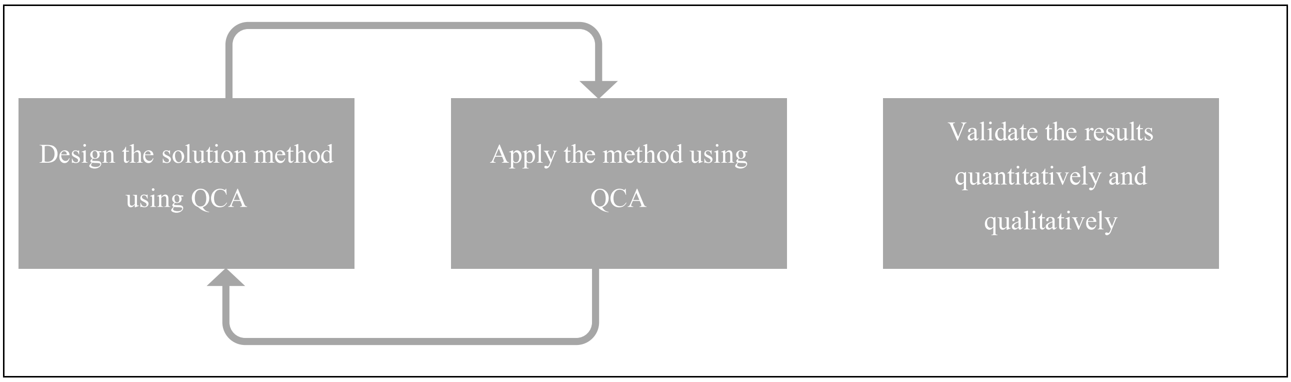


Figure 2: Process to fulfil the secondary aim

The logical process can be translated into the objectives discussed below:

Objective 1: To support the development of the solution requirements, contextual understanding of the problem is gained by in-depth research into the UHC in specific focus areas:

a. Explain what UHC is.

b. Describe how UHC outcome achievement is measured.

c. Understand which countries have implemented UHC.

d. Find out which conditions are known to contribute to the success of achieving UHC, according to the literature.

The learnings from the contextual understanding of the problem will be used to determine the requirements that a solution method needs to highlight which conditions contributed to the success of UHC outcomes.

Objective 2: Identify, evaluate, and select a method that can be used to identify which conditions contributed more or less to the success of UHC outcomes, following these steps:

a. Determine which methods can be used for this type of problem, according to the literature.

b. By evaluating and comparing the identified methods with the solution requirements, select the most appropriate method/s to solve the research problem.

Objective 3: Compile and apply a repeatable methodology to determine which conditions contributed to UHC success by using the selected method to:

a. Design the research problem by identifying the cases to be considered and the variables (conditions and outcome) for analysis.

b. Condition the variables in order to be analysed.

c. Analyse the data.

d. Interpret and validate the results.

Objective 4: Summary of and conclusion to identifying the suitable methodology for this type study.

1.4 Research design overview

A combined qualitative and quantitative paradigm is deemed suitable for this study. This combination is necessary to translate qualitative data into quantitative measures, in order to provide decision support by indicating causal links between conditions and UHC outcomes that can be used during policy making in a social sciences context. Countries where UHC had been implemented were selected as the unit of analysis, as UHC implementation is typically performed at a country level, and data on health conditions is more readily available at country level.

A structured literature review was conducted to gain contextual understanding of the problem and to identify suitable solutions methods using key-word searches. The literature was also perused to understand the selected method and to compile a repeatable methodology to address the real-world problem.

The modelling of the real-world problem was performed, first, through gathering non-contrived data by investigating relevant case studies and publicly available cross-national data. The calibration process was theory-driven, with some descriptive statistics where literature was not available to substantiate calibration thresholds or where theory was not yet available. The modelling was performed using the R Studio statistical software package.

The qualitative comparative analysis (QCA) method was used to model the real-world problem. The QCA method is not probabilistic in nature, but is based on analysing set relations, meaning that this study does not use conventional statistics to find causal links, but rather Boolean algebra to determine the causal contribution of different conditions to an outcome. Some descriptive statistics are used during the conditioning of variables. For the validation steps both regression analysis and descriptive case studies are used.

1.5 Thesis structure

This thesis is structured in such a way as to clarify the typical steps required for similar studies that aim to highlight conditions that contribute to the success of achieving UHC in an analytical, systematic, transparent, structured, and repeatable manner. Figure 3 provides a diagrammatic overview of the thesis structure, which is also described in the paragraphs below.

Chapter 1 aims to create an expectation in the reader about the research. This chapter describes the research problem and the corresponding aim and objectives in addressing the problem statement. It summarises the research design approach, sets out the thesis' structure, and defines the scope and limitations of the study.

Chapter 2 addresses objective 1 by unpacking and contextualising the research problem through a discussion on what health systems are, where UHC fits in to health systems, the principles of UHC, what UHC outcomes are, and how they can be measured. The contextualisation of UHC is followed by a study of the literature pertaining to the health system conditions (organisational, political, social, and economic) that influence UHC outcomes. Next, a requirement specification is compiled for the solution method; and this concludes the chapter and satisfies objective 1 stated above.

Chapter 3 addresses objective 2 by identifying and evaluating methods that can be used to highlight causal links between conditions and UHC outcomes. It starts by describing what comparative causal research is, and why it is appropriate for this research question. It then proceeds to explain what methods have been found in the literature that perform comparative causal research cross-nationally, and how these methods compare with the solutions requirements set in Chapter 2. A method is then selected and applied to the study.

Chapter 4 addresses objective 3 by providing a step-by-step methodology to determine the causal links between country conditions and UHC outcomes. The methodology addresses four main phases: (i) design, (ii) condition, (iii) analysis, and lastly (iv) interpretation and validation of results.

In Chapter 4, as part of explaining how the method works, the analysis steps are also performed, effectively determining the causal links between conditions and UHC outcomes by using the step-by-step methodology. This chapter makes the methodology practical by showing what data was used, how each step was completed, and what software can be used to complete the four phases. As part of the analytical procedure, Chapter 4 contains an analysis of the results produced by presenting them and discussing their relevance in the context of the countries being analysed. It also contributes to the final methodology by summarising feedback from the analytical procedures conducted. This chapter also validates the results through regression analysis and within-case study investigations.

Chapter 5 still forms part of objective 3 and was added to specifically highlight the learnings compiled from the applied example in chapter 4 into what is called methodological considerations. It is suggested that these considerations can inform the approached of future studies in which QCA might be used to determine which conditions influence UHC outcomes.

Chapter 6 addresses objective 4 by concluding the research through a summary of what it set out to do, and what was achieved. It also notes the research's limitations and what this study has contributed to the body of knowledge.

Research expectation setting	**Chapter 1: Introduction** • Research background • Problem statement • Aim and objectives • Thesis structure • Scope and limitations	
Contextualise and unpack research problem	**Chapter 2: The real-world problem of UHC** • Describing UHC • Measuring UHC • Countries with UHC • Conditions influencing outcomes • Solution requirement	**Chapter 3: Comparative causal research methods** • Methods for comparative causal research • Select appropriate method
Package and apply a step-by-step methodology	**Chapter 4: Methodology to solve the real-world problem** • Design analysis • Condition variables and outcome • Analyse variables and outcome • Interpretation and validation of results	**Chapter 5: Methodological considerations** • Design considerations • Condition considerations • Analyse considerations • Interpretation and validation considerations
Summary and conclusion	**Chapter 6: Summarise project and conclude** • Project summary • Research limitations • Research contribution • Future opportunities	

Figure 3: Thesis structure

1.6 Scope and Limitations

The literature study performed in this research contains information available between late 2016 and early 2018.

The limitations and scope of the application of methods such as key-word searches and QCA are mentioned in the relevant chapter describing how these methods were applied.

The countries selected to be studied were only those that were covered by the Evidenced Formal Coverage index, as discussed in sub-section 2.5. These countries were used as they had been empirically found to have attempted the implementation of UHC and could therefore form part of the comparative exercise that studies which of the countries that have attempted UHC had been more successful than others because of certain conditions. Countries then that did not form part of this index were excluded from the application of the solution method.

Conditions used in the solution method were selected based on key-word searches of literature on conditions influencing UHC outcomes as discussed in sub-section 2.6. Only conditions that were present across more than one of the extended UHC outcomes listed in sub-section 2.6 were selected for inclusion in the analysis. Any other condition that were not found in the keyword searches exercise and did not appear more than once in literature was excluded from the application portion of the solution method.

Data-gathering was limited to publicly available electronic data from legitimate sources.

1.7 Conclusion to Introduction

This chapter has created an expectation about the research agenda of this study. It began by stating the research problem, followed by the corresponding aim and objectives to address the stated problem. Next the theoretical research design principles used in this study, and the structure and sequence in which the research design was performed were discussed. This chapter has also highlighted the rise of UHC implementation globally, and the need for research to assist with decision support for policy making in this field. This study proposes that a methodology be compiled to determine the causal links between conditions in which UHC implementations take place and the outcomes of those UHCs, as well as the application of that methodology. The next chapter puts the problem of the UHC in context for the reader.

2 The Real-World Problem: UHC Contextualisation

This chapter aims to provide a contextual backdrop for the research problem by explaining what is meant by a health system and what it typically consists of. It will then zoom in on the health system called UHC by detailing the principles on which UHC is built, what its theoretical goal and measurable outcomes are, and what influences those measurable outcomes according to the literature. This chapter concludes by defining a requirement specification that serves to highlight which country conditions (contextual or organisational) contribute to UHC outcomes.

2.1 Health systems

The World Health Organization (WHO, 2000) defines health systems as the combination of resources, establishments, and people that are organised such that they improve the health outcomes of a defined population, while protecting the individuals in the population against impoverishment caused by poor health.

Van Olmen *et al.* (2012) state that health systems are composed of many different actors that affect the outcomes of the health system. Some of these actors are more influential and more important than others. They reveal the most influential actors in the health systems construct of their health systems dynamics framework (Figure 4). These actors are:

Leadership and governance: to lead, delegate, measure, and take accountability of what was delegated.

Resources: the different types of resources required to run a health system, the largest portion of which will be human resources.

Population is the defined group of people serviced.

Service delivery implies the actual work done to provide health care services: scheduling the correctly skilled health staff to be available at health facilities that are maintained and stocked with medicines, consumables, and so on. This also includes the responsiveness of the correctly skilled staff and the deployment of consumables when required.

Context here refers to the unique environment in which the health system finds itself, within a certain political environment, regulated by certain laws, serving unique culture groups with certain traits.

Something to note at this point, but which will be discussed later, is that these different actors are expected to influence the outcomes of a health system (towards a certain goal) positively or negatively.

The goals define aspects of the high-level purpose that the health system wants to achieve in society. The WHO describes the goals of a health system in the following terms (Murray and Evans, 2003):

- Improving the population's health gain
- Improving the responsiveness of the health system
- Fairness in financial contributions

The **outcomes** are the expected measurable results of the health system. UHC suggests that population health outcomes depend on the proportion of a population that is covered by essential quality health services, and the proportion of that population that are impoverished in the process of accessing those services.

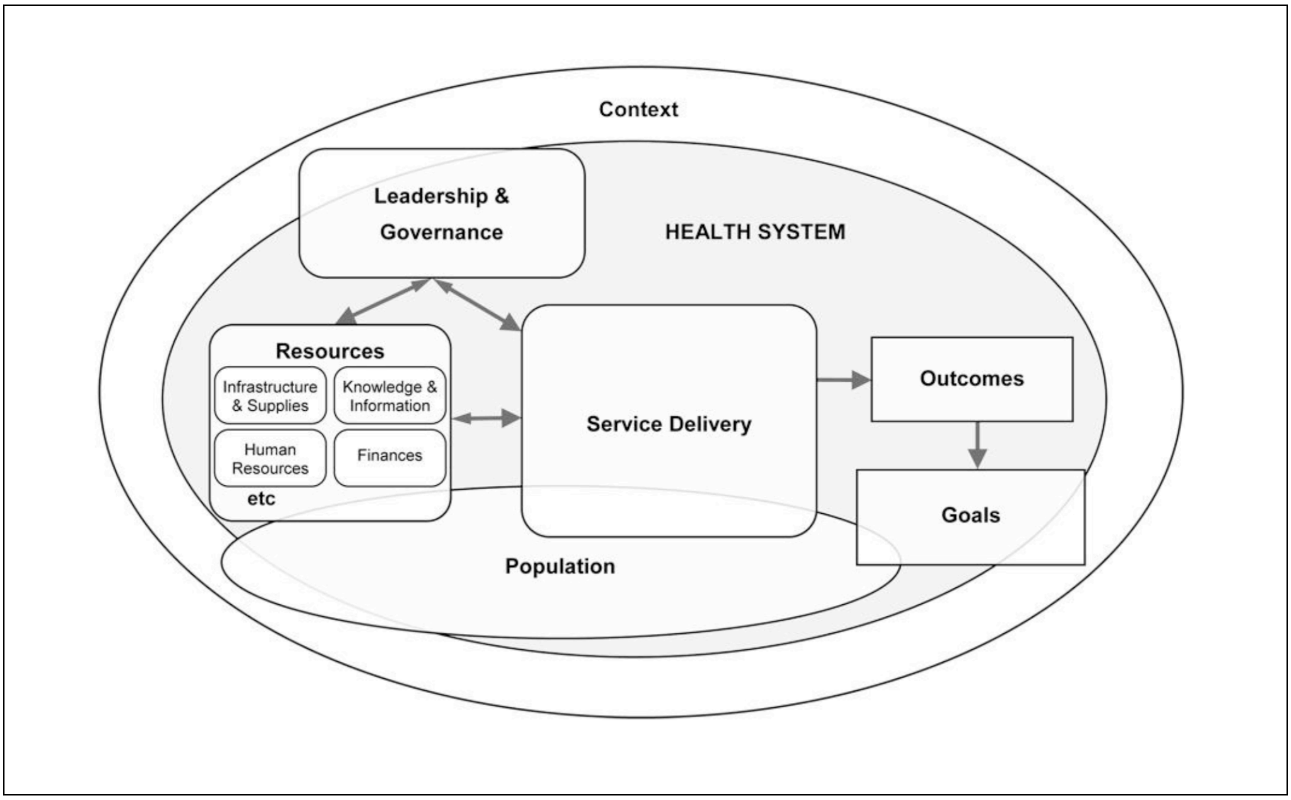


Figure 4: The health system dynamics framework (Van Olmen *et al*., 2012)

According to the Physicians for a National Health Program (Physicians for a National Health Program, 2016), when considering health systems globally, four models are most often observed: (a) the Bismarck model, (b) the Beveridge model, (c) the National Health Insurance (NHI) model, and (d) the out-of-pocket model.

The **Bismark** model refers to health care that is funded by a mandatory insurance in some form, and that is paid to insurers who are tightly regulated (Kutzin, 2011). Contributions are made specifically for health, and are typically levied on both employers and employees as a percentage of wages. Access or entitlement to health services is conditional on these health-specific contributions being made. This model is named after Otto Bismark, who established social insurance system in Germany in the 19th century. This model of health system must cover everyone, and it does not aim to make a profit (IQWiG, 2015). Doctors and hospitals tend to be privately managed. Some countries in which this model can be found are Germany, Japan, France, Belgium, The Netherlands, and Switzerland.

The **Beveridge** model, on the other hand, is funded by the government through tax payments rather than through a specific health tax (Econex, 2011), and the entire population is entitled to access health services. In this model, most health facilities tend to be owned by the government, and employees can work for either the public or the private sector. The fact that it implies a single payer gives the government bargaining power to negotiate good prices for health services, consumables, and medicine. This model is named after William Beveridge, who developed the principles for the National Health System (NHS) in Britain in 1942, which was implemented in 1948 (NHS, 2008). Countries that typically employ this model are Great Britain, Spain, the Scandinavian countries, and New Zealand (Physicians for a National Health Program, 2016).

The **NHI** model is a single payer system based on insurance principles such as risk pooling and cross-subsidisation (Econex, 2011). The service providers tend to be from the private sector, and are paid by a government-run insurance scheme that is mandatory for all citizens; benefits are enjoyed even by those who cannot contribute. Examples of countries where this system is used include Canada, Taiwan, and South Korea (Physicians for a National Health Program, 2016).

Out-of-pocket systems are usually not structured or formally planned (Econex, 2011), and require the patient to pay for the service as they use it, with no insurance safety net.

With an understanding of the health system models that exist globally, countries have now been tasked all to conform with what is called 'universal health coverage' (UHC) by the United Nations' sustainable development goals (World Health Organization, 2015). UHC can still have elements of these health system types, depending on the country's preference, but is in essence a health structuring mechanism that, at a high level, seeks to ensure that all the people within a population have (i) access to the necessary health services (ii) without being financially impoverished in paying for these health services (World Health Organization, 2014).

For the purposes of this research inquiry, UHC will be discussed in more detail in the paragraphs below. The next sub-section describes the historical development of UHC over time.

2.2 UHC: HISTORICAL DEVELOPMENT

Germany is believed to have started the first UHC-type system. The first legislation for a national social health insurance system appeared in 1883, after Germany had pursued several pooled-fund initiatives since the 17th century (Bärnighausen and Sauerborn, 2002). Pooled-funding is discussed in more detail in sub-section 2.3. The industrial revolution in Germany, alongside rapid urbanisation, left cities' physical infrastructure far outstripped by the population, and a breeding ground for disease and social revolution evolved (McKee *et al.*, 2013). As a result of this social revolution and pressure from trade unions, Bismarck (IQWiG, 2015) established a social insurance system that included health insurance.

Some years after Bismarck's establishment of a social insurance system, the UK's renowned NHS was established following the Second World War, in 1948 (NHS, 2008). Also, around the mid-20th century, Australia and Canada implemented UHC following a partnership between federal, provincial, state, and territorial governments. Countries such as Portugal and Spain implemented UHC principles in the 1970s, following their transition from dictatorship to democracy (McKee *et al.*, 2013). In 1978, at Alma-Ata, declarations were signed by 143 countries to take responsibility for achieving "an acceptable level of health for all people of the world" (Bump, 2010). This was the start of a global movement focusing on health services (Bristol, 2014). Developing countries such as Chile in 1952 and Brazil in 1988 also started expanding national health coverage (Bristol, 2014). Asian countries such as South Korea, Singapore, and Taiwan started implementing UHC after gains in economic development in these countries (McKee *et al.*, 2013). At the 2005 World Health Assembly, countries agreed to begin developing health financing systems to allow access to health while protecting individuals from impoverishment when accessing health services (Assembly, 2005). Figure 5 shows an index created by the WHO that indicates progress towards UHC by country (World Health Organization, 2017).

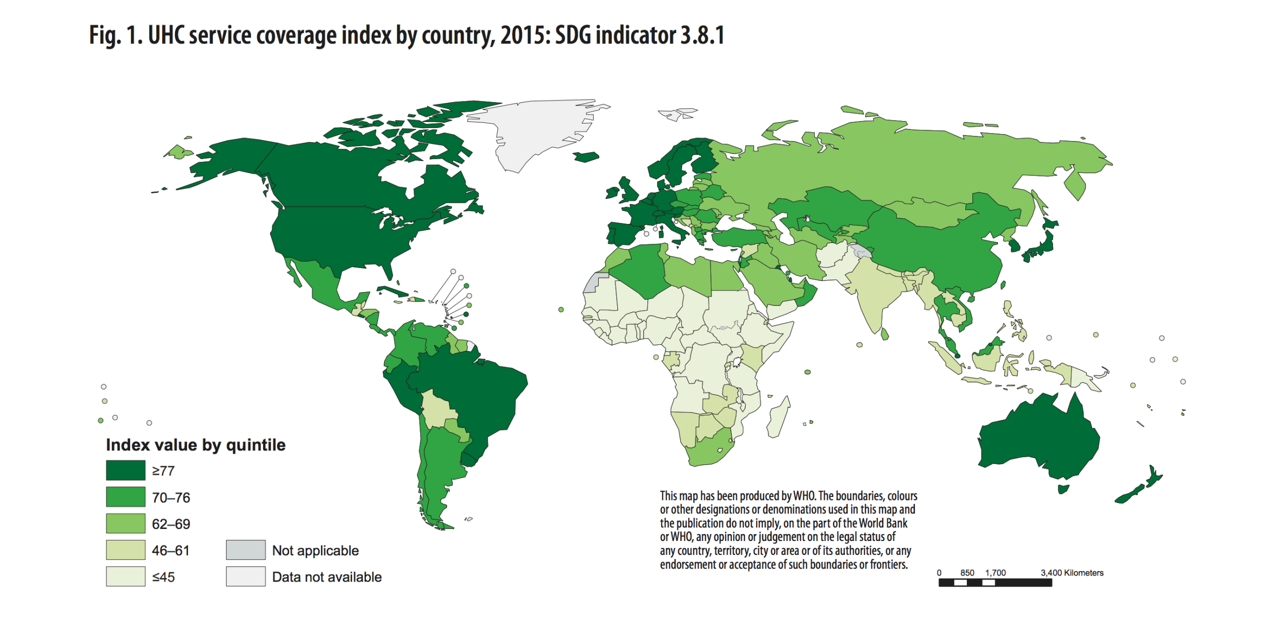


Figure 5: UHC coverage by country (World Health Organization, 2017)

Scope of legal coverage

- None
- Very limited scope (1–4 policy areas)
- Limited scope (5–6 policy areas)
- Semi-comprehensive scope (7 policy areas)
- Comprehensive scope (all policy areas)

Box 2: Key for Figure 6.

Figure 6 shows the global progression of social protection coverage over time, based on adopted legislation over time, offering benefits in cases of sickness, unemployment, old age, and employment injury, as well as family/child, maternity, invalid/disability, and survivors' benefits. UHC is an extension of traditional social insurance programmes (Social Protection and Universal Health Coverage, 2017). Figure 6 also shows which countries have mechanisms in place for social protection, which is required in a well-implemented UHC (McKee *et al*., 2013).

In order to understand how UHC works, the next sub-section will discuss the three dimensions on which UHC is built: the proportion of health costs covered, the range and level of services and specialisations covered, and the portion of population covered.

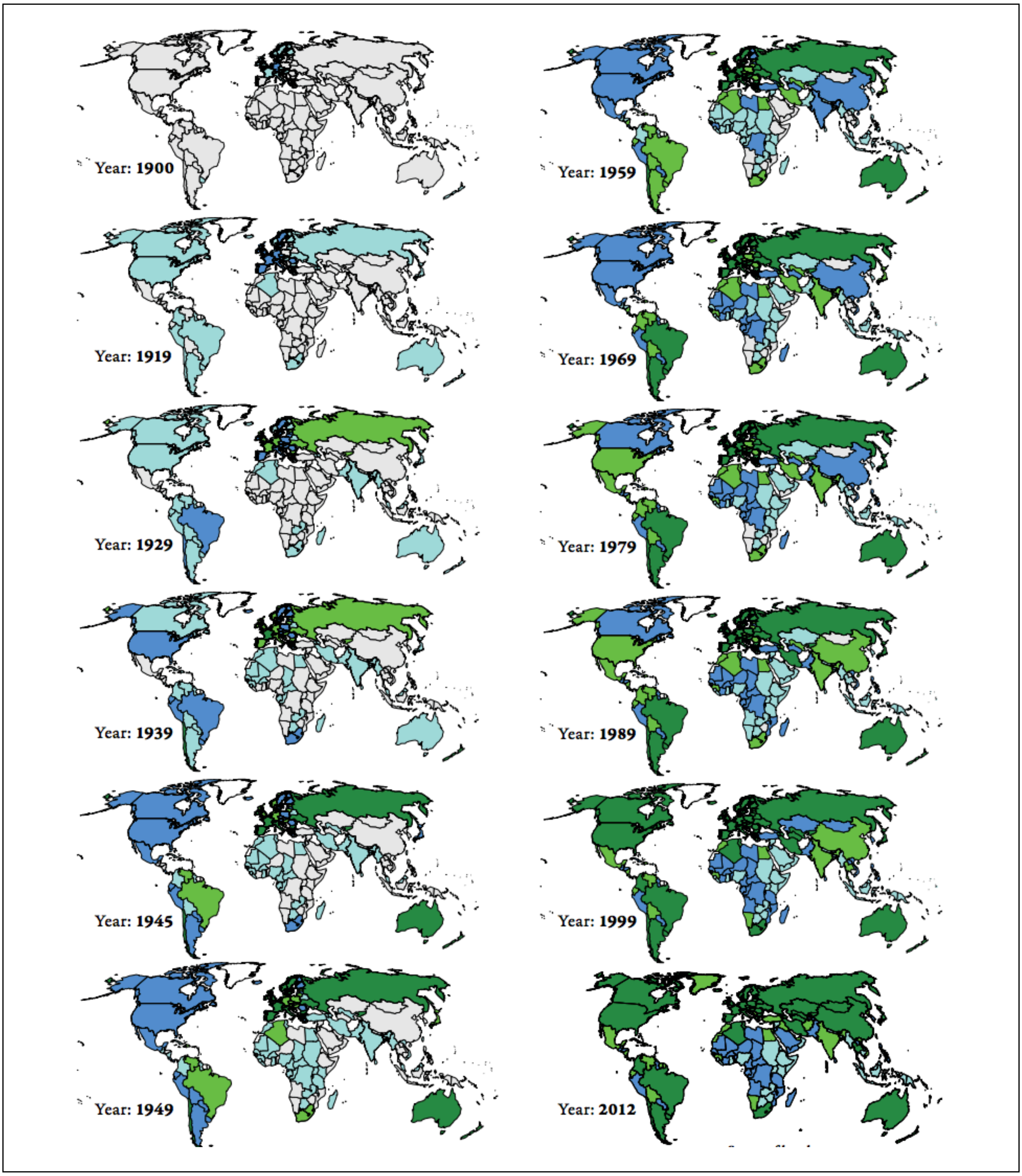


Figure 6: Global areas covered by social protection (McKee *et al*., 2013)

2.3 UHC DIMENSIONS

> *"Universal health coverage is the single most powerful concept that public health has to offer. Universal coverage is relevant to every person on this planet. It is a powerful equalizer that abolishes distinctions between the rich and the poor, the privileged and the marginalized, the young and the old, ethnic groups, and women and men. Universal health coverage is the best way to cement the gains made during the previous decade. It is the ultimate expression of fairness. This is the anchor for the work of WHO as we move forward."*
>
> **Dr Margaret Chan, DG WHO, address to the World Health Assembly, May 2012**

From the historical development, it can be noted that there has been an increasing drive to make access to healthcare a human right in all countries; and the sustainable development goals (SDGs) suggest the implementation of UHC to achieve that.

Instead of providing very specific organisational structuring recommendations, the UHC provides a set of goals that countries should aim to achieve (Missoni *et al*., 2010). In sub-section 2.1 the goal of UHC (aligning to health system goals) is to ensure that the population have access to good quality health services when they need them, and that individuals in the population are protected from financial hardship in accessing these health services (World Health Organization, 2014).

In order to achieve the goals of UHC, the WHO (2010) identified three dimensions that compete for the same pool of available funds: (i) the proportion of health costs covered, (ii) the range and depth of services covered, and (iii) the percentage of the population covered. In theory, as the pool of funds increases, these dimensions will also increase proportionally. Figure 5 is a schematic representation of these dimensions in relation to each other and to a country's pooled funds. These three dimensions are discussed further in the sub-sections that follow.

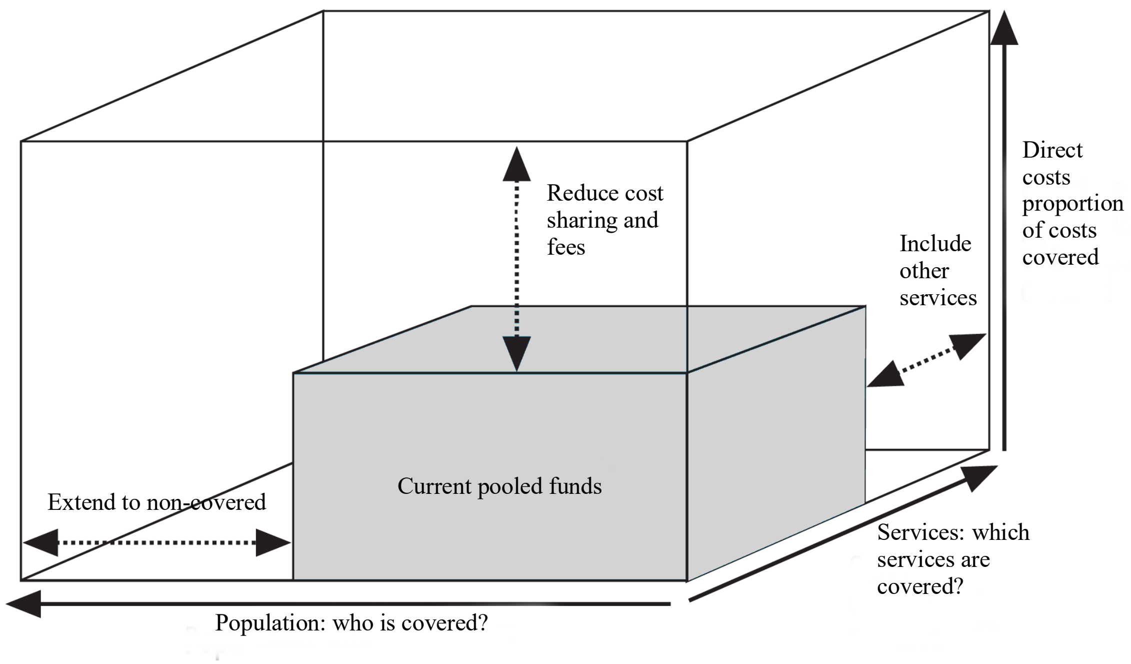


Figure 7: The three dimensions of UHC (WHO, 2010)

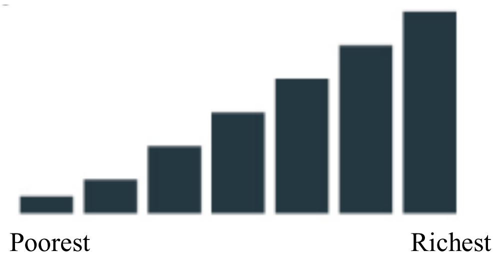
2.3.1 PROPORTION OF HEALTH COSTS COVERED

Health financing policies need to enable the goals of UHC and the functions typically required by health financing models for UHC, including financing elements such as revenue collection, pooling, purchasing, and managing member benefits (Kutzin, 2008).

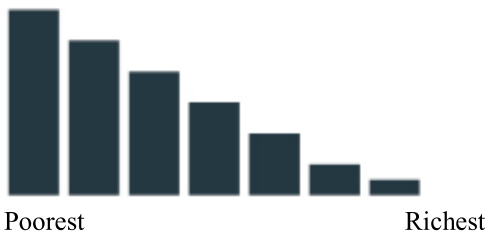
Revenue collection for UHC implies the assurance of a stable and predictable flow of funds to the UHC service delivery, relying mainly on two questions: (i) Who pays? And (ii) How much do they pay? (Jowett and Kutzin, 2015).

The United Nations Sustainable Development Solutions Network (2015) performed an analysis to understand what it means to raise adequate funds for UHC. They determined that a country would have to spend $86 per capita to contribute adequately towards UHC. For Sub-Saharan countries this could amount to around 5% of the country's GDP (United Nations Sustainable Development Solutions Network, 2015).

Ensuring such a stable flow of funds can typically be accomplished by applying taxes. When considering the addition of a form of taxation in a given context, Jowett and Kutzin (2015) recommend that one needs to ensure equity by levying the taxation types fairly. The different types of tax are described in Figure 8.



Progressive tax implies the proportion of income that the rich pay towards tax is more than the proportion that the poor need to pay. Examples of this includes:
Income tax and corporate tax tend to be progressive, as well as wealth, property and sales tax on luxury goods.



Regressive tax implies the proportion of income that the poor pay towards tax is more than the proportion that the rich need to pay. Examples of this includes: VAT and sales tax can be regressive, unless they are applied only luxury items and not to bear necessities.

Proportional tax implies that everyone contributes the same percentage of their income to tax. An example of this includes: taxes on TV licences.

Figure 8: Taxation types (ITEP, 2015)

Evans (2012) suggests the following alternatives to consider when raising revenue for UHC:

- Sales taxes, such as value-added tax.
- Taxing unhealthy lifestyles (which should always be used with the main aim of reducing unhealthy choices instead of a means to raise revenues).
- Currency exchange taxes, such as air tickets and foreign exchange transactions.
- Solidarity levies, such as imposing a levy on companies for handling remittances from abroad.

Jowett and Kutzin (2015) suggest the following alternatives to use to raise revenue for UHC:

- External funding for health, usually coming from international agencies. This funding currently comprises on average 30% of total health spending for low income countries.
- Increasing fiscal space for health spending.
- Non-tax revenues: this includes, for example, state-owned industries that produce revenue.

Pooling is also used in health financing to accomplish two objectives, according to Kutzin (2008):

- Equity in resource distribution, because the authority that manages the pool can equitably decide how to distribute the funding to the areas with the greatest health need.
- Financial risk protection: the healthy indirectly pay for the sick at any given time.

Purchasing refers to the payment of providers that deliver health care to the population. Røttingen *et al*. (2014) promote the use of *strategic* purchasing, which constantly assesses (i) which services to prioritise, (ii) the performance of health providers, (iii) how to negotiate better prices and delivery, and (iv) how incentives can improve health provision.

The alternative to purchasing is *passive* purchasing, which makes a decision based on last year's budget and pays providers based on disbursements submitted, making it retrospective and reactive (Røttingen *et al*., 2014).

Typical decisions that countries have to make about purchasing policy, according to Kutzin (2008), are:

- Whether or not to have a purchaser-provider split.
- Whether to have one purchaser of health services, or multiple purchasers.
- The level of autonomy that purchasers and providers may have to make their own decisions.

Countries typically use one of the following payment methods to fund providers: salary, fee-for-service, performance-based funding, global budget, or payment for a certain portion of the population (also known as capitation) (United Nations Sustainable Development Solutions Network, 2015).

Alongside the financing system, health financing policies should aim to drive quality, equity, efficiency, and accountability in the health system in order to achieve the health system's goals (Kutzin, 2008).

2.3.2 PERCENTAGE OF POPULATION COVERED

Nicholson *et al.* (2015) recommend, where necessary, a phased approach to initialising UHC coverage that covers more of the population before it coverers more of the services, as shown in Figure 9. This approach implies a progression from the coverage of basic benefits for the whole population to covering the whole population with more advanced services. This is suggested instead of initially covering only a portion of the population with a higher level of service and then progressing to the whole population. This recommendation is endorsed by leading organisations in the field such as the WHO Consultative Group on Equity and Universal Health Coverage (2014), Røttingen JA *et al*. (2014), and Agyepong and Liu (2014).

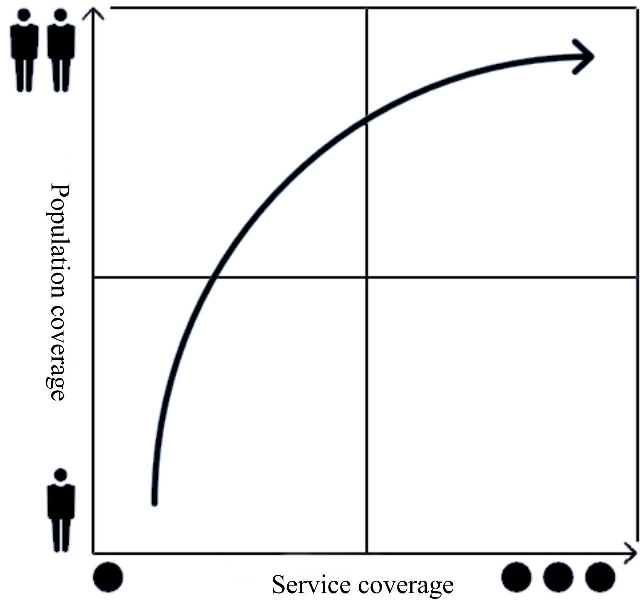


Figure 9: Service coverage vs population coverage expansion ***(Nicholson et al., 2015)***

The benefit of covering the population with basic benefits first and then expanding those benefits over time is that the whole population recognises the benefit of UHC and feels more equally treated.

Countries that followed the recommended approach, as shown in Figure 9, created a system that provided protection from healthcare costs that was experienced by all. Examples of countries where the recommended approach was used are Thailand, Brazil, and Sri Lanka.

In an approach that first covers a portion of the population with more advanced benefits and then expands those benefits over time to the rest of the population, the poorest part of the population is typically covered first, with the revenues raised either from that (limited) part of the population or from the whole population. The richer portion of the population is less willing to be taxed for services they are unable to access. This approach does, however, provide financially protected healthcare to the people who need it sooner.

2.3.3 Range and depth of services covered

Decision-making about which services to include as UHC develops in a country should be driven by cost-effectiveness, financial risk protection, and giving priority to the worse-off (World Health Organization, 2014). Evidence suggests that the focus of decision-making should be on primary health care and preventative services (Jamison *et al.*, 2006). Assumptions are made that the services should be of a good quality, medicine should be available, the population should use the services, they should be accessible and provided on time, and they should be culturally and community sensitive (Nicholson *et al.*, 2015).

Member benefits in UHC is not an extensive list, but include the services and commodities that the purchaser can afford (also called 'rationing') and to which the population is entitled; but it also includes obligations to which the population need to adhere, such as using a referral system (Kutzin, 2008).

This sub-section has described the three dimensions of UHC – the health costs covered for the population, the range and depth of services covered, and lastly, which portion of the population is covered. When designing benefit packages, these three dimensions need to be optimised to find the best middle ground, given the available resources. The next sub-section will discuss of UHC can be measured and monitored.

2.4 MEASURING UHC OUTCOMES

There is some truth in the saying, "If you can't measure it, you cannot manage it" (Deming, 2000). The purpose of this sub-section is to understand how to measure the outcomes of UHC in order to understand whether or not UHC achieves what it sets out to do, and whether it improves over time. To achieve this, a form of monitoring and measurement is required.

Parts of the literature that address the measuring of UHC achievement include these:

- The OECD and WHO (2014) reports on key indicators of health status, determinants of health, health care resources and utilisation, health expenditure and financing, and quality of care in 27 Asia/Pacific countries and economies.
- Marten *et al.* (2014) completed an assessment of progress towards universal health coverage in the BRICS countries. This document compares the key health indicators, health financing indicators, and financial protection schemes, as well as the specific challenges faced by each country.
- Dmytraczenko and Almeida (2015) manually compare the key characteristics of health system financing and service delivery between Latin American and Caribbean countries.
- The WHO and the World Bank suggest a monitoring framework to measure progress towards UHC that includes two key components: coverage of the population with quality essential health services, and coverage of the population with financial protection (WHO, 2015).
- Lastly, the WHO compiled a report defining measures to monitor health for the SDGs (WHO, 2016). This is the latest and most comprehensive indicator for UHC to date.

At the time of this study, the latest and most comprehensive measurement framework available was the one specified by the WHO in the World Health Statistics report (2016-), which is largely based on the World Bank and WHO report, 'Tracking universal health coverage' (Boerma *et al.*, 2014).

In summary, a World Health Statistics report suggests a framework of monitoring indicators developed through a set of country case studies, technical reviews, and consultations and discussions with country representatives, technical experts, and global health and development partners. The suggested framework categorises indicators into two logical groupings (Boerma *et al.*, 2014):

- Coverage of the population with quality essential health services for preventative services and treatment services respectively.
- Coverage of the population with financial protection, looking at (i) the degree to which health spending causes extreme hardship by pushing families below the poverty line; and (ii) the number of households of all income levels that incur health payments that are higher than a certain proportion of their resources.

The definitions of the UHC-specific outcome indicators by Boerma *et al.* (2014) and updated by the WHO (2016) can be seen in Table 2 below.

Table 2: UHC outcome indicators and corresponding definitions (WHO, 2016)

Outcome Indicator	Description
Family health	
1	Family Planning coverage: Percentage of women of reproductive age (15–49 years) who are sexually active and who have their need for family planning satisfied with modern methods (SDG indicator 3.7.1.)[1]
2	Antenatal care coverage: percentage of women aged 15–49 years with a live birth in a given time period who received antenatal care, four times or more.
3	Child immunisation coverage (three doses of diphtheria, tetanus, and pertussis-containing vaccine).
4	Health-seeking behaviour for child pneumonia.
Infectious diseases	
5	Tuberculosis treatment coverage: Percentage of TB cases successfully treated (cured plus treatment completed) among TB cases notified to the national health authorities during a specified period.
6	Antiretroviral treatment (ART) coverage: Percentage of people living with HIV currently receiving ART among the estimated number of adults and children living with HIV.
7	Sleeping under an insecticide-treated bed net (ITN): Percentage population in malaria-endemic areas who slept under an ITN the previous night.
8a	Proportion of population using safely managed drinking-water services (SDG indicator 6.1.1).
8b	Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water (SDG indicator 6.2.1).
Non-communicable diseases	
9	Non-prevalence of raised blood pressure
10	Non-prevalence of raised blood glucose
11	Cervical cancer screening
12	Non-use of tobacco
Outcome Indicator	Description
Service capacity and access	
13	Basic hospital access
14	Health-worker density
15	Access to essential medicines
16	Health security: International Health Regulations (IHR) compliance
17	Proportion of the population (or sub-population) not facing catastrophic health expenditure: Percentage of the population not spending more than 25% of non-food expenditure on health care.
Outcome Indicator	Description

[1] 'Modern methods' here refers to methods that enable couples to have sexual intercourse at any mutually-desired time with a low risk of falling pregnant (Hubacher and Trussell, 2015).

18	Percentage of the population neither impoverished by out-of-pocket payments nor pushed further into poverty by them.

In addition to the indicators defined in Table 2, Hogan, Hosseinpoor and Boerma (2016) developed an index that is a starting point for looking at UHC achievement over all indicators in a single composite index. The calculation for this index can be seen in Figure 10.

This sub-section has discussed how UHC outcomes can be measured, allowing one to understand whether countries are effectively achieving UHC and how they are improving over time. The next sub-section will present the countries that have attempted UHC.

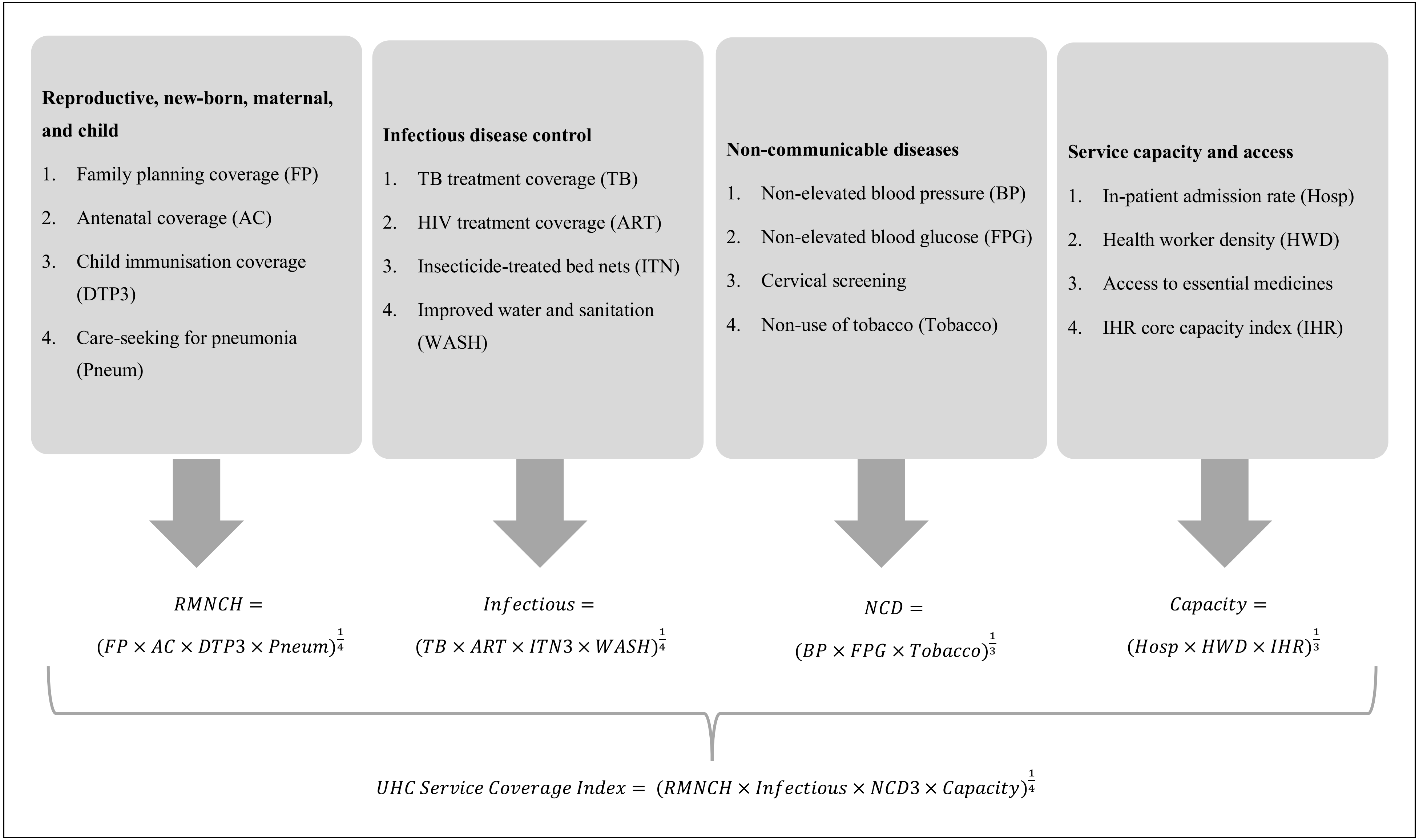


Figure 10: UHC service coverage index calculation ***(adapted from Hogan, Hosseinpoor and Boerma, 2016)***

2.5 Countries that have attempted UHC

Feigl and Ding (2013) developed an evidenced formal coverage (EFC) index to understand when a country has implemented UHC. The index combines three key UHC elements: legal framework, population coverage, and accessibility.

According to the World Health Assembly (2005), all member states of the World Health Organization committed in 2005 to develop their health financing systems so that all people could have access to health services without suffering financial hardship in paying for them. There are about 190-member states in total. According to the Feigl and Ding (2013) index, the 51 countries identified in Table 3 below have convincingly achieved UHC.

The EFC index consists of UHC dimensions of equal access (greater than or equal to 90%), formal coverage (greater than or equal to 85%), and whether a country has legislated UHC, as derived from the literature (Feigl and Ding, 2013). Countries with EFCOOP are based on EFC, but add the restriction of whether countries have out-of-pocket expenditure (OOP) of less than or equal to 25% of healthcare spending.

Table 3: List of countries that achieved UHC according to EFC index (Feigl & Ding, 2013)

Countries with EFC (n = 51)		Countries with EFCOOP (n = 32)	
Algeria	Japan	Algeria	Slovenia
Argentina	Latvia	Argentina	Spain
Armenia	Luxembourg	Austria	Sweden
Australia	Mongolia	Belarus	United Kingdom
Austria	Netherlands	Belgium	Uruguay
Belarus	New Zealand	Canada	
Belgium	Norway	Costa Rica	
Bosnia and Herzegovina	Oman	Croatia	
Brazil	Panama	Czech Republic	
Bulgaria	Portugal	Denmark	
Canada	Republic of Korea	Estonia	
Chile	Romania	Finland	
Costa Rica	Russian Federation	France	
Croatia	Serbia	Germany	
Cuba	Slovakia	Iceland	
Czech Republic	Slovenia	Ireland	
Denmark	Spain	Italy	
Estonia	Sweden	Japan	
Finland	Switzerland	Luxembourg	
France	Thailand	Mongolia	
Germany	Tunisia	Netherlands	
Greece	Ukraine	New Zealand	
Hungary	United Kingdom	Norway	
Iceland	Uruguay	Portugal	
Ireland	Venezuela	Romania	

Countries with EFC (n = 51)	Countries with EFCOOP (n = 32)		
Italy		Slovakia	

This sub-section has briefly explained how to determine whether a country is 'serious' about achieving UHC through the evidenced formal coverage (EFC) index, and has also listed the countries that have achieved UHC according to the EFC index.

2.6 Conditions influencing UHC outcomes

This sub-section will investigate the existing literature to understand which conditions in a country's context influence the success of UHC outcomes.

Figure 4 presented the different actors (from here on called 'conditions' to prevent ambiguity) in a health system. In re-examining Figure 2, the conditions that theoretically influence the outcomes of the health system are denoted as context, leadership, governance and service delivery, resources, and characteristics of the population under question.

Anand and Bärnighausen (2004) found that the conditions that are expected to influence health system performance will probably surface in the following domains: resources for health, and socioeconomic, environmental, and behavioural conditions.

To understand which conditions theoretically influence UHC outcome indicators according to the literature, keyword searches were performed for each UHC outcome indicator listed in sub-section 2.4, Table 2.

The steps followed for these key-word searches were:

1. A search was completed for each UHC outcome indicator, using the wording prescribed in Table 4; it was based on the Article Title, Keywords, and Abstracts of the Scopus database only.
2. The resulting articles were investigated, and conditions theoretically influencing UHC outcomes were listed.
3. These input conditions were recorded in more detail in APPENDIX A.

The indicator relating to 'sleeping under an insecticide-treated bed net' coverage was excluded at this point, because malaria is prevalent in only about half of the countries in the world (WHO, 2015b).

The conditions theoretically influencing UHC outcomes were grouped into the following simplified themes, as found in Figure 4:

1. Country context: these included conditions concerning physical geography, climate, and population characteristics.
2. Health system organisation and delivery: this relates to health leadership, governance, and service execution related conditions.
3. Resources: this relates to investment availability for health.

The spread of conditions related to the country context theme were the most prominent in the literature, as can be seen in Figure 11.

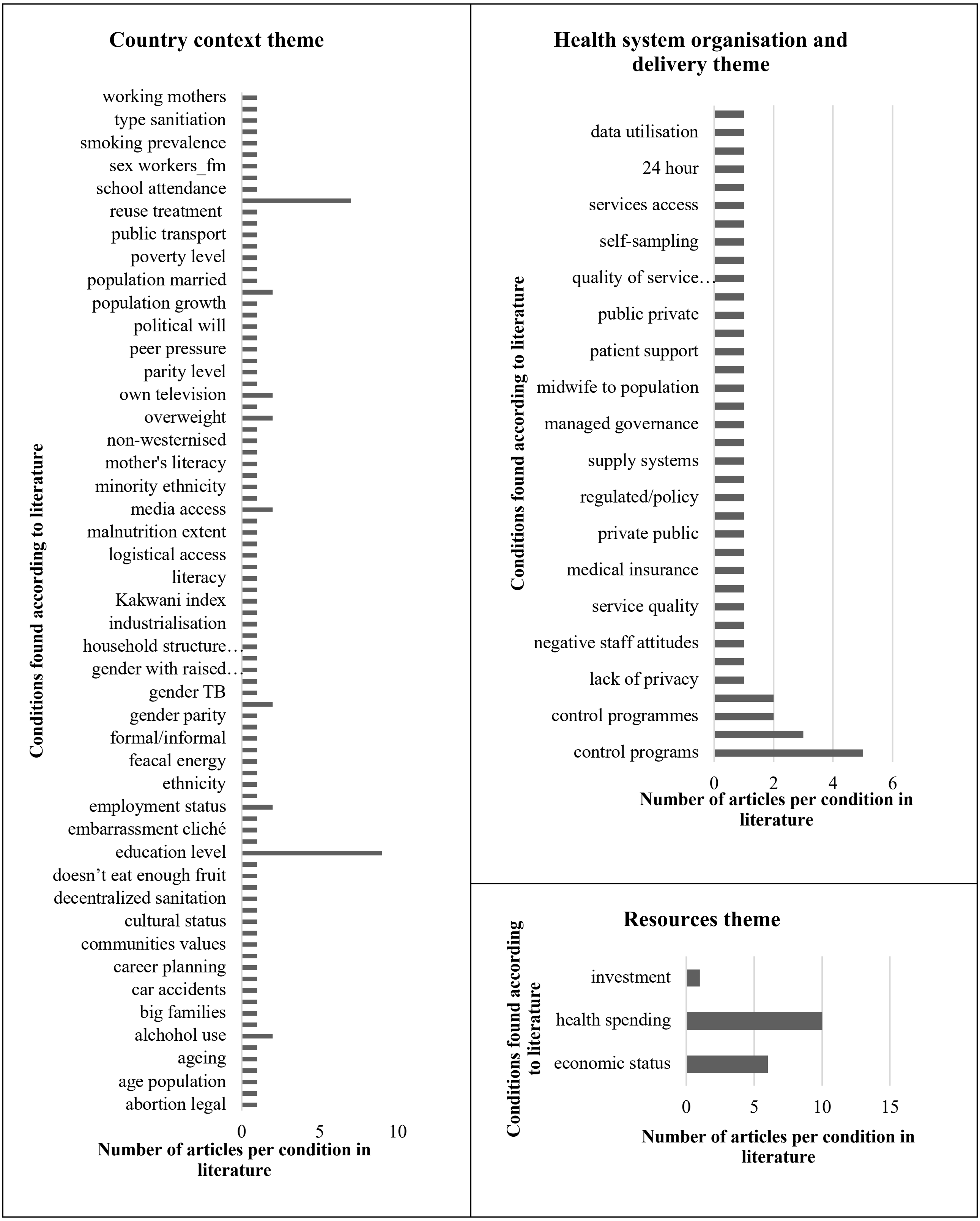


Figure 11: Conditions theoretically influencing UHC outcomes

Table 4 below indicates the conditions theoretically influencing UHC outcomes per outcome indicator. (These outcome indicators were listed in sub-section 2.4, Table 2.) The search phrase (representing the UHC outcome indicator) used for the key-word search can be seen in the heading, followed by a word cloud of all the identified conditions.

Table 4: Theoretically influencing conditions per UHC outcome indicator

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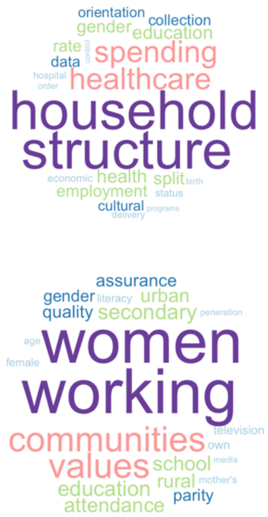
</td><td>
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<tr><th>“Health-seeking behaviour for child pneumonia”</th><th>“Tuberculosis treatment coverage”</th><th>“Antiretroviral treatment coverage”</th></tr>
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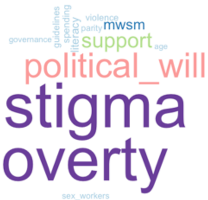
</td><td>
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<tr><th>“safely managed drinking water”</th><th>“safely managed sanitation services”</th><th>“OOP spending” OR “OOP expenses” AND “protection”</th></tr>
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<tr><td>“Cervical cancer screening coverage”</td><td>“Non-use of tobacco”</td><td>“hospital access” AND basic</td></tr>
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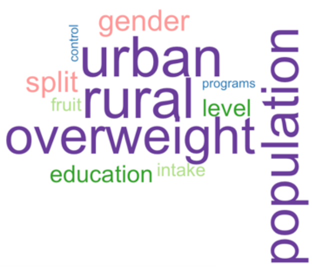
<td>
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Note that in Table 4, the word searches only produced one result for “IHR compliance”, that health spending seems to influence this outcome, according to the literature.

This sub-section has investigated which conditions influence the individual UHC outcome indicators by performing a structured literature study. The sub-sections up to this point have created a backdrop for the next sub-section, which goes about compiling the requirements for a solution method for the research problem.

2.7 REQUIREMENTS FOR A SOLUTION METHOD

This sub-section will determine the requirements for the solution method that needs to be used to address the problem statement of this research inquiry which was to: understand how to identify the underlying causal links that influence the success of a UHC implementation in a country.

The implementation of UHC in a country has many complex decision-making requirements, and is affected by a range of conditions in that country. Van Olmen *et al*. (2012) suggest that health systems should be geared towards goals and outcomes, and that some elements are more important than others (as was discussed in sub-section 2.4).

To begin considering how a solution method needs to work that will highlight which conditions contribute more or less to the success of UHC outcomes, Figure 4 was adapted into Figure 12 to clarify how each condition can relate in a mathematical model. Each condition grouping has either been classified as condition variables or outcome variables. The data that can measure each of these conditions needs to be found in a legitimate secondary source.

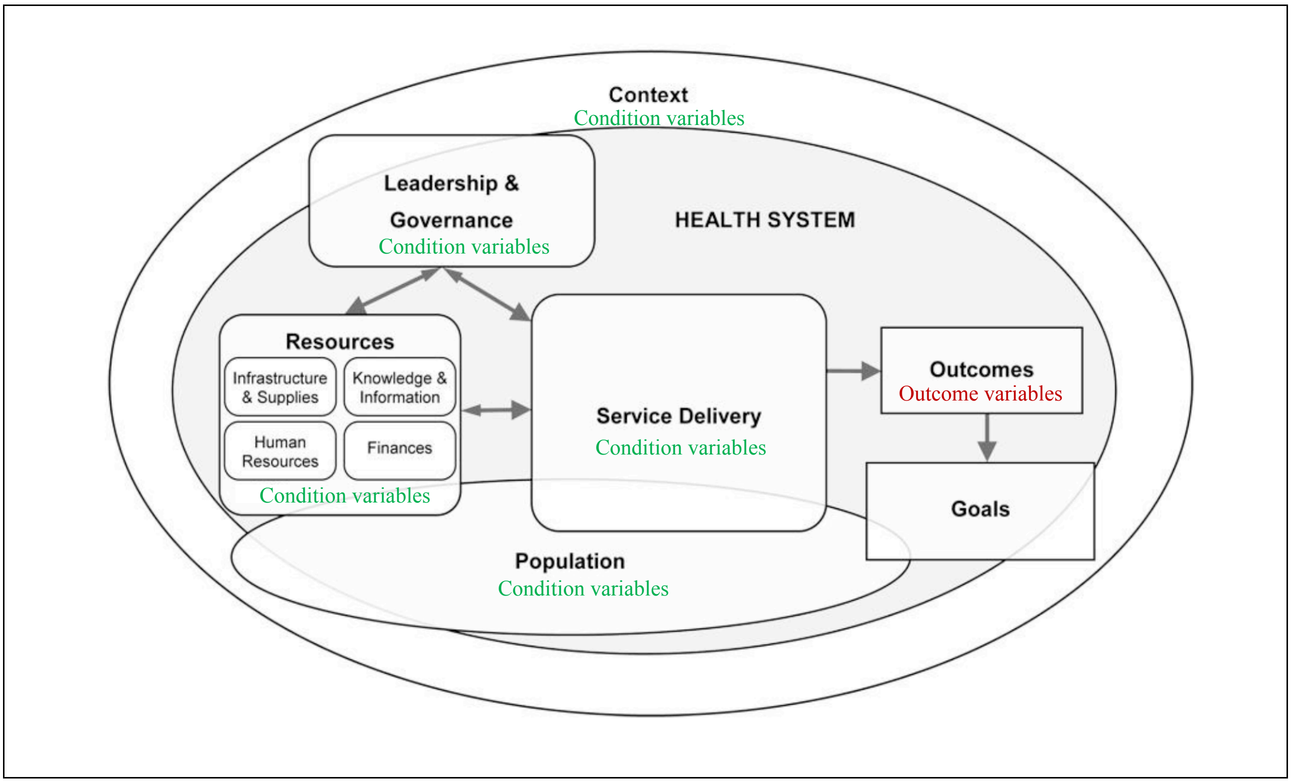

Figure 12: Relationships of condition and result variables in a real-world system

In considering the real-world problem's system requirements, the type of data expected, and the requirements arising from the problem statement, the following solution requirements are proposed:

1. **Decision support**: the selected approach and method should provide decision support to policy making for UHC implementation.
2. **Multivariate:** it is expected that multiple variables may correlate to a certain outcome – for example, both the political climate and the social conditions might affect a certain outcome. This implies that the solution method needs to allow multivariate variable sets and equifinality.
3. **Comparative case study research:** in order to see trends in the relationship between inputs and outputs, an analysis would have to be completed across different cases (specifically, countries) in this application. This implies that the research design for this study is of a comparative case study nature.
4. **Qualitative/quantitative conditions:** it is expected that this kind of study would be required to consider qualitative and quantitative conditions, because the organisation of a health system can be quantitative (e.g., doctor-to-patient ratio) and the contextual conditions can be more qualitative (e.g., is the country a democracy, yes or no?). The outcome data will, by and large, be quantitative data when considering how WHO (2016) proposes the measurement of UHC outcomes. These indicators are mostly measured as percentages for coverage.
5. **Prioritise conditions:** it will be especially valuable if the solution method can prioritise the effect of certain conditions on outcomes to inform policy-makers that certain contextual/organisational conditions carry more value and need to be managed with higher significance than others.

6. **Sample size:** given that all countries may not be comparable, the solution method needs to cater for small to medium sample cases.
7. **Cross-sectional study:** a cross-sectional study is suggested because UHC is a recent development for most countries, and comparing outcomes over time is not yet useful.
8. **Causal inference:** the objective of the study makes it clear that the solution method should support any causal links that need to be made with given results. The method should highlight which conditions influenced UHC outcomes.
9. **Equifinality:** different conditions should be able to produce the same outcome.
10. **Formal, systematic, transparent, repeatable, and structured approach:** the approach should be a recognised method that is structured and analytical, following pre-defined rules. It must be applied so that the student and reader should never feel that a black-box analysis was completed, but rather a communicated approach with understandable steps and computations. This also implies that the analysis should be repeatable.
11. **Allow for counterfactual discussion:** the approach should identify which conditions or combinations of conditions were not observed, and understand what the outcome would have been for those unobserved conditions of combinations of conditions. This will only be possible for conditions that were originally part of the modelling process; and it needs to be noted that it will not be possible to consider conditions not applied in the mathematical model. Figure 13 summarises the elements discussed in this chapter, and aims to indicate how they interact: UHC exists in countries under certain conditions. This study will determine which causal links exist between these conditions and UHC outcomes.

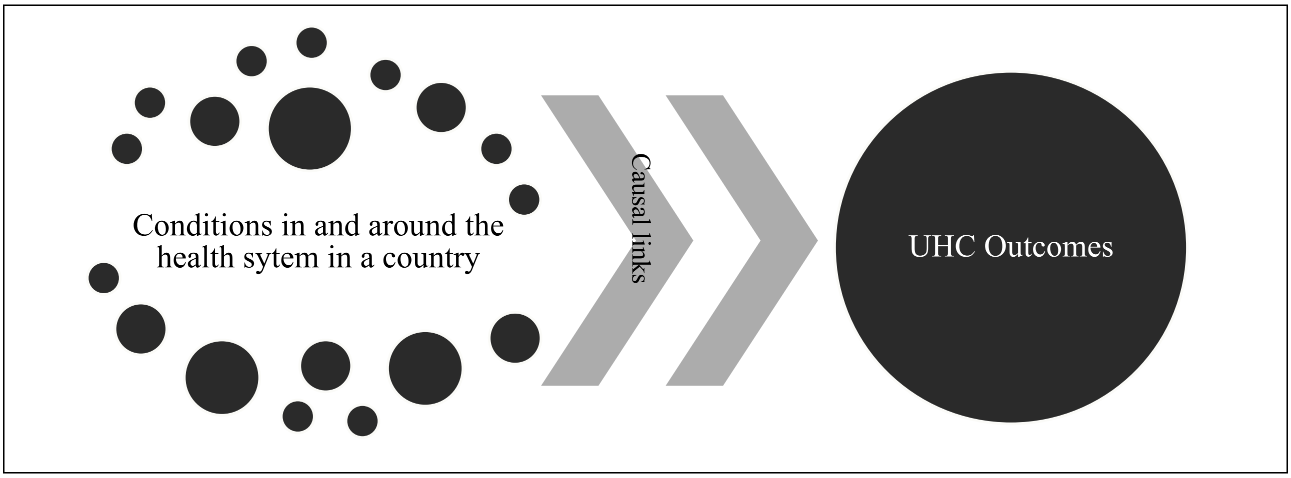

Figure 13: Solution method requirement interactions

Given the solution requirements defined in this chapter, it is proposed that a comparative causal research method is required for this research inquiry.

2.8 CONCLUSION: THE REAL-WORLD PROBLEM

This chapter has described the real-world problem by providing contextual information about UHC, briefly explaining what health systems are, and how UHC fits into them. It has discussed the historical development of UHC, the principles upon which UHC is built, the outcomes that it tries to achieve, and how the achieved outcomes can be monitored. The chapter has then detailed which conditions influence these outcomes according to the literature and, lastly, has outlined the solution requirements given real-world system requirements, the expected type of data, and the requirements determined by the problem statement. A comparative causal method is suggested as the high-level solution method type to highlight the causal processes between the conditions in the health system in a country and its UHC outcomes.

3 COMPARATIVE CAUSAL RESEARCH METHODS

The aim of this chapter is to identify methods that will assist in understanding the causal links between country conditions and UHC outcomes to provide decision support to policy-makers. In the previous chapter, comparative causal research was suggested to find these causal links. This chapter will briefly explain comparative causal research, what methods exist in this field of study, and which method is the most appropriate for this specific application.

First, it is important to note that there is often confusion about the comparative methods approach as a result of its having been given many names, including comparable case strategies (Lijphart, 1975), case-oriented comparisons (Ragin, 2014), method of systematic comparative illustration (Smelser, 1973), and so on.

It is also important to note that there is scepticism about the subject of causal research, especially in Hume's theories (Suppes, 1970), which is noted as part of this research inquiry's considerations. Hume argues that causal relationships are always studied retrospectively, based on experience – but that cannot be all it is based upon. He also argues that cause is outside of effect (Suppes, 1970). Immanuel Kant also reasons that causal relationships can only be drawn if experience is combined with prior understanding; and Tacq (2011), by way of example, explains that "Adam could not deduce from seeing water that it could suffocate him".

An opposing view is presented by Mackie (1965), who uses the example of a toy train on a table bumping into a second toy train, causing the second train to start moving. Mackie argues that this has nothing to do with prior faculty knowledge, because the second train may have been moved by a magnet under the table. Mackie (paraphrased by Tacq, 2011) reasons that finding causal relationships should be *"the act of hypothesizing knowledge in a tentative way, with experiment and observation needed to come to a conclusion"*.

To add to Mackie's reasoning here, causal research as used in this research inquiry will give policy-makers an indication of the expected outcome of a certain action and will provide decision support and guidance. It must also be noted that the comparative analysis performed in this study is not equivalent to that of an experimental method, but is only a very imperfect substitute (Berg-Schlosser, 2016).

3.1 COMPARATIVE CAUSAL RESEARCH FOR POLICY MAKING

Causal or explanatory research is used to identify cause-and-effect relationships as well as the nature of such relationships (Zikmund et al., 2013). The research design of comparative causal research is retrospective in nature, and its goal is usually to determine whether an independent variable has affected an outcome by comparing two or more cases with each other.

Comparative causal research in policy making is not a novel concept. An example of its application is the nineteenth century policy-makers in France who implemented policies to encourage an increased birth rate and immigration, in order to prevent the worsening problem of an aging population (Tacq, 2011).

Multiple theories are used in causal research (Little, 2005). These include:

- **Causal regularities:** this theory argues that events of type A will always be followed by events of type B.
- **Necessary and sufficient conditions:** this theory argues that A is a necessary and/or sufficient condition for B. Sufficiency is observed when condition A is always present when outcome B occurs. Necessity occurs when outcome B is always present when condition A is present.
- **Causal mechanisms:** this theory argues that there is a chain of causal mechanisms leading from A to B.

- **Probabilistic causation:** this theory argues that, if A occurs, the probability of the occurrence of B will be higher.

Tacq (2011) reports that studies on causality in qualitative research and in a mixture of qualitative and quantitative research have been especially abundant over the last decade. Berg-Schlosser (2016) also notes that the developments in comparative analysis using Boolean algebra have made it more difficult to refer to a qualitative/quantitative divide in social studies, which used to be the norm before Boolean algebra became so popular.

The next sub-section provides a systematic literature review of comparative causal research with the aim of identifying which methods have been used by other researchers.

3.2 Systematic review of causal research

In order to understand what methods have been used in the field of comparative causal research, a systematic review of the literature was conducted. A similar methodology to that of Chappin and Ligtvoet (2014) was used to evaluate the landscape of the literature on the methods used to perform causal comparative studies.

3.2.1 Key-word search steps

Four steps were followed for the keyword-based search in order to provide the objective:

Step 1:

Countries were selected as the units of analysis for this study, even though it might as easily have been provinces/regions/cities. This selection was based on the reasoning that cross-national data is more readily available in secondary databases, and also that this research wishes to provide decision support at a country level. The aim was then to find methods relating to causal comparative research, specifically for cross-country application. The variations of "causal", "comparative", and "cross-national" were included in the search phrases, as seen in Box 3, and "method" was also added to find articles more specifically related to a method of analysis.

"causality" OR "causal" OR "causation"
AND
"comparative" OR "compare" OR "comparison"
AND
"cross-national" OR "cross-country" OR "countries"
AND
"method"

Box 3: Keyword search terms for method search

Step 2:

The search was only performed on the titles, abstracts, and keywords of articles, using the SCOPUS databases, with no restrictions on publication date for the sake of comprehensiveness.

Step 3:

The unfiltered search results were extracted in order to visualise the original population of the search results. The initial spread of publications across research areas can be seen in Figure 14. In the interest of focusing on articles that deal primarily with social research in support of the objective of this paper, filtering was performed to include only subject areas that were relevant to this study. Subject areas viewed as relevant included articles with subject areas in the social sciences (see Table 5 for the Scopus definition of these areas)[2].

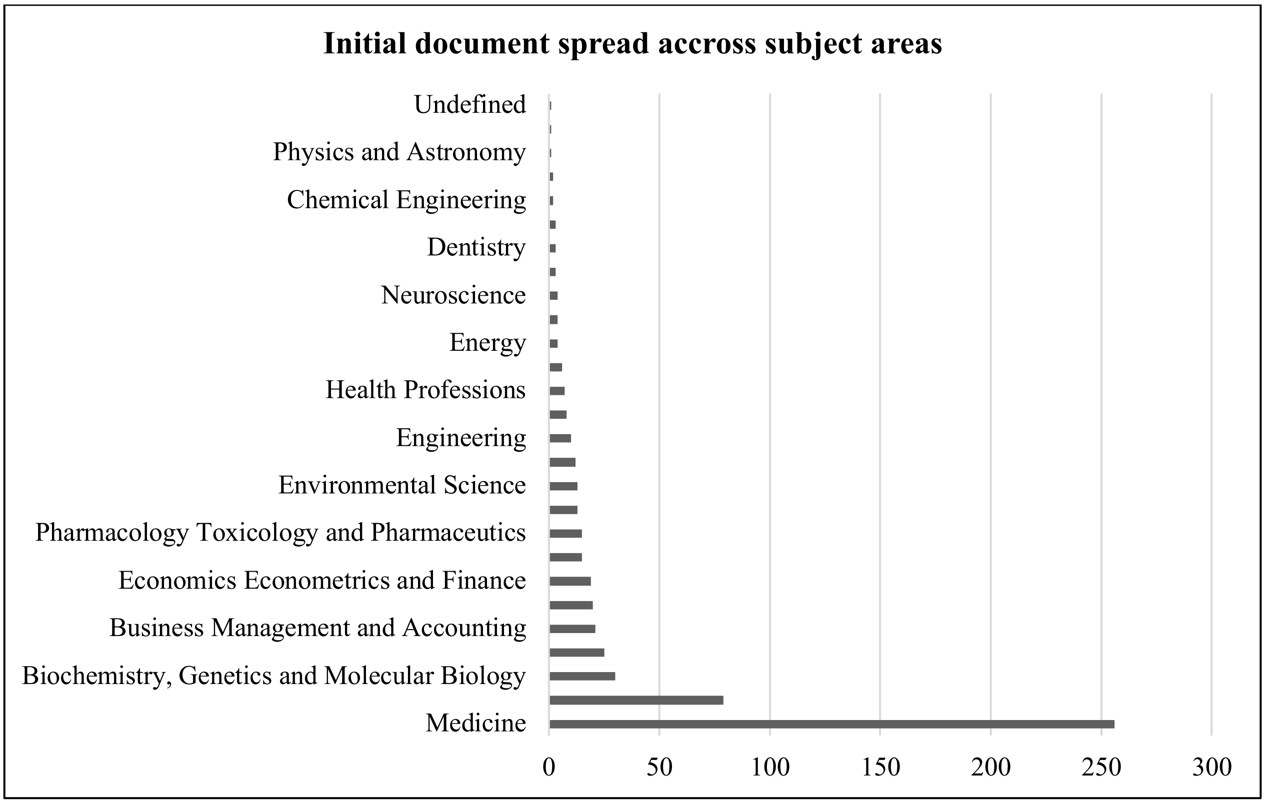

Figure 14: Initial publication spread across areas: unfiltered search.

Table 5: Scopus subject areas (Scopus, 2017)

Social sciences	Health sciences	Physical sciences	Life sciences
Psychology	100% MEDLINE	Chemistry	Neuroscience
Economics	Nursing	Physics	Pharmacology
Business	Dentistry	Engineering	Biology
A&H			

Step 4:

The results were extracted for further analysis with citation, keyword, and abstract information. The outcomes of these four steps are detailed in the paragraphs below.

3.2.2 KEY-WORD SEARCH INITIAL RESULTS

A high-level summary of the initial result statistics can be seen in Table 6.

[2] For the specific search, the excluded subject areas were: medicine, biochemistry, genetics and molecular biology, agricultural and biological sciences, pharmacology, toxicology and pharmaceutics, and immunology and microbiology.

Table 6: Search statistics

Documents in the unfiltered search	405
Total unfiltered authors	229
Total unfiltered citations	1708
Filtering criteria	Subject areas = social sciences
Documents in the filtered search	100

A total of 109 documents remained after the filtered search; nine of them were excluded because of incomplete data, leaving 100. The document distribution per country and per year can be seen in Figure 15 and Figure 16.

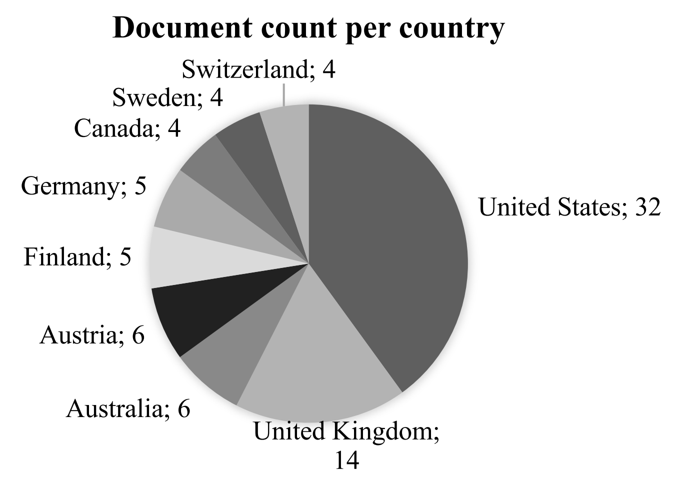

Figure 15: Number of documents per country: filtered search

Figure 15 shows the countries that had more than three documents. The majority of studies are concentrated in Western countries, with the United States far outweighing the other countries. No documents were found for the African regions.

Figure 16 highlights the substantial growth and peak of documents produced in this field of study in the last 10 years. Note that 2017 drops significantly, due to that being the year in which this specific exercise took place.

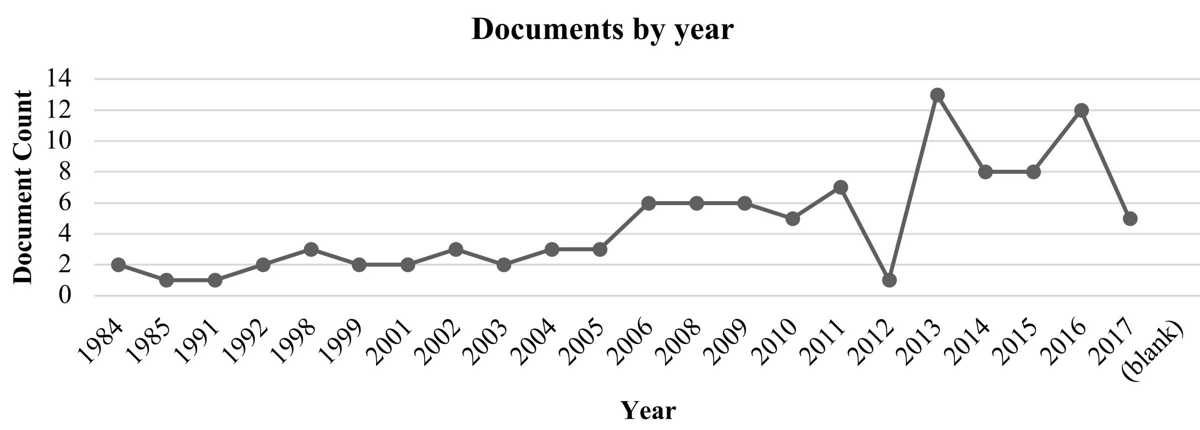

Figure 16: Document count by year: filtered search

The analysis methods identified in this key-word search are summarised in Figure 17. Methods were categorised into method groupings, based as far as possible on the same parent method; for example, the sum of least squares is a regression type, and so it was added to the regression category. It was found that the majority of the methods belonged to two groups: regression types and qualitative comparative analysis. Certain pieces of literature also contained more than one method.

The next sub-section will compare the methods discovered in this sub-section and compare them with the solution requirements set for this research. The chapter will be completed by the selection of a solution methodology.

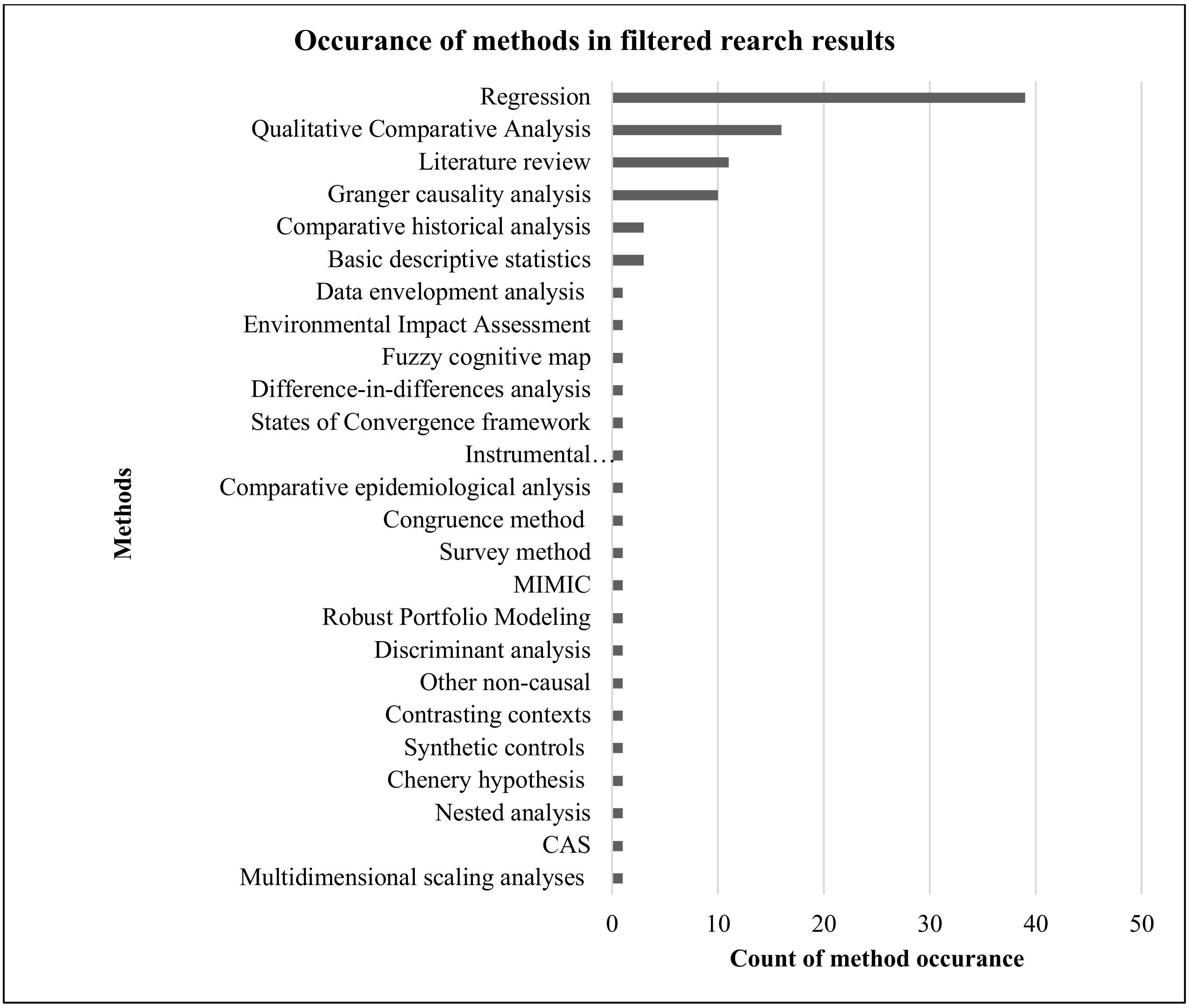

Figure 17: Number of documents per method found in systematic review

3.3 Method Selection

In the previous chapter, the requirements for the solutions method were identified (sub-section 2.7), and from there the need to use comparative causal research surfaced. In sub-section 3.2 a structured literature review was completed to understand which methods have previously been used to apply comparative causal research. This sub-section will continue to investigate which of the identified methods are best suited to meet the solution method requirements by first briefly describing the methods, and then comparing them with the requirements in a matrix.

In order to understand the purpose and workings of the most frequently occurring methods, as identified during the keyword-based searches in sub-section 3.2, comment is made on the nature of its comparative causal ability.

Regression: A statistical method that uses sample data to estimate parameter values (Crawley, 2007). Various types of regression were found during the keyword-based searches; however, they are grouped together for the purposes of a more concise discussion.

Qualitative comparative analysis (QCA): This analysis uses Boolean algebra to determine the causal contribution of different conditions to an outcome. QCA techniques strive to meet the advantages of both "qualitative" (case-oriented) and "quantitative" (variable-oriented) techniques (Rihoux, 2009).

Literature review: There are different methods to use when performing structured literature reviews. In this context, this method looks at a large body of the literature and finds trends in the findings of other researchers.

Granger causality analysis: This method uses a statistical hypothesis test to determine whether one time series is useful in forecasting another (Bahadori and Liu, 2012), and is inherently longitudinal.

Basic descriptive statistics: Used to determine prevalence, probability, and thematic analysis of certain phenomena and their significance.

Comparative historical analysis: A social science method that studies historical events by combining comparative and within-case methods to identify causal processes. These insights can then be applied beyond the particular time and place of the original study. They focus either on what happened during a particular time and place, or on the features of a phenomenon at a certain time and place (Lange, 2013). This method uses qualitative data (Murchú, 2011), and is longitudinal in nature.

A comparison is now performed between the solution requirements determined in sub-section 2.7 and the solution method options discussed above. Table 7 presents a matrix of this comparison, indicating "Y" for "Yes" if the requirement is met, and "N" for "No" when the requirement is not met.

Table 7: Solution requirements vs methods

	Method	**Decision support (Y/N)**	**Multivariate (Y/N)**	**Comparative case study research (Y/N)**	**Qualitative and quantitative conditions (Y/N)**	**Prioritise the effect of conditions (Y/N)**	**Sample size: small to medium N (Y/N)**	**Cross-sectional (Y/N)**	**Causal inference (Y/N)**	**Equifinality (Y/N)**	**Formal, systematic, mathematical, transparent, repeatable, structured (Y/N)**	**Counterfactual (Y/N)**
1	Regression	Y	Y	Y	N	N	N	Y	Y	N	Y	N
2	QCA	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
3	Structured literature review	Y	N	Y	N	N	Y	Y	N	N	N	N
4	Granger causality analysis	Y	N	N	N	N	N	N	Y	N	Y	N
5	Basic descriptive statistics	Y	Y	N	N	N	N	Y	N	N	Y	N
6	Comparative historical analysis	Y	Y	Y	N	N	Y	N	Y	Y	N	N

Table 7 indicates that QCA is the most appropriate for this application because it meets all of the specified requirements. To get an idea of how often this method has been applied in UHC research, another keyword search was performed to determine how many documents have discussed the use of QCA when applied to the UHC application. Keyword based searches were used again, searching only Scopus databases. The search phrases are shown in Box 4.

> "qualitative comparative analysis"
>
> AND
>
> "UHC" OR "universal health coverage" OR "universal health care"

Box 4: Keyword search for QCA in UHC

No documents were available from this search at the time of this study, resulting in the conclusion that there is a limited literature on this combination of method and application.

3.4 Conclusion: Comparative Causal Research

In this chapter, a key-word based search has been performed to find documents containing methods that could be used in a study to determine which country conditions theoretically influence UHC outcomes. From the resulting documents it was observed that there was a growth in the literature from 2006 onwards, with a noticeable peak in 2013. The most frequently used methods for comparative causal research were regression, QCA, structured literature reviews, Granger causality analyses, basic descriptive statistics, and comparative historical analyses, of which QCA suited the solution requirements the best.

4 METHODOLOGY TO MODEL THE REAL-WORLD PROBLEM

This chapter will describe the proposed methodology to determine analytically which country conditions influence countries' UHC outcomes. The application of the methodology and its findings will also be discussed.

Sub-section 4.1 will introduce qualitative comparative analysis (QCA), explain what it is used for, what types of QCA exist, and what the limitations are within the QCA methodology. Sub-section 4.2 will continue to develop a methodology to determine which country contextual conditions influence a UHC outcome using QCA. QCA is also applied in sub-section 4.2 to an example of how to determine which country conditions influence a UHC outcome. Sub-section 4.3 will discuss the results and findings after applying the methodology, and sub-section 4.4 concludes the chapter.

4.1 QCA INTRODUCTION

In the previous chapter, QCA was selected as the preferred method to determine analytically which country conditions produce a positive UHC outcome. This sub-section continues to explain what QCA is and what it is used for, indicates the types of QCA that currently exist, and also notes the limitations of the QCA methodology that need to be taken into account.

Baptist & Befani (2015) describe QCA as a rigorous method for assessing impact. It is a case study research method that aims to transcend the qualitative/quantitative divide (Thomas *et al.*, 2014) by using Boolean set logic to highlight trends in the specific combination of conditions that produce a given outcome of interest.

QCA is a non-probabilistic method that acknowledges that different paths can lead to the same outcome. Rihoux and Ragin (2009) explain that QCA can be used in the following ways:

i. To summarise data by compacting and synthesising it, allowing for descriptive analytics;

ii. To check the coherence of data by highlighting cases that have similar conditions but different outcomes;

iii. To check hypotheses by indicating whether theories can be falsified or corroborated;

iv. To test conjectures by allowing researchers to test a part of a theory; and

v. To develop new theoretical arguments.

QCA also does not assume permanent causality, uniformity of causal effects, unit homogeneity, additivity, or causal symmetry (Rihoux & Ragin, 2009) such as one would find in conventional statistical causal analyses. Four types of QCA currently exist, including (Thiem and Dusa, 2013):

i. Crisp set QCA (csQCA): a QCA method that treats variables as binary.

ii. Fuzzy set QCA (fsQCA): a QCA method that supports ordinal variables.

iii. Multi-value QCA (mvQCA): a QCA method that supports multinomial variables.

iv. Temporal QCA (tQCA): a QCA method that supports longitudinal data.

Crisp and fuzzy sets will be briefly compared in order to motivate which type will be used during the method application. The crisp-set technique was the first development in QCA, while the fuzzy-set technique was an extension of the crisp-set technique (Ragin, 2000) that effectively enhanced the value that QCA offers to the researcher. Fuzzy sets allow partial membership in a category for both the variables and the outcome, whereas crisp sets assign only a dichotomous membership (Stokke, 2007). As an example: when looking at using democracy in this study, the crisp-set technique helps the researcher to decide whether or not democracy exists, whereas the fuzzy-set technique enables the researcher to understand the degree to which it exists in a given case.

The fuzzy-set technique is therefore far richer than the crisp-set technique, because many real-world problems are not dichotomous; because some empirical information gets lost during the dichotomisation process; because a variable's relative strength is oversimplified; and because the analysis is more sensitive with dichotomous data (Wagemann, 2013). The fuzzy-set technique is, however, far more complex than the crisp-set technique, and dichotomous data is often easier to understand and explain (Wagemann, 2013).

The QCA method typically suffers from some limitations that are briefly discussed in the light of work done by Berg-Schlosser (2016).

- Over-determination concerns the ability of the analyst to generalise an outcome with the number of observations at hand. An analysis is over-determined when the degrees of freedom of that analysis are negative, with the degrees of freedom being the **"number of cases minus the number of explanatory variables minus 1".** This over-determined analysis cannot conclude any causation, according to Campbell (1975), and this is something that needs to be guarded against. By increasing the number of observations, the analyst increases the ability to regulate variation, and eventually the analysis may graduate to a statistical analysis (Berg-Schlosser, 2016). This phenomenon is also called limited diversity.
- Sampling bias creeps in as a result of using case selections rather than a statistical design's random sampling. In essence, this implies that the analyst selects only cases that support their theory, making the experiment inherently biased and causing incorrect inferences to be made about the rest of the untested population.
- Not limited to QCA, but also to most causality studies, is the fact that a mathematical model will only consider conditions that were put into the mathematical model.
- QCA does not identify causal relationships between conditions and an outcome, but rather identifies empirical connections.
- As mentioned below in 4.2, the results generated by QCA could be theoretically meaningless, and should be sense checked.

This sub-section provided a brief introduction to what QCA is, what it is used for, which types of QCA exist, and the limitations of QCA that need to be considered. In the next sub-section a discussion follows on how the QCA methodology is applied by using an example.

4.2 QCA METHODOLOGY AND APPLICATION

This sub-section will detail how to apply QCA, and will exemplify the methodology by applying it to determine which combination of country conditions are necessary – but, more importantly, are sufficient – to produce a positive UHC outcome.

When applying the QCA methodology, four phases are proposed, as shown in Figure 18. There are four high-level phases through which the research has to progress: (i) design, (ii) condition, (iii) analysis, and (iv) interpretation and validation of results. It should be noted that the design phase of this UHC application has in essence already been completed, and reference will be made to the prior chapters where readers can understand how to perform these design steps.

The design phase is described in sub-section 4.2.1, and details how the method is configured. An evaluation question is designed that clarifies why research is required and what the research question is. Sub-section 4.2.2 selects the unit of analysis; this step is taken to understand the appropriate level by which to compare by, given that QCA is a comparative method.

Sub-section 4.2.3 selects an outcome variable and gathers data, defining which variable the researcher wants to influence and then gathering this data. Sub-section 4.2.4 selects the condition variable and gathers its data, to understand which variables are suspected influencers of the outcome, and to gather their corresponding data.

The condition phase contains only one step, in sub-section 4.2.5, which calibrates variables into more appropriate comparable variables in preparation for analysis.

The analysis phase begins with the construction of a truth table in sub-section 4.2.6. Given the relatively high number of variables, the analysis is broken down into a two-step analysis. Sub-section 4.2.7 performs the necessity analysis for step one, and sub-section 4.2.8 performs the corresponding sufficiency analysis using fuzzy minimisation. Thereafter sub-section 4.2.9 performs step two's necessity analysis, and sub-section 4.2.10 its corresponding sufficiency analysis using fuzzy minimisation.

The interpretation and validation phase discusses the necessity findings of the analysis in sub-section 4.2.11 and the sufficiency findings in sub-section 4.2.12.

The importance of sense-checking and understanding of the cases needs to be highlighted at this point. Legewie (2013) makes it clear that, when trying to determine whether a causal relationship exists between a set of conditions and an outcome, then one first needs to determine these potential links systematically (with something like QCA, perhaps); second, one needs to explain the links through performing within-case-analysis to confirm or deny the links. This is why it is important to have an understanding of the cases that the researcher is investigating, and to validate the results. Dusa (2007) also warns that, when applying the results produced by QCA mechanically, they may be theoretically meaningless; and so Dusa proposes that the results of QCA analysis should be considered alongside logic.

For this reason, phase four includes multiple validation steps to sense-check the validity of the findings. QCA often include within-case discussions that validate results by sense-checking the results found during analysis with the cases under investigation, as seen in sub-section 4.2.14. An additional validation step is added that is not usually seen in these types of analysis: a cross validation with regression analysis. The regression analysis is performed in sub-section 4.2.13, to understand whether regression analysis highlights a similar correlation to the causal links found between the conditions and the outcome in QCA.

All calibration and analysis steps are performed with the software program R Studio, using the package "QCA" (Dusa, 2018b). The four phases, originally proposed by Devers *et al.* (2013) but adapted for the UHC application, will be discussed in more detail in the paragraphs below.

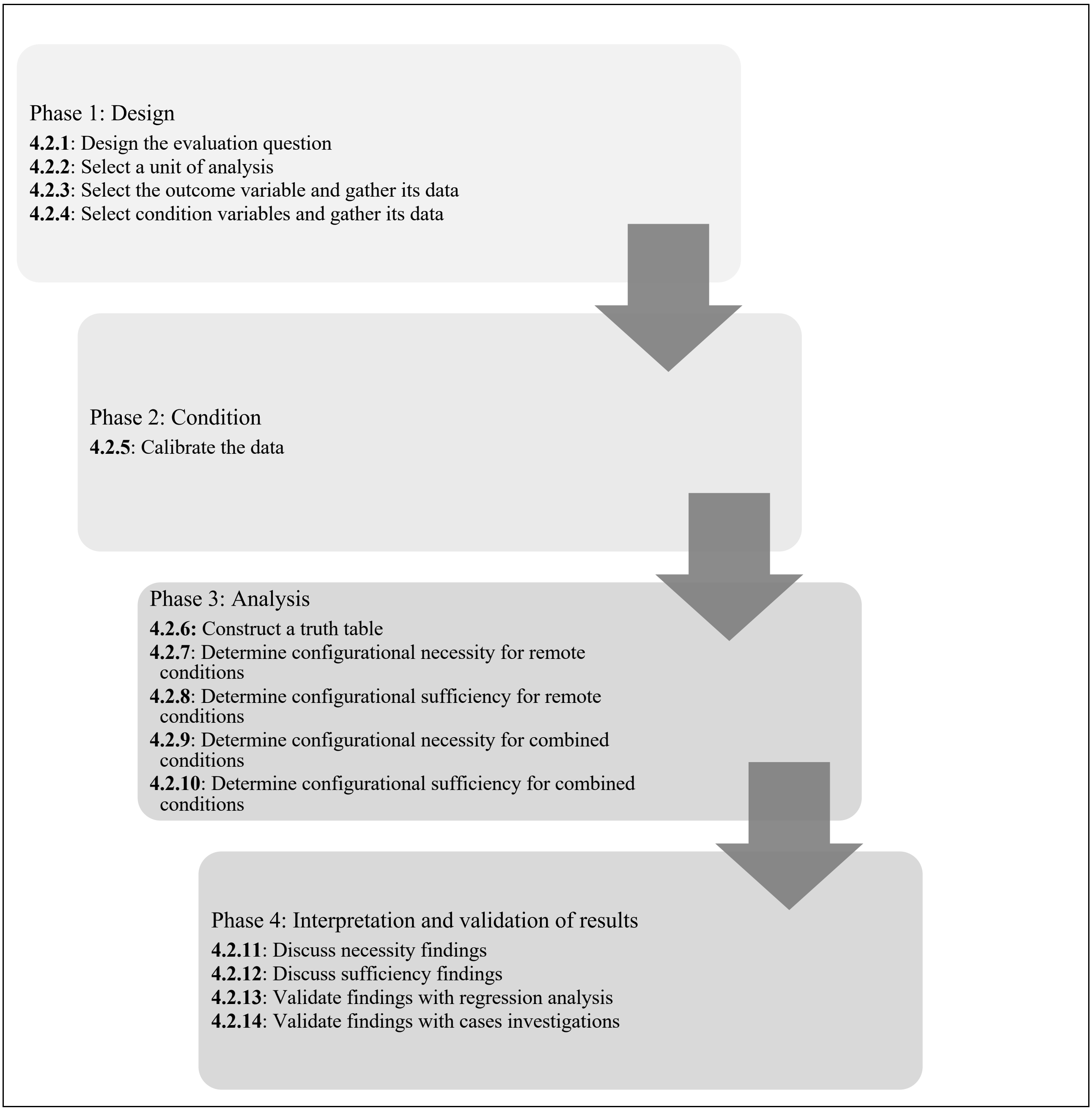

Figure 18: QCA methodology steps (adapted from Devers *et al.*, 2013)

PHASE 1: DESIGN

4.2.1 DESIGN THE EVALUATION QUESTION

The design phase starts by clarifying exactly why the study is required and what the outcome of the analysis must be, effectively defining success criteria for the analysis.

When applying QCA to the UHC research application at hand, the reason for determining which conditions influence the UHC outcome was discussed in sub-section 1.1 and sub-section 1.2. In sub-section 1.1 the recent drive to achieve UHC was described providing a background for the QCA application. Sub-section 1.2 noted that UHC implementation can be quite transformational for countries and there is then a need for an understanding of the relationship between country conditions and UHC outcomes using a structured repeatable approach.

The outcome of the analysis should then be to determine which conditions and combinations of conditions influence UHC outcomes across different countries, in order to offer decision support to policy-makers operating within the health system space of a country. Decision support is offered to countries for the configuration of conditions under their control, and the management of conditions outside of their control. The method would be deemed successful if it highlighted the conditions that are sufficient for a certain UHC outcome, and if these conditions confirmed logical expectations that made sense to the researchers and policy-makers.

4.2.2 Select a unit of analysis

The unit of analysis of a QCA study is based on the nature of the research, the availability of data, and the outcome selected (Devers *et al.*, 2013). In selecting the cases, should the number of cases be too large, it is difficult to become familiar with these cases and to perform logic sense checks. When the number of cases is too small (typically below 10, according to Schneider and Wagemann (2012)) the number of counterfactuals tends to be high, which means that combinations of conditions could end up only covering one case each (Schneider and Wagemann, 2012). Counterfactuals are those combinations of conditions in the truth table that have not been observed, but that are also theoretically possible options.

From exposure to the UHC literature, one can observe that UHC implementation is typically performed at a country level, and thus data on contextual circumstances is more readily available at the same level. Therefore, this research inquiry will compare the contextual circumstances and interventions of countries that have committed to implementing UHC at a national level.

For the example application of QCA, the specific cases to be used will be the same as those discussed in sub-section 2.5, as this was deemed a rigorous approach to selecting countries that have formally committed to achieving UHC. Recall that the 51 countries discussed in sub-section 2.5 adhere to the EFC index, which indicates a commitment towards the achievement of UHC. Thus these 51 countries will be used in the example application of the method.

4.2.3 Select the outcome variable and gather its data

Selecting the outcome variable is part of designing the evaluation question. It is the variable that is most important for the researcher to understand and explain. In traditional statistics, this variable would be known as the dependent variable.

The outcome variables to be used in this research were discussed in sub-section 2.4. As mentioned there, multiple outcomes (referred to as extended UHC outcomes) are measured to evaluate UHC achievement; however, there is also a composite measure that is suggested for the QCA application. The composite cross-national data variable that tracks UHC achievement is called the UHC service coverage index (UHC Service Coverage Index, 2015). The details of the outcome variable data are summarised in Table 8.

Table 8: Output variable selected

Outcome variable	**UHC outcome achievement**
Representative data variable	UHC service coverage index (UHC)
Abbreviation	UHC
Year	2015
Citation	(*UHC Service Coverage Index*, 2015)
Variable Type	Ratio

4.2.4 SELECT CONDITION VARIABLES AND GATHER ITS DATA

The condition variables are equivalent to independent variables in traditional statistics. Devers *et al.* (2013) note that a major challenge is often that the researchers end up with too many condition variables, which typically causes a limited diversity problem. Devers *et al.* (2013) recommend countering this abundance of conditions by using assumptions based on existing theories and research findings to reduce the number of condition variables. Ragin (2008) recommends that the number of causal conditions range between three and eight when applying QCA.

For the application of this research inquiry, conditions influencing UHC outcomes were discussed in sub-section 2.6, where details were provided on the conditions that influence UHC outcomes according to the existing literature. Only conditions that were present across more than one of the extended UHC outcomes listed in sub-section 2.6 were selected for inclusion in the analysis. This set of condition variables is depicted in Figure 19. The conditions across each of the extended UHC outcomes can be seen in APPENDIX A. Figure 19 also shows the categorisation of the condition variables into the different conditions that one finds in a health system, in line with the discussion accompanying Figure 4.

The data for these theoretical variables is collected next. As shown in Table 9, a representative data variable was selected for each condition variable, based on cross-national data that is publicly available from a reputable source. The rationale for selecting each representative data variable is also provided in Table 9, along with the variable type provided in the data. Because the outcome variable data source was only available for 2015, the condition variable data sources were also selected for this year or the closest year available. The raw dataset for the condition and outcome variable, per country, is included in APPENDIX B. Four variables are excluded from the rest of the analysis mentioned in Table 9 below. At the time of this study no cross-national data was available on a legitimate source for the first three variables that were excluded, namely "Control programmes", "Health education", and "Information system". The fourth variable that was excluded is called "Regulated/policy". This variable was excluded because, as part of the EFC index, a country has to have legislation to give effect to UHC, and thus it is assumed that all cases included would inherently have regulations or policies for UHC.

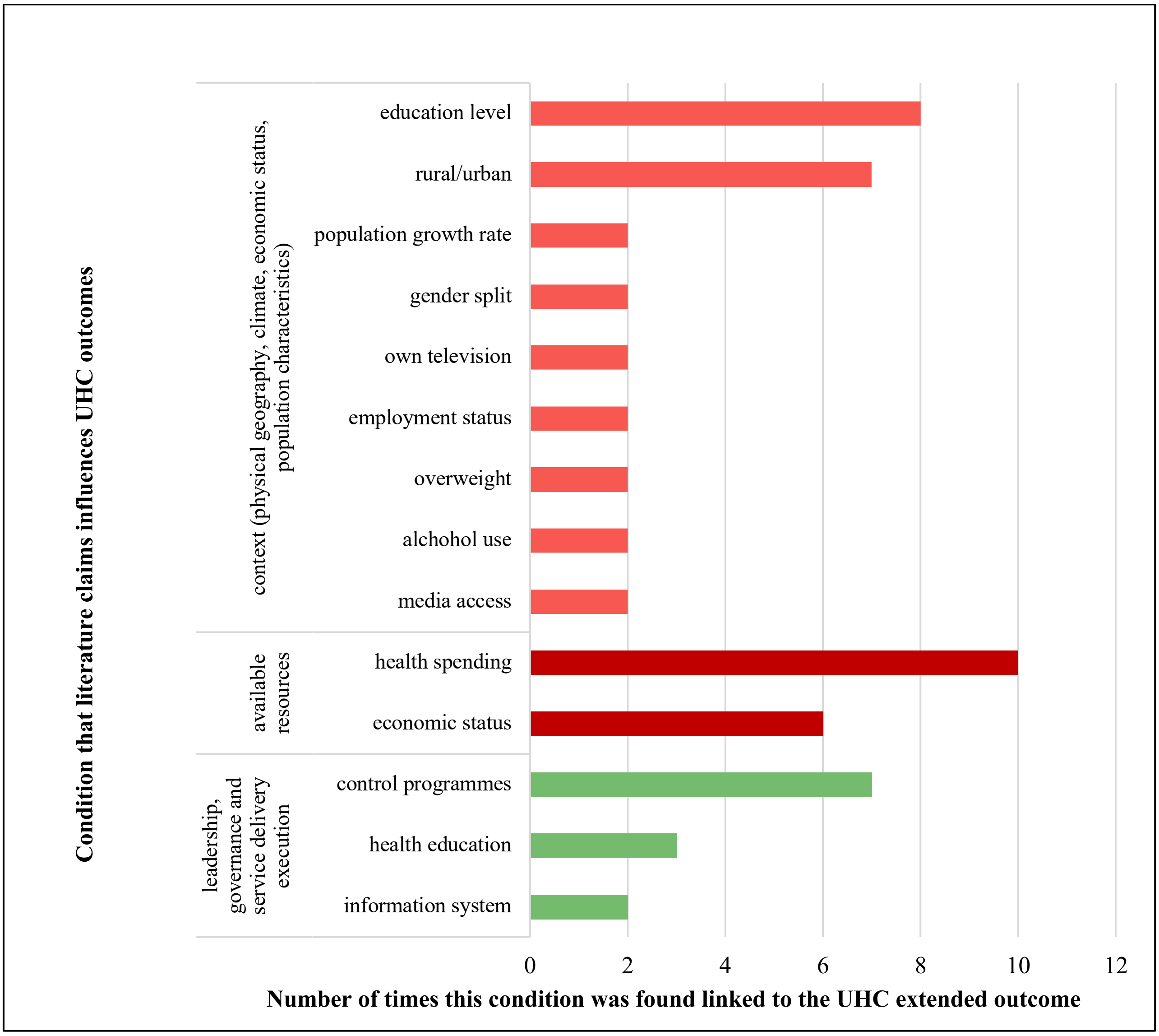

Figure 19: Theoretical conditions that were present over multiple UHC extended outcomes.

At this point it needs to be noted that in considering the outcome and condition variables, it was determined that a combination of fuzzy set QCA and multi-value QCA would be used for the application of the methodology in this research inquiry. Also, given the nature of the data to be studied, the research should understand the degree to which a condition influences an outcome, and not just whether it does or does not influence it (as in crisp-set QCA). There is also a multi-value variable in the data; and therefore some multi-value QCA (mvQCA) is required. The analysis will be cross-sectional in nature, as sufficient data is not yet available to complete a longitudinal QCA study, using tQCA, for the UHC application.

Gathering the condition variable data is the last step of the design phase. The next phase will condition the variables that were gathered in this sub-section in preparation for analysis.

Table 9: Condition variables selected and data sources

Condition variable	Representative data variable	Variable Type	Abbreviation	Year	Reasoning for selection	Citation
education level	Adult literacy rate, population 15+ years, both sexes (%)	Ratio variable	LIT	2011	Adult literacy is the most basic data that gives an idea of basic education.	(UNESCO Institute for Statistics, 2014)
education level	Gross enrolment ratio, tertiary, both sexes (%)	Ratio variable	TER	2014	Tertiary enrolment rate gives an idea of more specialised education.	(World Bank, 2014)
rural/urban	Urban population (% of total)	Ratio variable	URB	2015	Widely accepted by development organisations, and an almost exact dataset was found that matches the variable type required.	(United Nations Population Division, 2014)
population growth	Fertility rate	Ratio variable	FAM	2015	Fertility rate was selected instead of population growth rate because more guidelines for thresholds selection for calibration were available, which will be described in sub-section 4.2.5.	(United Nations Population Division, 2017)
gender split	Population, female (% of total)	Ratio variable	GEN	2015	This dataset indicates what proportion of the population is female, and was therefore deemed appropriate.	(Female population % of total, 2015)
own television	TV households, (% of all households)	Ratio variable	TEL	2012	This dataset was one of the few that provided some form of information about what portion of the population owns a television.	(TV Households, Percent all Households, 2012)
employment status	Employment-to-population ratio – International Labour Organization (ILO) modelled estimates (%)	Ratio variable	EMP	2015	This dataset provides a measure of what part of the population is employed, and is comparable ,and provided an idea of employment status of a country.	(International Labour Organization, 2017)
overweight population	Prevalence of obesity among adults, BMI & >=18+ years	Ratio variable	OBE	2015	This is the most popular overweight statistic; it is not banded, and is available from a reliable source.	(World Health Organization, 2016)

Type of variable required	Variable selected from public data source		Abbreviation	Year	Reasoning for selection	Citation
alcohol use	Total alcohol consumption per capita (litres of pure alcohol, projected estimates, 15+ years of age) (2015)	Continuous variable	ALC	2016	This dataset is straightforward and comparable, providing a view of how much alcohol the population of a country uses.	(World Health Organization, 2016a)
media access	Network readiness	Interval variable	NET	2015	This measures to what level countries exploit the opportunities offered by information and communications technology (ICT) to drive the country's well-being.	(World Economic Forum, 2015)
health spending	Health expenditure, total % of gross domestic product (GDP)	Ratio variable	HEA	2014	This dataset provides a view of what % of the GDP is spent on health, which shows what importance health enjoys in the population.	(World Health Organisation, 2014)
Economic status	Country classification	Ordinal variable	CLA	2014	This is a popular measure for economic status of a country, and is based on its gross national income (GNI).	(UN, 2014)
Control programmes					No comparable data available	
Health education					No comparable data available	
Information system					No comparable data available	
Regulated/policy					Cases were selected on this basis, so that all cases will have the same value for this condition. It is therefore disregarded.	

4.2.5 Calibrate the variables

Social science interventions and phenomena are difficult to measure because they are often of a qualitative nature (Dusa *et al.*, 2018). For example, how does one measure the extent to which a country is democratic or not? For this reason, variables are calibrated. The calibration of variables assists in the process of making variables absolute in order for them to be comparable and measurable in absolute terms (Dusa *et al.*, 2018). Calibration thus implies adjusting variables to conform to a known standard with the purpose of making the variable comparable with other variables that were not comparable before (Ragin, 2000). Ragin illustrates this concept with an example of measuring temperature with an uncalibrated unit. Doing so can tell one that one temperature is relatively higher or lower than another, but not whether that temperature is hot or cold in absolute terms.

Dușa (2017) defines six ways to calibrate variables: crisp recoding, direct assignment, direct method for s-shaped functions, direct method for bell-shaped functions, totally fuzzy and relative (TFR), and indirect assignment. These methods of calibration are summarised in Table 10 below. By using these calibration guidelines, one can investigate the data for any given application and select the appropriate calibration technique accordingly.

The data that has been selected to represent the outcome variable and the condition variables is now prepared for calibration. The combined dataset containing the condition and outcome datasets in one table is shown in APPENDIX B. The raw data table contains (i) the 51 countries (as selected in Table 3), (ii) the outcome measure, and (iii) the 12 condition variable measures (as discussed in Table 9).

Table 10: Calibration methods (reproduced from Dușa, 2017)

Calibration technique	Appropriate for which variable type?	Description
Crisp recoding	All variable types can be converted to this; most appropriate for nominal and small value ordinal variables.	Crisp calibration implies the recoding of a variable into discrete new values that typically produce binary or multi-value membership scores. For example, when selecting two thresholds based on theory for the adult literacy rate in a country, namely 75% and 90%, 0-74% would receive a score of 0, 75-89% would receive a score of 1. and 90% and above would receive a score of two. This method can also be used for categorical variables, excluding Likert scales, which are described later in this table.

Calibration technique	Variable type	Description
Direct assignment	Interval and ratio	This method requires an expert to select membership thresholds based on their expert knowledge. This does imply that this method is highly subjective, and replicating its results may be a challenge. For example, the expert may decide that the range 0-74% would receive a score of 0, 75-89% would receive a score of 0.5, and 90% and above would receive a score of 1. This makes the scores seem fuzzy. This method is not recommended.
Direct method, s-shaped functions	Interval and ratio	S-shaped here implies that the distribution of the raw data against the calibrated values continues to increase as the other also increases. Thresholds are also selected, based (preferably) on a theoretical understanding of the data and the membership scores translated according to the selected thresholds. This method assumes that raw and calibrated data are not linearly related to each other, but follow a logistic distribution and hence the s-shape. With R's calibrate() function, logistic distribution is the default function that can be replaced with a number of other functions if the default is not sufficient; see Thomann, Oana and Wittwer (2018) for more detail. Three thresholds have to be identified for this calibration type: an inclusion anchor, a cross-over anchor, and an exclusion anchor.
Direct method bell-shaped functions	Interval and ratio	Bell-shaped here implies that, when plotting the raw data against the calibrated values, as the raw data increases the calibrated data also increases up to a point, and then decreases again. For example, when specifying 'moderately developed' as the inclusion criterion, then 'underdeveloped' and 'highly developed' should receive low membership ratings. When using R's calibrate() function to complete fuzzy calibration of this kind, there are six thresholds: two inclusion anchors, two cross-over anchors, and two exclusion anchors.

Calibration technique	Variable type	Description
TFR	Ordinal variables with high numbers (>=7 scales), such as Likert scales	For ordinal Likert-type variables that have at least seven scales, Cheli and Bruno (1995) propose an approach called totally fuzzy and relative (TFR), which uses an empirical cumulative distribution function that is transformed to remain between 0 and 1 when the data is skewed.
Indirect assignment	Interval and ratio	This method is appropriate when the data has multiple levels of defined qualitative degrees, but is still numeric, and one wants to calibrate them into a fuzzy set. The indirect method consists mainly of two steps: (1) recoding variables, and (2) numerical transformation of the recoded variable using the original interval scale of the raw data. In step 1, Ragin (2008) recommends recoding to these qualitative categories: 1 - Completely in the set 0.8 - Mostly but not completely in the set 0.6 - More in than out of the set 0.4 - More out than in the set 0.2 - Mostly but not completely out of the set 0 - Completely out of the set Step 2 uses regression techniques to regress the estimates compiled in Step 1 on the raw data using a fractional logit model to determine predicted set membership scores.

There are still some incomplete cases at this stage – namely, outcomes variables that are blank, and condition variables that contain missing data and that need to be managed before calibration. According to Rohwer (2011) there are, at a high level, two ways to handle missing data. The first includes assuming values for the missing data, and the second option is to remove variables that contain missing data. The latter option, called the 'do not care' approach, is recommended by Rohwer (2011) as the "prudent strategy" because it does not risk making incorrect assumptions.

In applying the "prudent strategy", the steps below are used to clean the dataset:

i. Countries that have no available outcome variables are removed, decreasing the country count to 45. This is a logical first step, given that QCA cannot be performed without the outcome variable (although it can be performed without some of the condition variables).

ii. Next, all condition variables that are missing one or more observations are removed. Condition variables are removed, not cases, because it is important to try to keep as many cases as possible to ensure that the sample is sufficiently representative, and also to keep conditions low enough to prevent an overdetermined model. The variables removed in this step included NET, TEL, TER, and LIT[3] (see Table 10), decreasing the number of condition variables to eight.

The cleaned data is now ready for calibration. Some interesting initial observations in this dataset are that the UHC outcome variable seems to range between 60% and 80% for most countries. There are also mostly high-income countries in this set. Values before calibration for the UHC outcome variable range between 60-80% for most countries, and there are mostly high-income countries in the data set.

This dataset now needs to be calibrated to set membership scores using the guidelines discussed in Table 10.

Each variable was investigated to understand which of these calibration methods would be appropriate. For each variable, a set of details were determined similar to the detail seen in Table 11 for high employment-to-population ratio. Note that the descriptive naming of the calibrated variables includes the expected direction that is perceived as having a positive effect on the UHC outcome for that variable – e.g., low obesity and high health spending is expected to lead to positive health outcomes. Table 11 shows the calibration details of the high employment-to-population ratio; the calibration details of the other variables can be seen in APPENDIX C. These tables detail the selected thresholds and the reasoning behind the selected thresholds; the calibration method, and the reasons for its selection; whether the variable is remote or proximate (a concept described in sub-section 4.2.6); and some other descriptive details. Very importantly, the calibration details tables also show a screen shot of the calibration performed in R Studio, which includes a distribution of the data and the thresholds overlaid on the distribution.

Most of the variables were calibrated using the direct method of calibration. With regard to this method, Dușa (2017) mentions that there is no empirical evidence yet that spending effort on finding the exact correct calibration function actually makes a significant difference when using the same thresholds. He mentions that using the default logistic function (for s-shaped functions) is the simplest option for all QCA applications. This, therefore, is the default function that is used wherever appropriate. R Studio has a QCA graphical user interface that was used to perform the calibration.

Where theoretical information is not available to establish thresholds to calibrate variables, Devers *et al.* (2013) suggest understanding whether there is obvious clustering in the data and, as a last resort, using mechanical statistics such as mean or median. R has a function that performs clustering called findTH() that is used for QCA. It uses hierarchical clustering to suggest thresholds for calibration (Dusa, 2018a). The R documentation describing hierarchical clustering used by the findTH() function (Murtagh and Contreras, 2012) specifies that hierarchical clustering initially assigns each object as its own cluster, and then calculates the distance between clusters and groups objects that are most similar. This method was used to calculate thresholds when there was an absence of theoretical knowledge to substantiate these thresholds.

For the high employment-to-population ratio in Table 11 thresholds were selected based on a piece of literature that had also calibrated this variable as an inclusion (i) of 80% and an exclusion (e) of 40%. No cross-over threshold had been defined yet in the literature, and for this reason R Studio's threshold selector was used. The summarised calibrated variables can be seen in APPENDIX D.

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[3] NET – Network readiness

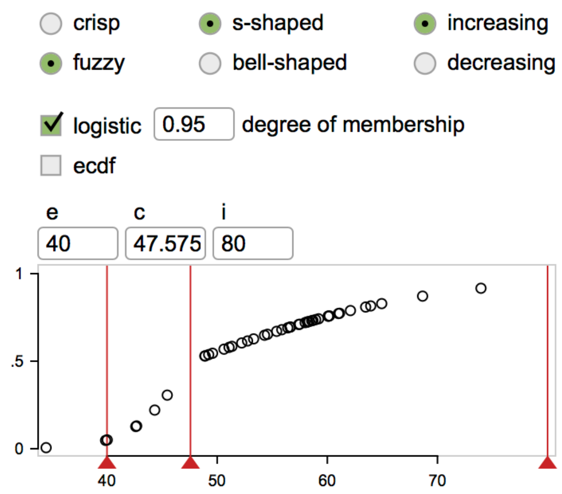
TEL - TV households, percentage of all households

TER - Gross enrolment ratio, tertiary, both sexes (%)

LIT - Adult literacy rate, population 15+ years, both sexes (%)

Subsequent to all variables being calibrated, the next step is to present the calibrated variables in a truth table, which marks the start of the analysis phase.

Table 11: Calibration of high employment-to-population ratio

<table>
<tr><td>Variable description</td><td colspan="2">High employment-to-population ratio – ILO modelled estimates (%)</td></tr>
<tr><td>Threshold selection reasoning</td><td colspan="2">Campagnolo and Carraro (2015) used an exclusion (e) and inclusion (i) threshold for a similar calibration exercise; these same thresholds were used. Exclusion was adjusted from 40% to 40.43% in order to prevent overlap with a variable. R’s threshold finder was used for the cross-over (c).</td></tr>
<tr><td>Calibration technique</td><td colspan="2">Direct method for increasing s-shaped functions was used because of this variable’s distribution, which causes it to be more included in membership as the variable’s value increases.</td></tr>
<tr><td>Remote/Proximate</td><td>Remote</td><td rowspan="4">
</td></tr>
<tr><td>Abbreviation</td><td>EMP_NEW</td></tr>
<tr><td>Variable type</td><td>Ratio</td></tr>
<tr><td>Thresholds</td><td>e = 40%
c = 47.575%
i = 80%</td></tr>
</table>

PHASE 3: ANALYSIS

4.2.6 CONSTRUCT THE RAW TRUTH TABLE

The analysis phase begins with the construction of a truth table – a recognised analytical procedure used in electrical engineering for the analysis of circuits, made popular by Claude Shannon (1940) at MIT. It is the central analytic device in QCA (Devers *et al.*, 2013), and is in essence a table that summarises the combinations of conditions, showing which cases have the same configurations and where any contradictions exist. The truth table aims to highlight connections between conditions and outcomes (Ragin, 2008). According to Dusa *et al.* (2018), the fuzzy minimisation procedure starts by transforming fuzzy calibrated datasets into crisp truth tables. ‘Fuzzy minimisation’ here refers to the analytical process to determine sufficiency in QCA, and starts with the construction of a truth table. This chapter will continue by describing how the truth table is interpreted, and will then explain what ‘necessity’ is in sub-section 4.2.7 and 4.2.9, and ‘sufficiency’ in sub-section 4.2.8 and 1.1.1. The application of these subsequent steps will also be shown.

Table 12: Example truth table

Configuration	A	B	C	n	Out	Inclusion	PRI	Cases
i	1	1	1	1	1	0.9	0.7	a
ii	1	1	0	4	0	0.8	0.7	b, c, d, e
iii	1	0	1	2	1	0.8	0.7	f, g
iv	0	1	1	0	?	?	0	
v	1	0	0	1	0	0.4	0	h
vi	0	1	0	3	0	0.33	0	i, j, k
vii	0	0	1	0	?	?	0	
viii	0	0	0	1	0	0.2	0	l

Table 12 is an example truth table that will be used to clarify how truth tables work. Each row in the truth table represents one of the possible combinations of conditions (here, conditions are depicted by capitalised A, B, and C) that a configuration could have, and that configuration's output, depicted by 'Out'. The 'Out' value is assigned '1' if there is perfect inclusion, and '0' if there is no inclusion. For fuzzy sets, 'n' is the number of cases found for a specific configuration, and 'Cases' explains which cases those were.

For fuzzy analysis, conditions A, B, and C are depicted as '1' if their calibrated value is higher than 0.5, and as '0' if it was below that. Variables must not fall on the 0.5 point.

'Inclusion' measures how consistent a certain configuration of conditions was for an outcome, and is calculated by determining which portion of outcome Y was found in the condition/s X. It is calculated in the same way as the sufficiency inclusion (Equation 3), where X is replaced by the inclusion scores of the cases in that particular combination only.

In truth table minimisation, an inclusion cut-off is selected; and whenever the inclusion value is higher than this threshold, the output value is indicated as '1' and '0' if it is below this cut-off (Schneider and Grofman, 2006). Wherever the output indicates a '?' it means that this configuration was not observed and is a logical remainder, also known as a counterfactual. The output value in the truth table is not the same as the outcome value in the original dataset.

The PRI score seen in the truth table is described in sub-section 4.2.8 below.

The raw truth table for the UHC application, using the calibrated variables from the previous step, can be seen in APPENDIX E. The resulting truth table contains eight causal conditions and 128 rows (of which 13 have positive output – i.e., above 0.5, and 11 have negative output of below 0.5, and 104 are counterfactuals). As an example, when looking at the first row of the truth table in APPENDIX E, the presence of employment to population ratio, low gen, high health spending, highly developed country classification of 3, highly urbanised, high obesity, and high alcohol use were often present when a positive UHC outcome was also present. Six cases like this were observed, and they had an inclusion score of 0.949, which is higher than our inclusion cut-off; and thus, the OUT value is assigned '1'.

As mentioned in sub-section 0, Ragin (2008) recommends that causal conditions be in the range of three to eight when applying QCA. For the UHC example there are currently eight condition variables; and after some initial test iterations of the analysis on the eight conditions, it was found that the solution produced with eight conditions is extremely complex, indicating a high limited diversity. The analysis for the UHC application will therefore be conducted in a two-step approach similar to the one performed by Schneider and Wagemann (2006).

The two-step analysis implies performing a first round of necessity and sufficiency analyses with only the remote conditions. The significant remote conditions are then retained and added to the proximate condition for round two of the analysis. This helps the researcher to keep the number of conditions low throughout the analysis.

The conditions will be categorised as either remote or proximate variables. Remote variables refer to contextual conditions that exist in a country but for which there is no visible link to the outcome variable; an example is the employment status in a country, which does not have a clear link to health care outcomes in a country. Although the literature suggests that this contextual variable impacts UHC outcomes, there is no visible link between employment status and UHC outcomes. Proximate variables refer to conditions that are easily and quite obviously linked to the outcome – for example, health expenditure can be quite obviously linked to UHC outcomes, because it is also health-related.

Remote conditions will be analysed first; the ones that contribute to sufficiency will then be added to the remote conditions for another round of analysis, keeping the number of conditions as low as possible with each round of analysis. Each of the calibrated variables has been classified as being either remote or proximate, as shown in Table 13. This classification relied on information provided in sub-section 2.6, where simplified health systems themes were discussed. In general, remote variables relate to the country context, and proximate variables relate to the organisation of the health system, the delivery of healthcare, and the resources available to the health system.

Table 13: Remote vs proximate variables

Calibrated variable	Abbreviation	Remote/ Proximate
High employment-to-population ratio – ILO modelled estimates (%) – called 'high employment ratio' for the rest of the study.	EMP_NEW	Remote
Low total alcohol consumption per capita – called 'low alcohol consumption' for the rest of the study.	ALC_NEW	Proximate
High health expenditure, total (% of GDP) – called 'high health spending' for the rest of the study.	HEA_NEW	Proximate
Low prevalence of obesity among adults, BMI & >=18+ years – called 'low obesity' for the rest of the study.	OBE_NEW	Proximate
Sustainable fertility rate	FAM_NEW	Remote
High country classification	CLA_NEW	Remote
High urban population (% of total) – called 'high urban population' for the rest of the study.	URB_NEW	Remote

In this sub-section, the truth table has been compiled and understood. The next sub-section will continue by performing a necessary analysis of the remote conditions.

4.2.7 Configurational necessity for remote conditions

The truth table is the main analytical tool used in the minimisation process that determines the necessity and sufficiency of a solution. This sub-section will first understand what necessity is and how it can be measured, and then apply it to the UHC application. The sub-section to follow will seek to understand sufficiency.

Necessary conditions are those that are so important that the outcome does not occur without them. For example, Skocpol's (1979) research indicates that a social revolution (Y) can only happen in the context of a state breakdown (X). Causal condition X is necessary for the outcome Y, while outcome Y is always present when condition X occurs.

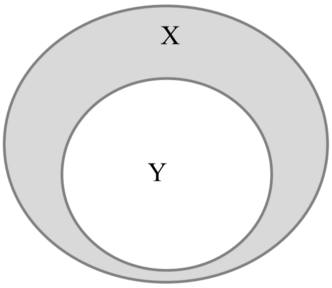


Figure 20: Showing that causal condition X is necessary for outcome Y

The test of necessity needs to be accompanied by the tests for necessity inclusion (also called consistency) and necessity coverage (Siebrits, 2014). Necessity inclusion measures the percentage of the outcome set found in the condition set (when it is a necessary condition) – in other words, the extent to which outcome set Y is included in condition set X (Dusa *et al.*, 2018). Equation 1 shows how necessity inclusion is calculated. A high inclusion measure would imply that, if the combination of conditions were present, then the outcome would also be present.

Equation 1: Fuzzy necessity inclusion

$$inclN_{X \Leftarrow Y} = \frac{X \cap Y}{Y}$$

It is important to accompany the necessity inclusion with the test of coverage, which determines the relevance / triviality of condition X for outcome Y (Schneider and Wagemann, 2010). Figure 21 helps to clarify why it is important to test for relevance when performing necessity analyses.

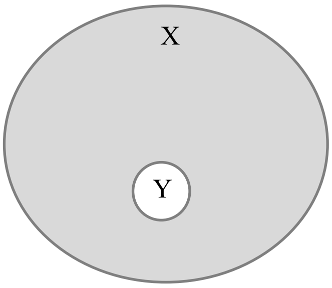


Figure 21: The trivial configuration

covN measures the proportion of the necessary condition/s (X) that is covered by the outcome (Y). It is calculated using the following formula:

Equation 2: Fuzzy coverage

$$covN_{X \Leftarrow Y} = \frac{\sum \min(X, Y)}{\sum X}$$

RoN, on the other hand, measures the relevance of the solution. In considering Figure 22 'trivialness' refers to when the condition is constantly equal to 1 across cases, making it somewhat meaningless (Dusa *et al.*, 2018).

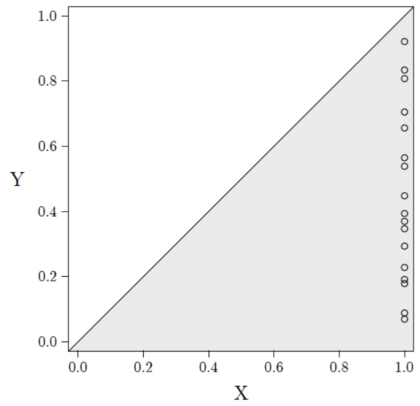


Figure 22: Fuzzy trivialness explained

There are multiple ways to visualise necessity conditions on the outcome with the application data, but Dușa (2017) describes the use of XY plots as a straightforward way of doing this, where the conditions considered to be necessary are seen below the diagonal line. See Figure 23 for an example of a necessity XY plot. In these figures, Y is the outcome and X the condition variable.

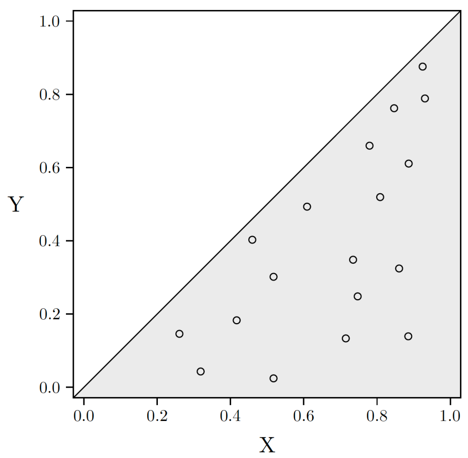


Figure 23: Necessary conditions visualised (adapted from Dusa *et al.*, 2018)

At this point the researcher needs to understand which of these measures of necessity in turn are good enough to be considered significant. Ragin (2008) suggests a benchmark of 0.85 necessity inclusion when identifying strong set relations, while Siebrits (2014) indicates that 0.83 can be considered a high coverage. Dușa (2017) notes that RoN measurement should be higher than 0.6, and that necessity coverage should be higher than 0.6. Table 14 below summarises the benchmarks discussed here for use later in the analysis.

Table 14: Benchmarks for necessity measures

Measure	Benchmark
InclN	Above 0.85
CovN	Above 0.6
RoN	Above 0.6

The configurational necessity for the UHC conditions can be seen in Table 15 below, which only includes the results that were higher than the benchmarks discussed in Table 14 – namely, inclN > 0.85, CovN > 0.6, and RoN > 0.6. Table 15 shows the first results of the UHC application analysis. It is a good place, first, to explain some of the notation used here for QCA. In a configurational solution formula, the conditions that are necessary or sufficient to the outcome are presented in letters that are linked with Boolean algebra, which include the operators logical OR (+) and logical AND (*);the presence of membership in a certain condition is denoted by {1} and its absence by {0}.

Table 15: Configurational necessity for remote conditions[4,5]

	Expression	inclN	RoN	covN
1	EMP_NEW{1}	0.925	0.695	0.727
2	EMP_NEW{1}*URB_NEW{1}	0.891	0.759	0.759
3	GEN_NEW{1}+FAM_NEW{1}+URB_NEW{0}	0.864	0.632	0.662

What the results of the necessity analysis in Table 15 show is that high employment to population (EMP_NEW) potentially produces positive UHC outcomes. Expression 2 does not say more than expression 1, because high employment to population was already necessary on its own. Expression 3 indicates that equal female to male population, or sustainable fertility rate, or the lack of urbanisation produce positive UHC outcomes. The lack of urbanisation is counter-intuitive, and is something that needs to be sense-checked again in the final results.

4.2.8 CONFIGURATIONAL SUFFICIENCY FOR REMOTE CONDITIONS

When looking next at sufficiency, it can be explained that sufficiency is observed when causal condition X is always present when outcome Y occurs, or that X was enough to make Y occur. This phenomenon is visualised in Figure 20 below. The analysis of necessity focuses on finding conditions that are a superset of an outcome, and the analysis of sufficiency focuses on finding conditions that are subsets of an outcome (Leischnig *et al.*, 2018).

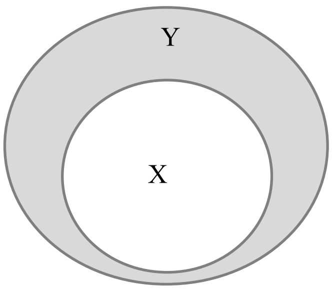


Figure 24: Showing that causal condition X is sufficient for outcome Y.

[4] The variables used in the QCA are the calibrated data; these abbreviations mean: EMP_NEW –Employment-to-population ratio, ALC_NEW – Total alcohol consumption per capita, GEN_NEW – Female percentage of the population, HEA_NEW – Health expenditure as % of total GDP, OBE_NEW – Prevalence of obesity among adults, FAM_NEW – Fertility rate, CLA_NEW – Country classification, URB_NEW – Urban population as % of total, UHC_NEW – Universal health coverage index.

In order to understand which expressions are sufficient, the researcher first needs to perform a procedure called minimisation. Quine (1952), followed by McCluskey (1956), proposed that it is better to specify the simplest possible expression that has the same net effect as all the combined configurations; this is referred to as minimisation. The sufficiency between conditions and an outcome is calculated using truth table minimisation (Thomann, Oana and Wittwer, 2018b).

Truth table minimisation in its most basic format is executed by some combination of the following steps (Dusa *et al.*, 2018):

i. Generate a list of all possible two paired expressions;

ii. Identify where expressions differ by only one element, and minimise that element;

iii. The surviving expressions enter into the next minimisation iteration; and

iv. Repeat until nothing else can be minimised, and one is left with what are called 'prime implicants'. Prime implicants are those expressions that remain after minimisation has been completed, and that cannot be simplified further. Prime implicants turn into the result set of the analysis.

A prime implicants chart can be compiled that indicates which truth table rows contain these prime implicants (Timberlake & Ragin, 1987).

There are three main variations on the minimisation procedure: the conservative / complex solution, the parsimonious solution, and the intermediate solution. The three variations will be applied next in the paragraphs below in an attempt to explain them.

The conservative / complex solution does not allow simplifying assumptions in its application, and as a result it produces a complex result that does not assist in analysis (Legewie, 2013). It contains three basic steps, described below in terms of the UHC example (Dusa *et al.*, 2018):

1. Compile the raw truth table for remote conditions; for the UHC application the raw truth table can be seen in APPENDIX F.

2. Determine and select the case frequency threshold of configurations in the truth table that will be analysed as part of the minimisation process. According to Ragin *et al.* (2008), this frequency selection should capture at least 75-80% of the cases and therefore for this analysis n should be at least 1.

3. Lastly, find the solution expression.

There are then a few measures that can be used to understand whether conditions are sufficient. These will be described briefly before performing the sufficiency analysis. First, the main measure of sufficiency is its inclusion, which can be calculated as seen in Equation 3, and is in effect all the cases where both condition (X) and outcome (Y) occur in all the cases where X occurs.

Equation 3: Fuzzy sufficiency inclusion / consistency

$$inclS_{X \Rightarrow Y} = \frac{X \cap Y}{X}$$

Next, the PRI score measures the phenomenon of simultaneous subset relations, where X appears to be sufficient for Y and the negation of Y, which logically should not be possible; it is calculated with the formula in

Equation 4.

Equation 4: Proportional reduction in inconsistency equation (PRI)

$$PRI = \frac{\sum \min(X,Y) - \sum \min(X,Y,\sim Y)}{\sum X - \sum \min(X,Y,\sim Y)}$$

When the PRI score is smaller than a high inclusion score, but still high (above 0.6), then the tested condition/s are sufficient for Y and not also for its negation (Ragin, 2015).

The raw coverage shows how much of the outcome Y is explained by a condition/s. Raw coverage for sufficiency is calculated with the formula in Equation 5.

Equation 5: Raw coverage equation for sufficiency

$$covS = \frac{\sum \min(Y,X)}{\sum Y}$$

Lastly, the unique coverage shows how much of that explanation can be uniquely attributed specifically to that set. Unique coverage is calculated with the formula in Equation 6.

Equation 6: Unique coverage equation

$$covU_{A \Rightarrow Y} = \frac{\sum \min(Y,A)}{\sum Y} - \frac{\sum \min(Y,A,B)}{\sum Y}$$

Figure 25 explains this concept, where raw coverage is the whole section that A covers (including where B overlaps), and unique coverage is only the section that A covers and excludes B.

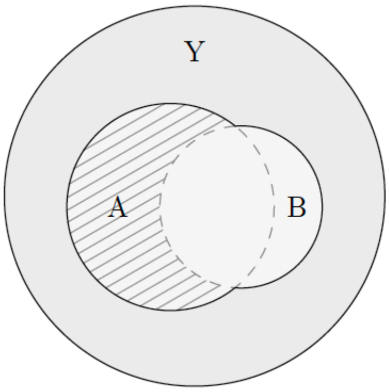


Figure 25: Raw vs unique coverage of sufficiency

Parameters of fit (PoF) measures are named inclS, PRI, and covS, and are used to determine whether the QCA analysis explains something about the conditions that are significant to explain a certain phenomenon (or not).

See Figure 26 for an example of a sufficiency XY plot. In these figures Y is the outcome and X the condition variable.

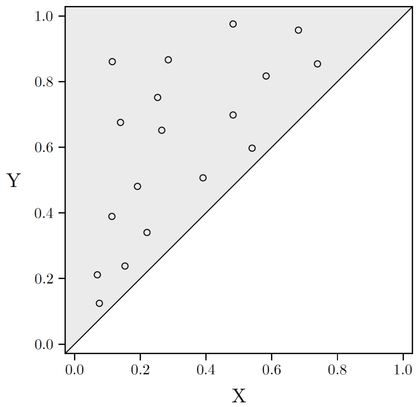


Figure 26: Sufficient conditions visualised (adapted from Dusa *et al.*, 2018)

Similar to the necessity benchmarks, at this point the researcher again needs to understand, when measuring sufficiency, whether it is significant. Similar to the necessity benchmarks, Ragin (2008) suggests a benchmark of 0.85 for sufficiency inclusion, while sufficiency coverage should be higher than 0.6. For PRI, Dușa (2017) notes that 0.5 is low and that PRI therefore needs to be higher than 0.5, but still lower than the related inclusion value. Table 14 below summarises the benchmarks discussed here for use later in the analysis.

Table 16: Benchmarks for sufficiency measures

Measure	Benchmark
InclS	Above 0.85
CovS	Above 0.6
PRI	Above 0.5 but lower than InclS

When applying the conservative algorithm to the UHC application, the output can be seen in Table 17 and Table 18 below. Only expression 1 is close the benchmark PoF range defined in Table 16 (inclS > 0.85, PRI > 0.5 and covS > 0.6). Expression 1 suggests that high employment to population, a developed country classification, and high urbanisation were always present when positive UHC outcomes were present. Twenty-four countries were included in the configuration shown in expression 1 (see Table 18).

Table 17: Conservative solution results with PoF

	Expression	**inclS**	**PRI**	**covS**	**covU**
1	EMP_NEW{1}*CLA_NEW{3} *URB_NEW{1}	0.82	0.58	0.67	0.16
2	EMP_NEW{1}*GEN_NEW{0} *FAM_NEW{0}*CLA_NEW{3}	0.89	0.56	0.38	0.01
3	EMP_NEW{1}*GEN_NEW{1} *FAM_NEW{1}*CLA_NEW{3}	0.95	0.80	0.27	0.01
4	EMP_NEW{1}*GEN_NEW{1} *CLA_NEW{2}*URB_NEW{1}	0.81	0.01	0.06	0.05
5	GEN_NEW{0}*FAM_NEW{0} *CLA_NEW{3}*URB_NEW{1}	0.83	0.46	0.42	0.05
6	EMP_NEW{1}*GEN_NEW{0} *FAM_NEW{0}*CLA_NEW{2}* URB_NEW{0}	0.92	0.01	0.09	0.08
	Solution PoF	0.80	0.52	0.88	

Table 18: Conservative solution with cases

	Expression	Cases
1	EMP_NEW{1}*CLA_NEW{3}*URB_NEW{1}	AUT,HUN,JPN,OMN,PRT,URY, BEL,CZE,EST,FIN,DEU,LVA,CHE, GBR, AUS,IRL,LUX,KOR,SWE, CAN,CHL,DNK,ISL,NOR
2	EMP_NEW{1}*GEN_NEW{0}*FAM_NEW{0}*CLA_NEW{3}	SVK, AUT,HUN,JPN,OMN,PRT,URY
3	EMP_NEW{1}*GEN_NEW{1}*FAM_NEW{1}*CLA_NEW{3}	SVN, CAN,CHL,DNK,ISL,NOR
4	EMP_NEW{1}*GEN_NEW{1}*CLA_NEW{2}*URB_NEW{1}	PAN, CRI
5	GEN_NEW{0}*FAM_NEW{0}*CLA_NEW{3}*URB_NEW{1}	GRC,ITA,ESP, AUT,HUN,JPN,OMN,PRT,URY
6	EMP_NEW{1}*GEN_NEW{0}*FAM_NEW{0}*CLA_NEW{2}*URB_NEW{0}	THA

Since the original solution algorithm designed by Quine and McCluskey, there have been some adjustments to the workings of the minimisation procedure. The original procedure produced a conservative solution; but now there are two other options – the parsimonious and intermediate solutions, and also variations of these (Thomann, Oana and Wittwer, 2018a). These alternative solutions will be calculated next and are based on the assumption that only the presence of the selected causal conditions can contribute to the outcome.

In contrast to the conservative solution, the parsimonious solution includes logical counterfactuals in its analysis without understanding whether or not these counterfactuals have potential sufficiency relationships (Thiem and Dusa, 2013). What this implies is that the unobserved combinations of conditions might be impossible, but that the parsimonious solution includes them mechanically. A scientific approach to dealing with counterfactuals is to perform experiments to generate data for the lack of empirical evidence. However, such experiments are not feasible in the social sciences. The only remaining option, then, is to perform thought experiments in the form of "what if…?" questions, which are executed in the form of counterfactual analysis (Dusa *et al.*, 2018). When calculating the parsimonious solution, all counterfactuals are assumed to contribute equally to the simplifying solution. The parsimonious solution results can be seen in

Table 19 and Table 20.

Table 19: Parsimonious solution results with PoF

	Expression	inclS	PRI	covS	covU
1	CLA_NEW{3}	0.56	0.30	0.75	0.48
2	GEN_NEW{1}*CLA_NEW{2}	0.57	0.00	0.06	0.02
3	EMP_NEW{1}*FAM_NEW{0}*URB_NEW{0}	0.95	0.36	0.42	0.11
	Solution PoF	0.59	0.28	0.92	

Table 20: Parsimonious solution results with cases

	Expression	cases
1	CLA_NEW{3}	GRC,ITA,ESP,SVK,AUT,HUN,JPN,OMN, PRT,URY,BEL,CZE,EST,FIN, DEU,LVA,CHE,GBR,AUS,IRL,LUX, KOR,SWE,SVN,CAN,CHL,DNK,ISL,NOR
2	GEN_NEW{1} *CLA_NEW{2}	PAN,CRI
3	EMP_NEW{1}*FAM_NEW{0}*URB_NEW{0}	THA,SVK

None of the measures of the expressions fall within the benchmark range defined in Table 16 (inclS > 0.8, PRI > 0.6 and covS > 0.6), and for this reason they are not worth considering further.

Lastly, the intermediate solution will be investigated. This solution in effect compares the conservative and the parsimonious solutions by combining their prime implicants matrices using directional expectations (Ragin and Sonnett, 2005). These directional expectations refer to the contribution that causal conditions are supposed to make, given the existing literature or logic (Dusa *et al.*, 2018). For example, it is expected that, for someone to be pregnant, they also need to be female. The directional expectations for the UHC application are defined in Table 21 below. To explain how the directional expectations work, consider the high employment ratio. It is expected that, if the high employment ratio tends to '1', it will have a positive impact on UHC outcomes.

Table 21: Directional expectations for the combined conditions

Calibrated variable	Abbreviation	Directional expectation
High employment ratio	EMP_NEW	1
Equal population, female (% of total)	GEN_NEW	1
Sustainable fertility rate	FAM_NEW	1
High country classification	CLA_NEW	3
High urban population	URB_NEW	1

The intermediate solution also only includes easy counterfactuals (those that do not oppose existing theory about the specific analysis) in the minimisation process (Thiem and Dusa, 2013) by creating directional expectations in the algorithm. The difficult counterfactuals that need to be excluded are those that:

i. Contain logical impossibilities (Dusa *et al.*, 2018) – e.g., someone who is pregnant is also male.

ii. Have contradictory simplifying assumptions that indicate sufficiency for the outcome and for its negation (Rihoux and Ragin, 2009).

iii. Are necessary for the outcome and sufficient for its negation.

These difficult counterfactuals are removed with a function called findRows() in R Studio. The function finds the expressions representing these difficult counterfactuals, and simply excludes them from the minimisation.

The intermediate solution results can be seen in Table 22 and Table 23.

Table 22: Intermediate solution results for remote conditions with PoF

	Expression	inclS	PRI	covS	covU
1	EMP_NEW{1}*CLA_NEW{3}*URB_NEW{1}	0.817	0.581	0.67	-

Table 23: Intermediate solution results for remote conditions with cases

Expression	Cases
EMP_NEW{1}*CLA_NEW{3}*URB_NEW{1}	AUT,HUN,JPN,OMN,PRT,URY;BEL,CZE,EST,FIN,DEU,LVA,CHE,GBR;AUS,IRL,LUX,KOR,SWE;CAN,CHL,DNK,ISL,NOR

The expression found in Table 22 is close to the benchmarks (inclS > 0.85, PRI > 0.5, and covS > 0.6), indicating whether measures are good enough to indicate sufficiency. What the results of the sufficiency analysis for remote conditions suggest is that a combination of high employment ratio, country classification, and high urbanisation was always present when positive UHC outcomes were present. These three conditions were the most prominent in the three solutions (conservative, parsimonious, and intermediate) leading up to this point, and will be included in step two of the two-step approach. It can also be seen that the intermediate solution was in fact the most useful of the three solution types, because it was not as complex as the conservative solution and, unlike the parsimonious solution, it produced useful results.

4.2.9 Configurational necessity for combined conditions

The two-step analysis provides the possibility to perform QCA on fewer conditions at a time, minimising the effect of limited diversity. For this reason, at the end of the first step, the conditions that have been highlighted as potentially important conditions are retained in the truth table and added to the conditions left out in the first step. A new truth table has to be compiled for the second part of the two-step analysis, containing the conditions that were highlighted as potentially important in step one of the analysis, namely EMP_NEW, URB_NEW, and CLA_NEW. Alongside these conditions are added the proximate variables that were excluded initially, as can be seen in Table 13, with the new truth table now containing some remote variables and all the proximate variables seen in APPENDIX K. Configuration necessity was recalculated, and can be seen in The result findings will be discussed in more detail in 4.2.11.

Table 24. The results of the necessity analysis that have measures higher than the benchmarks in Table 14 (inclN > 0.85, CovN > 0.6, and RoN > 0.6) of the combined conditions in step two again suggest that high employment to population (EMP_NEW) potentially produces positive UHC outcomes. The result findings will be discussed in more detail in 4.2.11.

Table 24: Configurational necessity for combined conditions

	Expression	inclN	RoN	covN
1	EMP_NEW{1}	0.925	0.695	0.727
2	OBE_NEW{0}	0.905	0.693	0.717
3	EMP_NEW{1}*URB_NEW{1}	0.891	0.759	0.759
4	EMP_NEW{1}*ALC_NEW{0}	0.897	0.756	0.759
5	HEA_NEW{1}*ALC_NEW{0}	0.857	0.642	0.665
6	URB_NEW{1}*OBE_NEW{0}	0.884	0.75	0.75
7	URB_NEW{1}*ALC_NEW{0}	0.929	0.66	0.706
8	OBE_NEW{0}*ALC_NEW{0}	0.871	0.751	0.746
9	EMP_NEW{1}*URB_NEW{1}*ALC_NEW{0}	0.864	0.806	0.788
10	URB_NEW{1}*OBE_NEW{0}*ALC_NEW{0}	0.85	0.798	0.776

4.2.10 Configurational sufficiency for combination conditions

In this sub-section, the configurational sufficiency will be calculated for the combined conditions. This time only the intermediate solution will be calculated, because the intermediate solution is simpler than the conservative solution and more realistic than the parsimonious solution (Siebrits, 2014), which means it is effectively the most useful of the three. All three of these solutions were calculated in the previous step to introduce them and, as shown in the discussion in sub-section 4.2.8, the conclusion that is reached is in agreement with Siebrit's (2014) finding that the intermediate solution is the most useful. Thus the conservative and parsimonious solutions will not be calculated for the combined conditions.

The directional expectation was set to the values shown in Table 25. All difficult counterfactuals are again excluded, including logical impossibilities, contradictory simplifying assumptions, and expressions that are necessary for the outcome and sufficient for its negation.

Table 25: Directional expectations for the combined conditions

Calibrated variable	**Abbreviation**	**Directional expectation**
High employment ratio	EMP_NEW	1
Low alcohol consumption	ALC_NEW	1
High health spending	HEA_NEW	1
Low obesity	OBE_NEW	1
Sustainable fertility rate	FAM_NEW	1
High country classification	CLA_NEW	3
High urban population	URB_NEW	1

The intermediate solution is presented in Table 26 below. The results indicate a good inclusion but a mediocre coverage. Table 27 corresponds to Table 26 by indicating the cases that are relevant for this expression.

Table 26: Intermediate solution results of combined conditions with PoF

Expression	inclS	PRI	covS	covU
EMP_NEW{1}*HEA_NEW{1}*CLA_NEW{3}*URB_NEW{1}*OBE_NEW{0}	0.902	0.719	0.574	-

Table 27: Intermediate solution results of combined conditions with cases

Expression	cases
EMP_NEW{1}*HEA_NEW{1}*CLA_NEW{3}*URB_NEW{1}*OBE_NEW{0}	AUS,AUT,BEL,CAN,CHL,CZE,DNK,FIN,DEU,HUN,ISL,IRL,LUX,NOR,PRT,SWE,CHE,GBR,URY

The result findings will be discussed in more detail in 0

Given that this is the final solution for this analysis, it is a good point to understand which of the cases are inconsistent in the expression, and which are useful for further discussion. If the expression's consistency / inclusion is set at 0.9, then the expression covers some cases that do not display the outcome and therefore deviate from the general pattern found in the data. It is important to take note of these deviant cases, and to be able to explain them in order to prevent doubts raised about the sufficiency of a solution. Deviant cases should not be confused with difficult counterfactuals, as these are different concepts.

The XY plot can be useful to identify inconsistent cases in the solution set. When considering the generic XY plot in Figure 27, the different cases in the solution set can include the following (Schneider and Rohlfing, 2016):

- Cases in Area 1 in the upper right quadrant, above the diagonal, representing sufficient cases.
- Cases in Area 2 in the upper right quadrant, below the diagonal, indicating the "deviant cases consistency in degree". To explain "deviant cases consistency in degree", it is first useful to recap some basics about fuzzy membership. A fuzzy set membership can range between 0 and 1, and three ranges exist in this membership: cases that have full membership (1), cases that have full non-membership (0), and cases on the cross-over point. Cases on different sides of the cross-over are different in kind, and cases that differ on the same side of the cross-over are different in degree (Legewie, 2013). "Deviant cases consistency in degree" are those cases that have a membership in the UHC outcome that is higher than the cross-over point (0.5), and their membership in the conditions is higher than in the UHC outcome.
- Cases in Area 3 in the lower right quadrant indicate "deviant cases consistency in kind". These cases have a membership in UHC outcome that is lower than the cross-over point (0.5), but they have high membership in the conditions.
- Cases in Area 4, entire lower left quadrant, indicate irrelevant cases.
- Cases in Area 5, upper left quadrant, indicate the deviant cases coverage. These cases have low membership in the conditions.

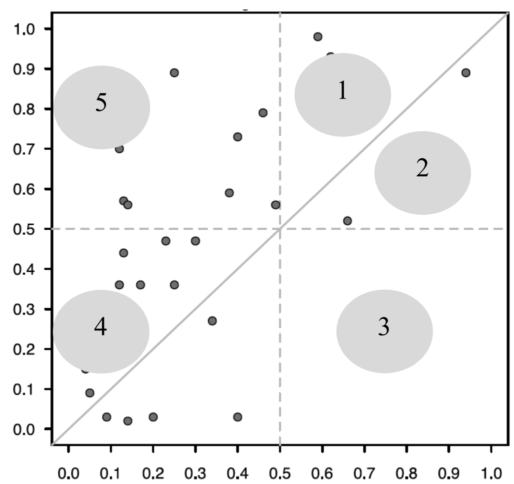


Figure 27: Generic XY plot

The XY plot for expression 1 of the intermediate solution can be seen in Figure 28, and will be discussed in more detail in the discussion on sufficiency findings in sub-section 0.

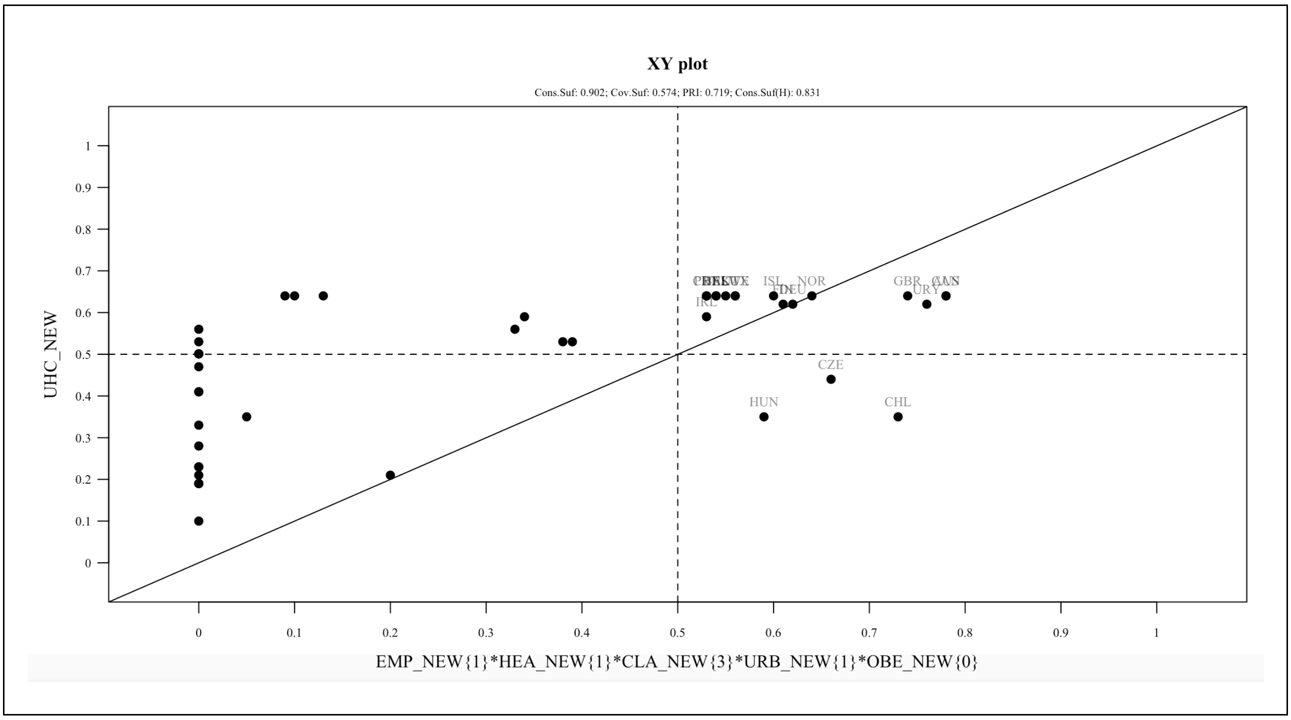


Figure 28: Intermediate solution XY plot for combined conditions

The negation of the UHC outcome was also analysed for sufficiency, but there were no expressions that contained a coverage that was adequate to infer any findings. The results of the sufficiency analysis using the negated outcome can be seen below in

Table 28. Notice the very weak coverage score, which indicates that these results cannot be used to make inferences. The calculations for the negated sufficiency analysis can be seen in APPENDIX N.

Table 28: Intermediate solution results of combined conditions with cases for negated outcome.

Index	Expression	inclS	PRI	covS	covU
1	EMP_NEW{1}*HEA_NEW{0}*CLA_NEW{1}*URB_NEW{1}*OBE_NEW{0}	1.00	1.00	0.07	0.01
2	EMP_NEW{1}*CLA_NEW{1}*URB_NEW{1}*OBE_NEW{0}*ALC_NEW{0}	1.00	1.00	0.07	0.01
3	EMP_NEW{1}*CLA_NEW{2}*URB_NEW{1}*OBE_NEW{0}*ALC_NEW{0}	0.87	0.57	0.19	0.11
4	EMP_NEW{0}*HEA_NEW{1}*CLA_NEW{1}*URB_NEW{1}*OBE_NEW{0}*ALC_NEW{1}	1.00	1.00	0.03	0.02
5	EMP_NEW{0}*HEA_NEW{1}*CLA_NEW{2}*URB_NEW{0}*OBE_NEW{0}*ALC_NEW{0}	1.00	1.00	0.13	0.03
6	EMP_NEW{1}*HEA_NEW{0}*CLA_NEW{3}*URB_NEW{1}*OBE_NEW{0}*ALC_NEW{1}	0.90	0.55	0.06	0.06
7	EMP_NEW{0}*HEA_NEW{1}*CLA_NEW{2}*URB_NEW{0}*OBE_NEW{1}*ALC_NEW{1}	1.00	1.00	0.06	0.00

4.2.11 Discuss necessity findings

This sub-section will discuss the necessity findings of the combined conditions. First, the configurational necessity for the UHC conditions can be seen in The result findings will be discussed in more detail in 4.2.11.

Table 24. These will be discussed briefly here, taking care to question whether these make sense. It was mentioned that necessary conditions are those that are so important that the outcome does not occur without them. The results of the analysis on combined conditions that need to be highlighted are briefly discussed here.

1. EMP_NEW{1} implies that, when there was a high employment to population ratio, then all instances of the UHC outcome were positive.
2. OBE_NEW{0} implies that, when there was high obesity, then the UHC outcome was positive. This does not make intuitive sense and, when investigating the pre-calibration data, it is noticed that there are biases in the data and that all cases tend toward high obesity.
3. HEA_NEW{1}*ALC_NEW{0} implies that healthcare spending had to be high and alcohol consumption per capita also had to be high. This finding is counter-intuitive. When looking at the pre-calibration data, biases are noticed, in that around 90% of the countries that are included as cases in the analysis had high alcohol consumption.
4. URB_NEW{1}*ALC_NEW{0} implies that, when urban population was high and alcohol consumption per capita was also high, then the UHC outcome was positive. When looking at the pre-calibration data for URB_NEW, biases are noticed in that around 84% of the countries that are included as cases in the analysis had high urbanisation.

From this discussion, in summary, the necessity findings indicate that only a high employment to population ratio and high healthcare spending are linked to positive UHC outcomes.

4.2.12 Discuss sufficiency findings

Next, in considering the intermediate solution for the sufficiency of the combined conditions, the results imply that, when a positive outcome is present, certain conditions (or combinations of conditions) are also present. The results of the sufficiency analysis performed on the combined conditions (the conditions present in step two of the two-step analysis process) are summarised in Table 29, in an adaptation of what Legewie (2013) calls an enhanced table of QCA results.

The consistency of 0.902 is high and instils confidence that the expression is included in the outcome set and is sufficient –, or, stated differently, that when a positive outcome was present, then the conditions were often also present. From the solution expression, an XY plot is presented in Figure 28. The deviant cases observed in the solution expression can be seen in Area 2 (deviant consistency in degree) and Area 3 (deviant consistency in kind). Three cases were observed in each. The case investigations will attempt to explain these deviant cases in sub-section 4.2.14. It is noted that the coverage is slightly below the recommended benchmark of 0.6 for covS as discussed in Table 16, but it is close to this benchmark, and will therefore be used in further discussion. The PRI score falls within the recommended benchmark range of above 0.5 but lower than InclS. Limited diversity measures how limited the diversity was in the analysis by understanding the proportion of logical remainders over the total number of truth table rows. A percentage of 73% shows that the analysis has high limited diversity (which is not uncommon in QCA studies).

Table 29: Enhanced table of QCA results

Expression	EMP_NEW{1} * HEA_NEW{1} * CLA_NEW{3} * URB_NEW{1} * OBE_NEW{0}
Inclusion / consistency	0.902
# of deviant cases total	6
# of deviant cases in degree	3
# of deviant cases in kind	3
Raw coverage	0.574
PRI	0.719
Limited diversity	17 observed configurations with 64 total possible combinations = 73%

When considering the expression, the results show the following:

1. EMP_NEW{1}implies that, when the UHC outcome was positive, there was always a high employment to population ratio.
2. HEA_NEW{1} implies that, when a positive UHC outcome was present, health expenditure as a percentage of GDP was also high.
3. CLA_NEW{3} implies that, when a positive UHC outcome was present, economic classification was also high.
4. URB_NEW{1} as discussed as part of the necessity findings, the URB_NEW data was biased, and this condition does not add any value to the findings.
5. OBE_NEW{0} as discussed as part of the necessity findings, the OBE_NEW data was biased ,and this condition does not add any value to the findings. From the sufficiency findings, it appears that the combination of high employment to population, adequately high health spending, and being a developed country constitutes sufficient conditions for positive UHC outcomes for the cases under investigation. This implies that, if a positive UHC outcome were observed, then a combination of these conditions was also present.

4.2.13 Validate findings with regression analysis

As a way to sense-check the results produced by QCA, regression analysis is also performed on the uncalibrated data. Even though Vis (2010) comments that the inferences drawn from regression analysis and QCA are sometimes different, it is nonetheless valuable to understand whether regression points in a similar direction in terms of inferences made about which conditions have causal links with the UHC outcomes. Multiple linear regression was performed on the uncalibrated data of the original eight conditions to determine whether this gives somewhat similar results; thereafter it was performed on the three conditions highlighted in sub-section 0. The dependent variable is set to the UHC outcome, and the conditions are set to the independent variables. For the analysis of the original eight conditions, the formula used for the regression analysis tests the hypothesis that the UHC outcome is a function (~) of ALC_IN + EMP_IN + GEN_IN + HEA_IN + OBE_IN + CLA_IN + URB_IN + FAM_IN[6].

[6] The variables used in the regression analysis are the pre-calibrated data. These abbreviations mean: EMP_NEW – Employment-to-population ratio, ALC_NEW – Total alcohol consumption per capita, GEN_NEW – Female percentage

Table 30 shows the summary statistics of the dependent variable, while the regression results are summarised in Table 31. Figure 29 contains the normal probability plot of residuals. Wherever results were observed that are useful for discussion, these will be highlighted below.

Table 30: Summary statistics of the dependent variable.

	Summary statistics; DV: UHC_OUT
Statistic	Value
Multiple R	0.81
Multiple RÂ²	0.65
Adjusted RÂ²	0.57
F(8,36)	8.31
p	0.00

Multiple R in Table 30 measures the correlation between the actual values and the values predicted by the regression model. A value of 0.81 is high, and indicates that the independent variables predict the dependent variable well. A Multiple RÂ² of 0.65 indicates that the model is relatively accurate in explaining the dependent variable, but not excellent. The Adjusted RÂ² highlights that 57% of the variance in the dependent variable is explained by the independent variables. A p-value below 5% shows statistical significance that the independent variables have predictive power to predict the dependent variable.

Table 31: Regression summary for dependent variable

	Regression summary for dependent variable: UHC_OUT R= .80538644 R²= .64864731 Adjusted R²= .57056894 F(8,36)=8.3076 p					
	b*	Std.Err.	b	Std.Err.	t(36)	p-value
N=45		of b*		of b		
Intercept			41.01	22.96	1.79	0.08
ALC_IN	-0.08	0.16	-0.18	0.36	-0.49	0.62
EMP_IN	0.33	0.13	0.27	0.11	2.56	0.01
GEN_IN	0.01	0.17	0.02	0.4	0.06	0.96
HEA_IN	0.2	0.12	0.61	0.37	1.62	0.11
OBE_IN	-0.09	0.12	-0.12	0.15	-0.8	0.43
CLA_IN	0.47	0.18	4.58	1.75	2.62	0.01
URB_IN	0.17	0.12	0.08	0.06	1.36	0.18
FAM_IN	-0.04	0.17	-0.65	3.07	-0.21	0.83

Two things are interesting in Table 31: first, which variables have statistically significant standardised and unstandardised coefficients; and second, whether these coefficients have a sign (negative or positive) that is intuitive. The sign of the coefficients can be interpreted, for example, as the lower that alcohol consumption is per capita (ALC_IN), the greater

of the population, HEA_NEW – Health expenditure as % of total GDP, OBE_NEW – Prevalence of obesity among adults, FAM_NEW – Fertility rate, CLA_NEW – Country classification, URB_NEW – Urban population as % of total, UHC_NEW – Universal Health coverage index.

will be Universal health coverage (UHC_IN). This example seems to make sense, even though the p-value is insignificant. The coefficients that are then statistically significant, with p-values lower than 5%, include the employment to population ratio (EMP_IN) and the country classification (CLA_IN). The coefficients for these two variables imply that the higher the employment to population ratio (EMP_IN), the higher Universal health coverage; and the higher the country classification (CLA_IN), the higher Universal health coverage. The rest of the variables do not have significant predictive power because their p-values are higher than 5%.

Figure 29 shows the regression line of good fit of the regression model on top of the residuals, which suggests that the data is normally distributed and that the statistical measures seen in Table 31 are relevant to making interferences.

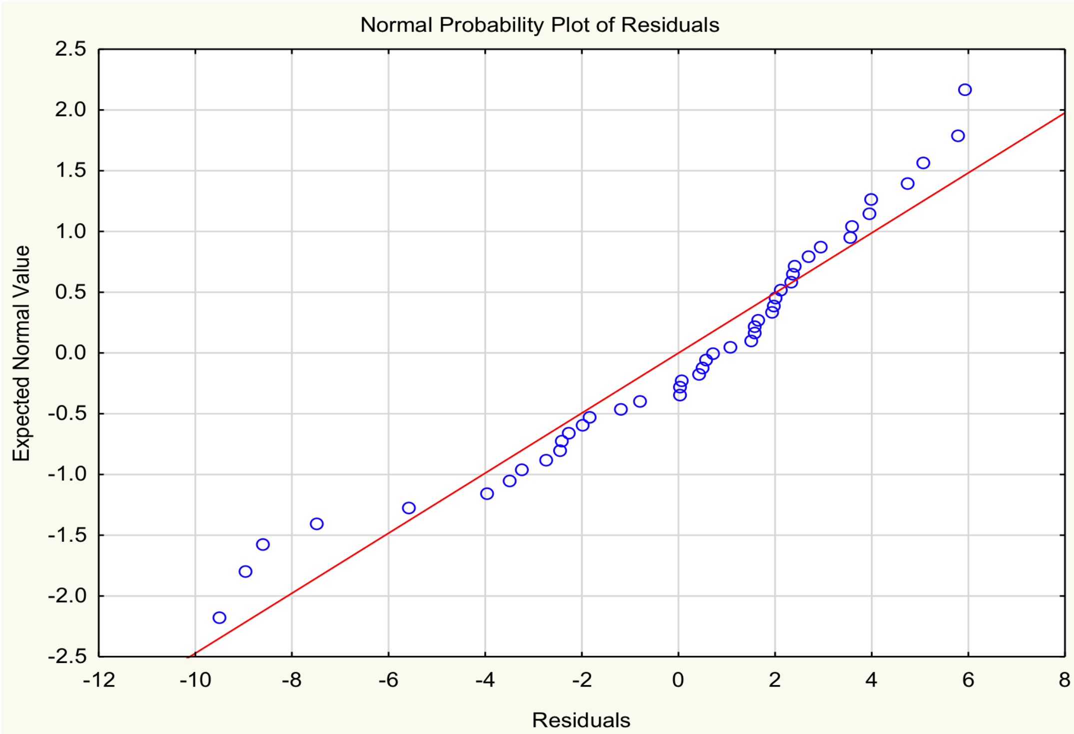


Figure 29: Normal probability plot of residuals

Next, for the analysis of the three variables highlighted by QCA, regression analysis tests the hypothesis that the UHC outcome is a function (~) of EMP_IN + HEA_IN + CLA_IN[7].

Table 32 shows the summary statistics of the dependent variable, while the regression results are summarised in Table 33. Figure 30 contains the normal probability plot of residuals.

Table 32: Summary statistics of the dependent variable.

	Summary statistics; DV: UHC_OUT
Statistic	Value
Multiple R	0.79

[7] The variables used in the regression analysis are the pre-calibrated data. These abbreviations mean: EMP_NEW – Employment-to-population ratio, HEA_NEW – Health expenditure as % of total GDP, CLA_NEW – Country classification, UHC_NEW – Universal Health coverage index.

Multiple RÂ^2	0.62
Adjusted RÂ^2	0.59
F(3,41)	22.12
p	0.00

A value of 0.79 for Multiple R is still high, and indicates that the independent variables predict the dependent variable well. A Multiple RÂ^2 of 0.62 indicates that the model is relatively accurate in explaining the dependent variable, but again not excellent. The Adjusted RÂ^2 highlights that 59% of the variance in the dependent variable is explained by the independent variables, which is now slightly better than the regression analysis performed on all eight variables. A p-value below 5% again indicates statistical significance that the independent variables have predictive power to predict the dependent variable.

Table 33: Regression summary for dependent variable

	Regression summary for dependent variable: UHC_OUT R= .78620267 R^2= .61811464 Adjusted R^2= .59017181 F(3,41)=22.121 p					
N=45	b*	Std.Err. of b*	b	Std.Err. of b	t(41)	p-value
Intercept			38.98	5.12	7.62	0.00
EMP_IN	0.39	0.10	0.32	0.08	3.84	0.00
HEA_IN	0.23	0.11	0.72	0.34	2.10	0.04
CLA_IN	0.47	0.11	4.60	1.12	4.10	0.00

Considering again the p-values of each independent variable in Table 33, it appears that all the variables included in this regression model are statistically significant. The coefficients for these variables imply again that that the higher the employment to population ratio, the higher health spending; and the higher the country classification, the higher Universal health coverage.

Figure 29 shows the regression line of good fit of the regression model on top of the residuals, which suggests that the data is normally distributed.

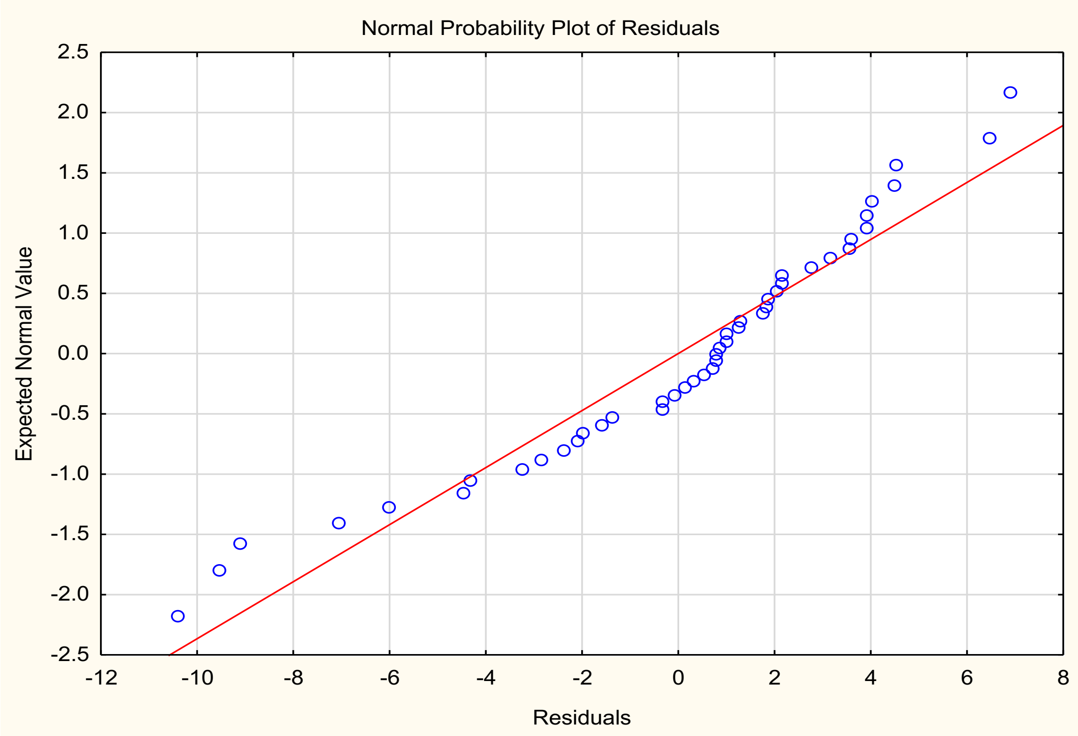


Figure 30: Normal probability plot of residuals

From both regression analyses it can be noticed that the country classification and the employment to population ratio correlate significantly with the UHC outcomes. When considering the results found by the QCA analysis in sub-section 0, it can be recalled that the combination of high employment to population, adequately high health spending, and being a developed country are sufficient conditions to promote positive UHC outcomes. There is then an obvious overlap in the findings for high employment to population and country classification having causal linkages to a positive UHC outcome, which implies that, with the countries and conditions that were used in the analyses, these findings potentially have the ability to explain the positive UHC outcomes to an extent that policy-makers can use for some level of decision support.

4.2.14 Validate findings with cases investigations

Another validation activity to perform on the obtained results is to conduct case investigations in the countries that presented the sufficient conditions highlighted in sub-section 0. The countries that contribute to the sufficient solution are: Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), Chile (CHL), the Czech Republic (CZE), Denmark (DNK), Finland (FIN), Germany (DEU), Hungary (HUN), Iceland (ISL), Ireland (IRL), Luxembourg (LUX), Norway (NOR), Portugal (PRT), Sweden (SWE), Switzerland (CHE), the United Kingdom (GBR), and Uruguay (URY).

This sub-section will proceed through the following three discussion points in order to investigate the cases presented in the final results:

1. Case investigations start with an understanding of the differences in UHC implementations in the different countries by showing how countries that contributed to the sufficient solution are geographically distributed (sub-section 4).
2. Then, in sub-section 4.2.14.2, a deeper level of understanding of the cases will be gained by comparing the different health system configurations.
3. In sub-section 4.2.14.3, the three conditions that were highlighted in sufficiency analysis will be discussed across the 19 country cases, highlighting whether there are other conditions that potentially influence these

conditions. The lowest-ranking country is also highlighted to understand the potential minimum requirements for countries to achieve UHC. This could give countries that have not achieved a positive UHC an idea of how much they need to influence the conditions they can control before they can expect to achieve positive outcomes.

4. Next, the "deviant cases consistency in kind" will be discussed to understand how they can have the combination of conditions without the expected outcome (sub-section 4.2.14.4).

4.2.14.1 GEOGRAPHICAL LOCATION

The geographical location of the cases under investigation can be seen in Figure 31 below. A few things stand out from the geographical distribution of cases: a large number of the cases are situated in Europe; there are no Asian or African countries in the list of cases; and most of the countries seem to be 'first world' countries.

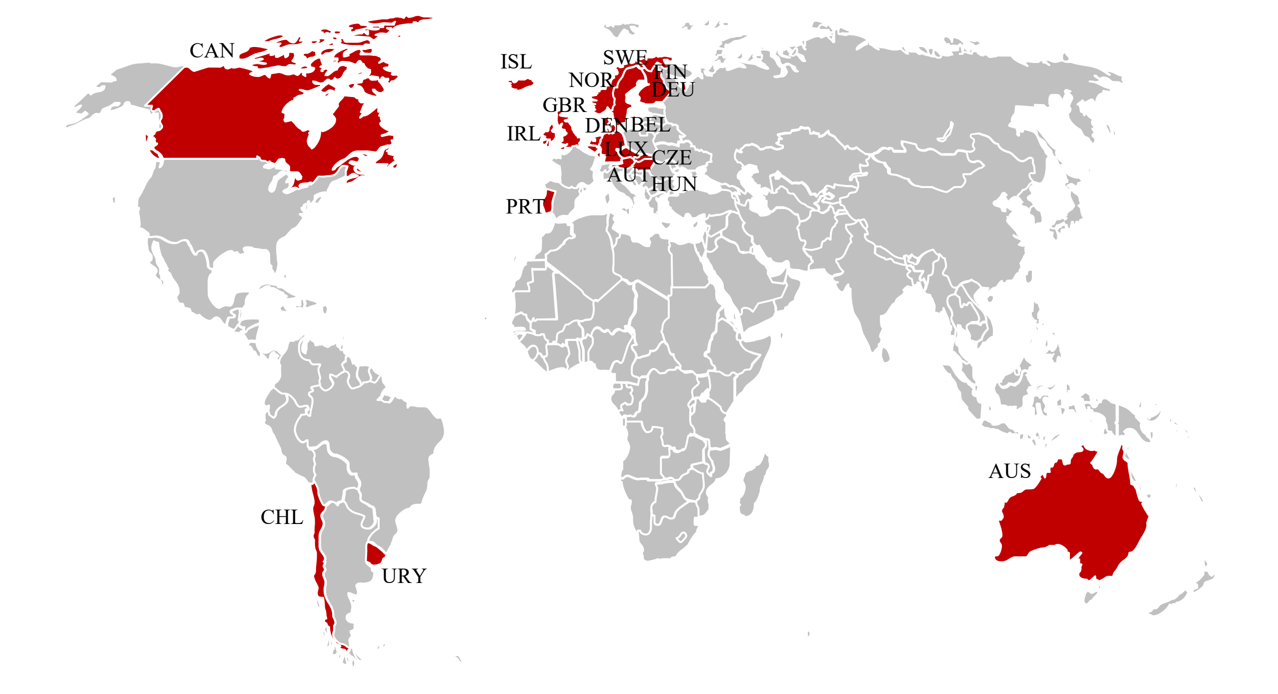


Figure 31: Geographical location of cases

When looking back at Figure 6, the countries represented in Figure 31 were generally early in adopting social protection, with the possible exception of Canada. This raises the question: Perhaps this historical alignment to social protection played a role in making the UHC outcomes more favourable in the present?

4.2.14.2 SELECTED HEALTH SYSTEM CHARACTERISTICS BY COUNTRY

Next, the type of health system, its ownership, how revenue is raised, and the out-of-pocket expenditure (OOP) are investigated across the different countries. The data of the country health system details across the 19 countries can be seen in APPENDIX O, which will be summarised and discussed in the paragraphs below.

The public versus private ownership of primary health facilities and hospitals can be seen in Table 34.

Table 34: Public vs private ownership

	Hospitals		Primary health facilities	
Country	**Public ownership**	**Private ownership**	**Public ownership**	**Private ownership**
Australia	X	X	X	
Austria		X	X	
Belgium	X	X	X	X
Canada	X	X	X	
Chile	X	X	X	X
Czech Republic		X	X	
Denmark	X		X	
Finland	X	X	X	X
Germany	X	X	X	
Hungary	X			X
Iceland	X	X		X
Ireland	X		X	X
Luxembourg	X			X
Norway	X		X	
Portugal	X		X	
Sweden	X		X	X
Switzerland	X		X	
United Kingdom	X		X	
Uruguay				
COUNT	16	9	15	8

The revenue raising methods are summarised in Table 35.

Table 35: Revenue raising methods

Country	Income tax	General tax
Australia	X	X
Austria	X	
Belgium	X	
Canada		X
Chile	X	
Czech Republic		X
Denmark	X	
Finland		X
Germany	X	
Hungary	X	
Iceland	X	
Ireland		X
Luxembourg	X	
Norway	X	X
Portugal		X
Sweden	X	X
Switzerland		X
United Kingdom	X	X
Uruguay	X	
COUNT	13	10

Figure 32 overlays financial protection and OOP, showing where there is high OOP relative to other countries, and where vulnerable groups are protected when there is OOP.

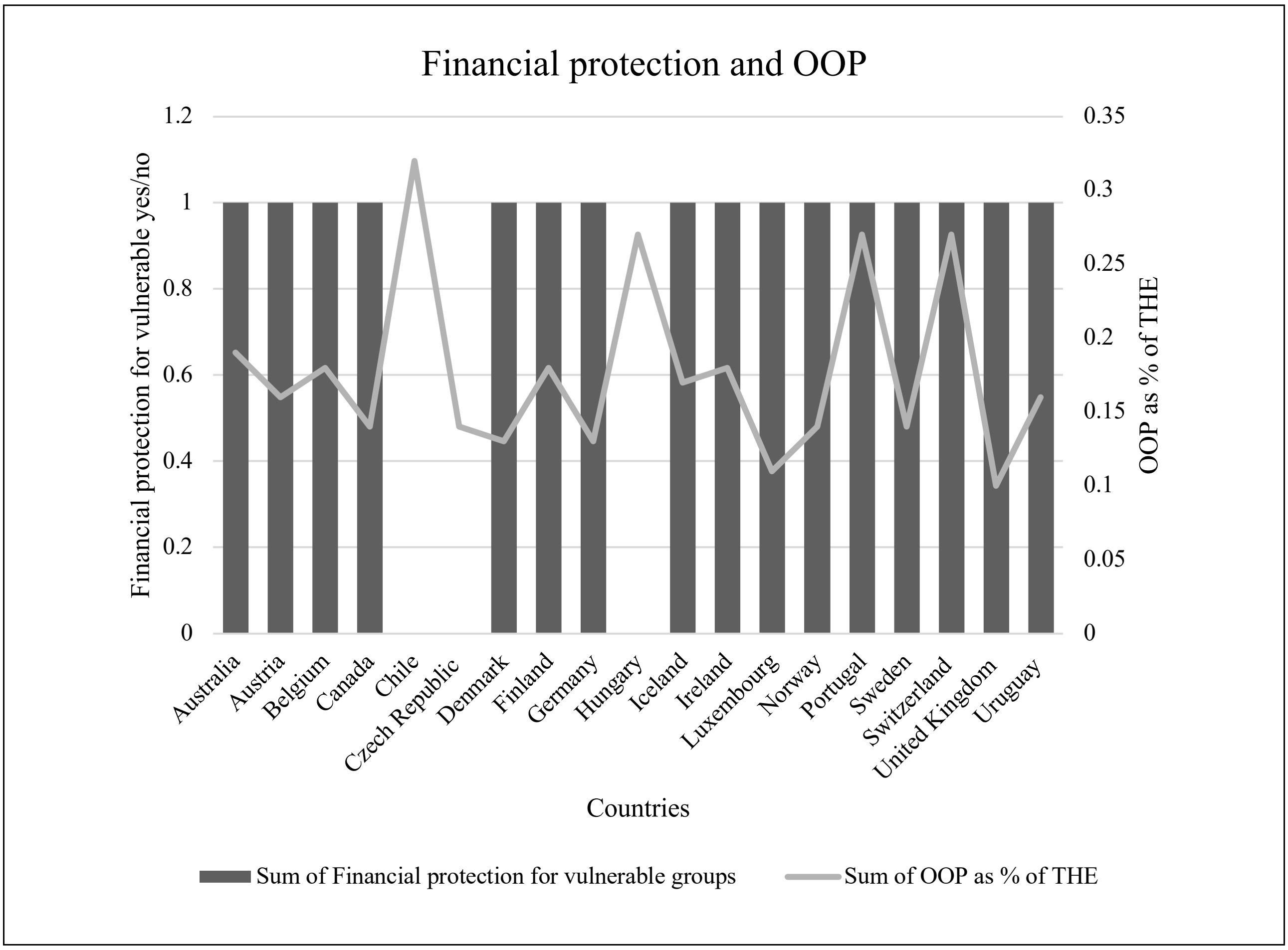


Figure 32: Financial protection and OOP

When considering APPENDIX O and the data summarised in the graphs in this sub-section, there are a few trends in the characteristics of the different health systems that need to be highlighted here:

- The systems were mostly statutory and compulsory. This implies that a mandate would have had to be instituted by the national government, and enforced accordingly.
- In considering Table 34 there seem to be more countries that have public hospital ownership and private primary health care ownership. However, Hsu (2010) argues that there is inconclusive evidence about whether the private delivery (and ownership) of health is relatively more efficient than the public delivery (and ownership) of health, or vice versa.
- Revenue was often raised through some type of employment tax or income tax, as seen in Table 35. This is in line with the health financing policy of the WHO (Jowett and Kutzin, 2015), which recommends the use of compulsory revenues types, including income tax. ('Compulsory' here should not be confused with the compulsory system mentioned above.)
- Most countries seem to offer a specific benefits package, and do not offer unlimited access to healthcare. OOP is mentioned in most of these health systems, but with very specific protection for vulnerable groups, as seen in Figure 32.

- The highest out-of-pocket spenders were Chile, Hungary, Portugal, and Switzerland, with Chile and Hungary not providing protection for vulnerable groups when there is high OOP. It needs to be highlighted at this point that Chile and Hungary are "deviant cases consistency in kind", which could be as a result of their lack of protection of vulnerable groups. Deviant cases will be discussed further in sub-section 4.2.14.4.

4.2.14.3 Sufficient conditions by country

This sub-section will discuss the sufficient variables for the 19 countries relating to understanding differences, similarities, and anomalies in the data. This sub-section will also consider other peripheral conditions that could have been part of the causal linkages to a positive UHC outcome; and lastly, it will look at the minimum performance that countries displayed in respect of conditions while still achieving positive UHC outcomes.

Table 36 shows the uncalibrated data for the sufficient variables across the 19 countries.

Table 36: Uncalibrated data for cases under investigation.

Abbreviation	UHC	EMP	HEA	OBE	CLA	URB
AUS	80	61%	9%	28%	High income	89%
AUT	80	57%	11%	20%	High income	66%
BEL	80	49%	11%	22%	High income	98%
CAN	80	61%	10%	29%	High income	82%
CHL	70	58%	8%	28%	High income	90%
CZE	73	57%	7%	26%	High income	73%
DNK	80	58%	11%	19%	High income	88%
FIN	79	53%	10%	22%	High income	84%
DEU	79	57%	11%	22%	High income	75%
HUN	70	51%	7%	26%	High income	71%
ISL	80	74%	9%	22%	High income	94%
IRL	78	55%	8%	25%	High income	63%
LUX	80	55%	7%	22%	High income	90%
NOR	80	62%	10%	23%	High income	80%
PRT	80	51%	10%	20%	High income	63%
SWE	80	59%	12%	20%	High income	86%
CHE	80	65%	12%	19%	High income	74%
GBR	80	59%	9%	27%	High income	83%
URY	79	60%	9%	28%	High income	95%

At first glance, what stands out in the dataset in Table 36 is that all 19 countries are high-income countries.

In considering the employment to population ratio (EMP_IN), this variable was calibrated with a cross-over of 47% and an inclusion threshold of 80%. It is interesting to see that all cases in the presented set fall between the cross-over and the inclusion threshold, which implies that the dataset could be slightly biased. One other measure that is suspected to influence the employment to population ratio is the GDP of a country – that is, the monetary value of goods and services it produces (Investopedia, 2017) – and so gives an idea of the country's capacity to employ. If the GDP is high, it is to be expected that the employment to population ratio will also be high. Table 37 below compares the GDP per capita across the 19 countries.

Table 37: GDP ranking (WHO, 2017) and per capita (WHO, 2015a) by country

Country	GDP per capita ranking	GDP per capita
LUX	5	$ 101 446.79
IRL	10	$ 61 807.67
NOR	11	$ 74 498.14
CHE	18	$ 82 016.02
ISL	25	$ 51 213.66
SWE	26	$ 50 812.19
DEU	27	$ 41 323.92
AUS	29	$ 53 799.93
AUT	30	$ 44 206.78
DNK	31	$ 53 013.00
CAN	34	$ 45 032.11
BEL	35	$ 40 361.15
FIN	38	$ 42 424.22
GBR	39	$ 39 720.44
CZE	57	$ 20 368.13
PRT	67	$ 19 252.63
HUN	68	$ 14 224.84
CHL	83	$ 15 346.44
URY	86	$ 16 245.59

In Table 37 it can be seen that more than 78% of the countries being considered in this discussion fall within the top 70% ranked countries. The average GDP per capita globally was $13 917, with all of the countries in the selection outperforming that comfortably. So, it can be concluded that all these countries that achieved a positive UHC also had high GDPs per capita.

Health expenditure as a percentage of GDP (HEA_IN) will be discussed next. The cross-over threshold for this variable was set at 6.6% and the inclusion threshold at 9.975% during calibration. More than half of the cases indicate a performance higher than the inclusion threshold. It can be argued that most of these countries spend relatively high amounts on health care because they mostly have compulsory health insurance, as discussed in APPENDIX O. It can also be related to the fact that all of them have been classified as high-income countries, and the population generally have money to access the health system (in the case of OOP). It needs to be noted at this point that Hungary, Chile, and the Czech Republic are deviant cases that do not follow the pattern of the rest, and do not produce a high UHC outcome, even though they have high membership in the conditions. Deviant cases will be discussed in sub-section 4.2.14.4.

Obesity and country classification seems to go hand-in-hand, according to Bleich *et al.* (2008), even though most of these countries' performance for obesity prevalence is quite close to the calibration cross-over of 18%. Bleich *et al.* (2008) suggest that the rising obesity in developed countries is a result of a rising calorie intake, which they relate to technological innovations and to changing sociodemographic factors that they analysed with multivariate regression models and simulation analysis. Their research suggested that obesity-related policies should focus on encouraging a lower calorie intake.

Lastly, Chen *et al.* (2014) prove empirically with cross-sectional data and panel data that there are close links between urbanisation levels and economic growth in GDP per capita. They do, however, add that there is no correlation between urbanisation speed and economic growth rate. It then makes sense that there could be causal linkages between health outcomes and country classification, and between health outcomes and employment to population ratio (which is related to economic growth, as mentioned earlier).

To conclude this sub-section, the minimum performance in combined conditions is briefly highlighted next. Table 38 shows the worst-ranked countries for the cases that were found to have contributed to the sufficiency expressions, pointing to Ireland as the lowest-ranking on these sufficient conditions, but still obtaining positive UHC outcomes. Also recall that the Czech Republic and Hungary were found to be deviant cases in the sufficiency analysis, as they indicated the presence of sufficient conditions, but did not have a positive UHC outcome.

Table 38: Uncalibrated data for cases under investigation, ranked

Country	EMP rank	HEA rank	OBE rank	CLA rank	URB rank	Composite rank
CHE	2	1	1	1	14	19
SWE	7	1	3	1	8	20
DNK	9	3	1	1	7	21
ISL	1	11	6	1	3	22
BEL	19	3	6	1	1	30
DEU	11	3	6	1	13	34
NOR	3	7	11	1	12	34
AUT	11	3	3	1	17	35
URY	6	11	16	1	2	36
AUS	4	11	16	1	6	38
FIN	16	7	6	1	9	39
CAN	4	7	19	1	11	42
LUX	14	17	6	1	4	42
GBR	7	11	15	1	10	44
CHL	9	15	16	1	4	45
PRT	17	7	3	1	18	46
CZE	11	17	13	1	15	57
IRL	14	15	12	1	18	60
HUN	17	17	13	1	16	64

4.2.14.4 Deviant cases

Legewie (2013) notes that cases should be explained where the outcome does not occur, even though all the conditions of the recipe are present. (Refer to cases in Area 3, which relate to “deviant cases consistency in kind”, according to the generic XY plot in Figure 27.) The deviant cases that were highlighted after the sufficiency analysis were Hungary, the Czech Republic, and Chile in Area 3, as seen in Figure 28.

Area 3 indicates a higher membership inclusion in the conditions than in the outcome, but the outcome is below 0.5 for inclusion. The questions to pose about Area 3 are why the conditions are present, even though there is a negative UHC outcome; and what was different in these cases from the rest of the countries. From the available data so far, health expenditure as a percentage of total GDP in these three countries is lower than that of the other countries, which displayed sufficient conditions. This suggests, perhaps, that the calibration for this condition should be refined.

Remembering that the exclusion threshold was set to e=5%, the cross-over to c=6.66%, and the inclusion to i = 9.975%, there is perhaps a case to state that health spending as a percentage of GDP should in fact be higher (alongside the other conditions) when hoping to achieve positive UHC outcomes.

It can also be noticed that these countries had by far the lowest GDP per capita of the countries being studied, with Uruguay and Portugal being exceptions. These exceptions could perhaps be explained by the fact that the health spending in these two countries was higher than 9% as a percentage of GDP. In a discussion with a public health specialist (further discussed in chapter 5) concerning this study it was mentioned for lower-income countries the GINI coefficient and female education level are also expected to influence health outcomes. Uruguay and Portugal are lower income than the rest of the countries. These are compared in Figure 33; and what can be noticed about Portugal and Uruguay is that, even though female educational attainment is lower than in most of the other countries, the GINI index for these two countries is average in relation to this sample. This does not explain these two countries' successful outcomes; and if it is not the fact that they have health expenditure that is higher than 9% of GDP, then there must be other conditions that explain this phenomenon but that are not covered here.

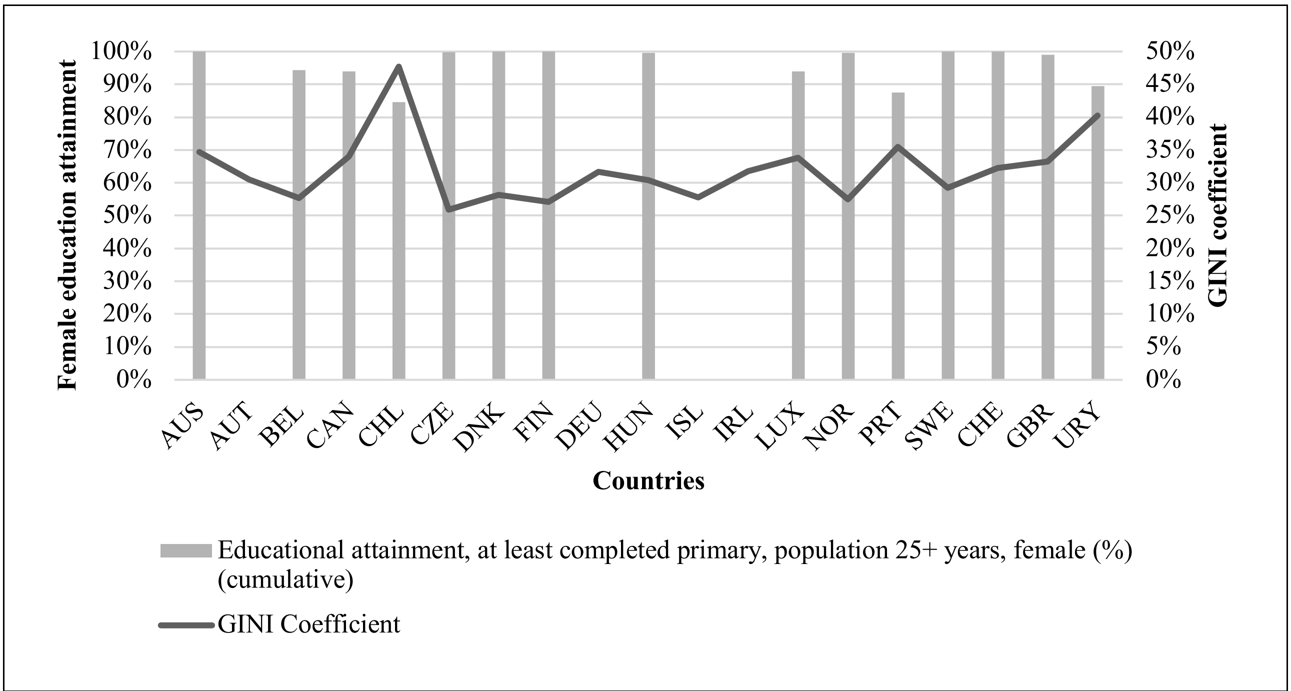


Figure 33: GINI coefficient (World Bank, 2015c) and female education level (World Bank, 2015a)

Lastly, Hungary and Chile also had limited OOP protection for vulnerable groups (which would affect the UHC outcome negatively) and high OOP when compared with the other countries in the sample.

This sub-section has attempted an objective investigation of the 19 cases highlighted by the sufficiency analysis. It first noted where these countries are located; then compared their health system configurations at a high level; discussed the sufficient conditions and the potential peripheral conditions that affect these; and looked at the minimum performance that countries displayed on conditions while still achieving positive UHC outcomes. Lastly, this sub-section made sense of the deviant cases.

4.3 Summary of Findings

This sub-section will briefly discuss the findings of the QCA and the two validations steps, validation with regression analysis and validation with case investigations.

4.3.1 QCA FINDINGS

The QCA is mainly about understanding the sufficiency of conditions for an outcome. The results of the QCA included: when the UHC outcome was positive, there was always a combination of high employment to population ratio, and high health expenditure as a percentage of GDP, and lastly high economic classification.

4.3.2 VALIDATION FINDINGS

When performing multiple regression analysis using the uncalibrated data for these variables, it was found that the country classification and employment to population ratio variables are relatively good predictors of the outcome, which aligns with the answers obtained by the QCA.

During the case investigations, the following observations were made:

- Most countries achieving UHC included in this study were generally early to adopt social protection, and were high income countries that were mostly located in Europe.
- The UHC programs were mostly compulsory and statutory.
- Primary health facilities were mostly privately-owned, but hospitals were mostly publicly-owned.
- Revenue was often raised through some type of income tax.
- Most countries seem still to have some level of OOP, but with specific protection for vulnerable groups. The highest out-of-pocket spenders were Chile, Hungary, Portugal, and Switzerland. Interestingly, Chile and Hungary were also found to be deviant cases (alongside the Czech Republic).
- More than 78% of the countries that have been considered in this discussion are among the top 70% ranked countries according to GDP per capita.
- Countries that had a high prevalence of obesity also had a high country classification.
- There also seems to be a link between urbanisation levels and economic growth in GDP per capita.

When wanting to use these findings for decision support, countries can use this method to determine what to focus on first. When looking at the result found in the exemplary application of UHC, policy-makers can incentivise higher employment rates and promote those conditions that improve their country classification. Policy-makers can use this method, for example, also to confirm whether higher health spending will bring a country closer to achieving UHC. These conditions, noted above, are examples of conditions that can be directly influenced through intentional policy-making and control.

4.4 CONCLUSION: METHODOLOGY TO MODEL THE REAL-WORLD PROBLEM

This chapter has described a methodology to apply QCA in the UHC application by explaining and applying certain steps: design, conditions, analysis, and interpretation. This chapter has also described the theory behind how each of these steps work, and applied each step to the UHC application.

The findings include the fact that the combination of high employment to population, high health spending as a percentage of GDP, and being a high-income country is sufficient for good UHC outcomes. The validation steps found that most of the countries that achieve UHC and that have been included in this study have a history of social protection; they were mostly high-income countries with high GDP per capita; and were mostly located in Europe.

The UHC programs were mostly compulsory and statutory, and hospitals were mostly publicly-owned, while primary health facilities were mostly privately-owned. Revenue was often raised through some type of income tax, and most countries still had some level of OOP. Countries that had a high prevalence of obesity also had a high country classification.

The next chapter will discuss the methodologic considerations that have arisen in this chapter.

5 Methodological Considerations

This chapter aims to detail the methodological considerations for future studies in which QCA might be used to determine which conditions influence UHC outcomes.

A great deal of learning took place during the development of this research inquiry, especially about how to approach a study of this kind. This study was also discussed with a public health specialist who provided some valuable input into these considerations that will also aid future studies of a similar nature. A summary of these learnings and inputs will be discussed in the paragraphs below. The discussion will proceed through the phases of QCA (listed in Figure 18), noting how these can be applied to provide decision support to policy-makers, especially highlighting how this approach should look with a specific country in mind. Policy-makers will typically apply this method in a specific country; and so these considerations will be useful. Considerations will be discussed for each of the phases of QCA – design, condition, analysis, and interpretation and validation – in the respective paragraphs below. Note that these considerations should be considered alongside the methodology discussed in chapter 4.

5.1 Design considerations

Ideally, policy-makers would hope to predict the reaction of a UHC outcome when influencing certain conditions of the country in question. The case selection can ensure that the findings are relevant to such a country by iterating through different country selection strategies:

- First, perform a broad QCA on all the countries for which data is available on some form of UHC outcome measure. This sample should then include countries that have successfully or unsuccessfully implemented UHC.
- Then perform more focused QCA iterations, selecting countries that are similar in political stability, country size, and GDP per capita to the country in question. These iterations compare the conditions along stratified lines, thus helping the policy-maker to understand whether the findings are relevant to their country. There are also other stratification criteria that can be selected, such as region or country classification.

Each of these iterations offers a different angle on the data, and combining and comparing them would give the researcher greater insight and a broader view of the possibilities to be considered. Recall that QCA results need to also be considered alongside a detailed understanding of the cases / countries being compared, to sense-check whether these results make sense in their context.

In selecting the condition variables, the policy-maker and/or researcher should also consider an iterative approach, first using conditions that were selected, and using a rigorous approach such as carried out in sub-section 2.6 of this study. The policy-maker and/or researcher can also consider selecting variables to prove a certain hypothesis. Note that conditions influencing UHC outcomes could be different along stratification lines. For example, the GINI coefficient and female education may be health outcome influencers in low-income countries, but not in high-income countries.

As data related to UHC measures becomes more available, it could be useful to perform this type of study longitudinally, predicting 'when' a country can expect favourable health system outcomes. 'When' here refers to the point at which a certain level on a condition has been reached, and when health outcomes are expected to become more favourable. For example, if it can be determined what level of female education level or GINI coefficient should be reached for UHC to be successful, policy-makers would have an indication of how much work is to be done and what to focus on. A longitudinal study would also help to understand how long it took in other countries to produce favourable results after a certain condition had improved.

5.2 CONDITIONING CONSIDERATIONS

The conditioning phase is very important for the analysis, and can substantially influence the results, depending on how thresholds are selected for calibration. A few considerations about conditioning will be discussed briefly in the paragraphs below.

Consider using a rigorous approach to select calibration thresholds, and seek subject matter expert validation on all calibration variable thresholds. After results have been found, it is not uncommon to perform recalibration on variables that react counter-intuitively, or that do not align in the case understanding. After recalibration, another iteration of the analysis is required.

Consider applying fuzzy set analysis as far as possible. Even though it is more difficult to apply, it does provide necessary detail when looking for policy-making decision support. As discussed in sub-section 4.2, fuzzy-set QCA has been enhanced from crisp-set QCA. Fuzzy-set QCA allows more granular understanding of the effect of conditions on an outcome because it allows for partial membership in a category for both outcome and condition variables. Using fuzzy-set QCA rather than crisp-set QCA should be considered.

5.3 ANALYSIS CONSIDERATIONS

The analysis phase of the QCA should focus on the sufficiency analysis, as this is the main meaningful answer required for the study; the necessity analysis is simply a contributor leading up to this result. Recall that the sufficiency conditions are those that, when they occur, are good enough to make the outcome occur. Necessary conditions are those that are always present when a certain outcome occurs.

Then, in sub-section 4.2.8, three types of sufficiency solution are performed – conservative, parsimonious, and intermediate – to demonstrate how it works. However, as recommended by Siebrits (2014), the intermediate solution is the best of the three; and a focus on that solution should be considered.

Recall that the application of QCA in chapter 4 followed a two-step approach. This is recommended if there are too many variables. If the result produced by the analysis is difficult to interpret, it is best to find a rigorous and sensible approach to reducing the conditions. The two-step approach is a rigorous option to follow; however, one could also use hypotheses to reduce the number of conditions.

5.4 INTERPRETATION AND VALIDATION CONSIDERATIONS

During interpretation and validation, it is important to note, first, that the researcher needs to have an intimate knowledge of the cases being studied in order to sense-check their validity. As also discussed in more detail in sub-section 4.2, QCA is dependent, first, on determining potential causal links systematically, and second, on being able to explain these links through case-analysis, confirming or denying their validity. Cross-validating these links with subject matter experts or with other probabilistic methods can also be considered.

All of these considerations are summarised in the already familiar Figure 34 below, which was adapted from Figure 18 with the additions already discussed in the relevant paragraphs in this chapter. The additions that are different and that are deemed important to highlight are indicated in red text, and have already been discussed in sub-sections 5.1 to 5.4.

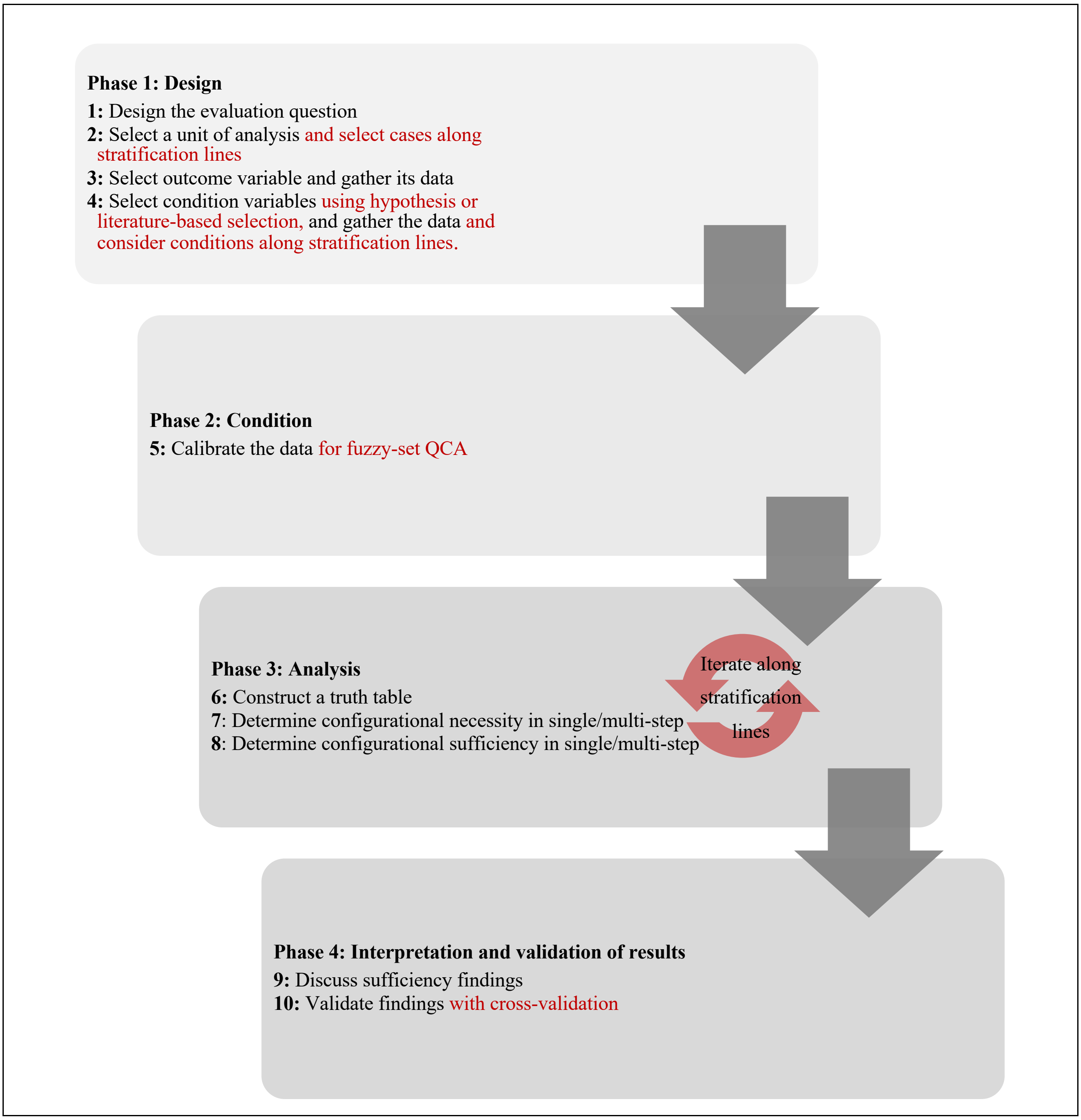


Figure 34: QCA methodology phases (final adaptation from Devers *et al.*, 2013)

5.5 Conclusion: Methodological considerations

This chapter has detailed the considerations compiled from the learnings that have been gained during the compilation of this research inquiry and that should be considered in future studies. This chapter proceeded through the phases of QCA (design, condition, analysis, and interpretation and validation) with considerations noted for each phase, highlighting how policy-makers will typically apply this method.

6 SUMMARY AND CONCLUSIONS

This chapter concludes the study by summarising the completed project and highlighting the limitations that need to be considered for future studies of this kind. It will also explain what contribution this study aims to make to the existing body of knowledge, and highlight future opportunities that flow from this research enquiry.

6.1 PROJECT SUMMARY

It is crucial for policy-makers and participants in the implementation of UHC to understand which conditions in a country influence the success of UHC outcomes.

The aim of this study was to contribute to research on how better to implement UHC in a country through understanding the conditions that influence UHC outcomes, using a structured engineering approach. This was done by applying QCA, inputting country conditions as model condition variables, and the UHC outcome as the model outcome. As part of the process to understand these influencing conditions, a replicable methodology was applied using an existing step-by-step methodology, and adapting it for the UHC application.

As context to the research, chapter 2 explains what health systems are and what UHC is within the larger concept of health systems. That chapter details the principles of UHC, how its outcome can be measured, and which conditions in a country, according to the literature, influence the outcomes of UHC. These conditions are typically health organisational, political, economic, or social. From this contextual understanding, a solution requirement is defined to solve the research problem using comparative causal research methods.

As a starting point in finding an appropriate method for the solution requirement, chapter 3 identifies methods from the literature that are classified as comparative causal research methods. These methods are then compared with the solution requirements, and QCA is selected as the method to apply in this study.

In chapter 4, the QCA methodology is explained and applied to the UHC application to understand which conditions influence UHC outcomes. The research problem is operationalised, followed by the selection of variables, data-gathering, and the conditioning of variables. The variables are then analysed using QCA, and results are presented and validated. Findings include that the combination of high employment to population, high health spending as a percentage of GDP, and being a high-income country is sufficient to achieve a positive UHC outcome. The regression validation step aligned with the results of the QCA, showing that high employment to population and country classification are good predictors of a UHC outcome.

The case investigations validation steps found that most of the countries in this study that achieved UHC had a history of social protection – these being mostly European countries with high income levels and a high GDP per capita. The characteristics of the health systems highlighted in the countries included in the sufficiency findings were that the UHC programmes of these countries were mostly compulsory and statutory, and that revenue was often raised by some form of income taxation. Hospitals in these countries were mostly publicly-owned, and primary health facilities were mostly privately-owned and most of the countries still had some level of OOP.

Chapter 5 detailed the methodological considerations for future studies in which QCA might be used for the UHC application. The learnings gained throughout the study are summarised in this chapter. Some considerations include that stratification should be performed, that QCA iterations should be initiated through the different stratification lines, and that fuzzy QCA should be used for this type of study.

The research is concluded in the current chapter, summarising the research and its findings, explaining the contribution that the research makes to the body of knowledge, and highlighting the limitations that need to be considered.

6.2 Research limitations

This sub-section will note the limitations of the QCA method and of study-specific limitations that other researchers need to know about for future studies of a similar nature.

QCA typically suffers from the limitations that are mentioned in sub-section 4.1 and that are highlighted below, as they apply to this study:

- Over-determination or limited diversity in this study was managed as far as possible by performing a two-step QCA analysis. The degrees of freedom before the two-step analysis were 36 to 40, which is reasonable.
- Sampling bias creeps in as a result of case selections as opposed to using statistical design's random sampling. This phenomenon was seen in this study because most of the selected countries were high-income, had a high country classification, and were located in Europe.
- Not limited to QCA, but also found in most causality studies, is the fact that a mathematical model will only consider conditions that were in the mathematical model. This was highlighted by the public health specialist's validation when suggesting that this study should have also included the GINI coefficient and female education levels.
- As mentioned in sub-section 4.2, the results generated by QCA could be theoretically meaningless, and should be sense-checked. This could be seen when QCA highlighted high alcohol use and high obesity as contributors to positive UHC outcomes. This did not make sense, and occurred as a result of sampling bias.

This study specifically had to deal with other limitations:

- Data availability was not always acceptable for cross-national data, and certain variables could not be processed by the mathematical model because of this.
- The study is dependent on case study information being available. The countries under analysis will, by definition, be selected if there is data available on them.
- The investigation was applied cross-sectionally; however, it may well be that causal conditions react non-linearly over time. This study did not address this issue.

6.3 Research contribution

This research contributes to both the academic literature on the application of mixed methods and the public health management body of knowledge, specifically in the following areas:

a. It adds to the complex social sciences literature by applying a mixed method to a real-world application of UHC policy-making decision support;

b. It adds to the mixed method literature by proposing a framework for selecting the most suitable method for application to a real-world problem;

c. It adds to the QCA literature by applying the method in a step-by-step method to a real-world application, indicating how to handle decision points during the QCA process and showing all coding details.

d. It provides health policy-makers with a structured and replicable method to understand conditions that will influence UHC outcomes in a country.

e. It highlights conditions that influence UHC outcomes in a country so that health policy-makers can understand its importance.

7 LIST OF REFERENCES

Agyepong, I.L., G, and Reddy, S., et al.(2014). Health in the Framework of Sustainable Development. Technical Report for the Post-2015 Agenda. Paris, France and New York, USA: SDSN.

De Almeida Simões, J., Augusto, G.F., Fronteira, I. and Hernández-Quevedo, C., 2017. Portugal. Health systems in transition, 19(2), pp.1-184.

Anand, S. and Bärnighausen, T. (2004) 'Human resources and health outcomes: Cross-country econometric study', *The Lancet*, 364(9445), pp. 1603–1609. doi: 10.1016/S0140-6736(04)17313-3.

Ataguba, J.E., Day, C. and McIntyre, D., 2014. Monitoring and evaluating progress towards universal health coverage in South Africa. PLoS medicine, 11(9), p.e1001686.

Bahadori, M. T. and Liu, Y. (2012) 'Granger causality analysis in irregular time series', SIAM Conference on Data Mining (SDM' 12), pp. 1103–1114.

Bärnighausen, T. and Sauerborn, R. (2002) 'One hundred and eighteen years of the German health care system - are there any lessons learnt for low and middle income countries?', *Social Science & Medicine*, 54(1559–1587), pp. 1559–1587.

Berg-Schlosser, P. D. (2016) 'Comparative research design and methods'. African Doctoral Academy, pp. 1–170.

Bleich, S. N. *et al*. (2008) 'Why is the developed world obese?', *Annual Review of Public Health*, 29(1), pp. 273–295. doi: 10.1146/annurev.publhealth.29.020907.090954.

Boerma, T. *et al*. (2014) 'Monitoring intervention coverage in the context of universal health coverage', *PLoS Medicine*, 11(9). doi: 10.1371/journal.pmed.1001728.

Bossert, T. J. and Leisewitz, T. (2016) 'Innovation and change in the Chilean health system', *New England Journal of Medicine*, 374(1), pp. 1–5. doi: 10.1056/NEJMp1514202.

Bristol, N. (2014) 'Global action toward universal health coverage', Center for Strategic and International Studies, Washington, DC. , (January), pp. 1–28. Available at: https://csis-prod.s3.amazonaws.com/.../140109_Bristol_GlobalActionUniversalHealth_W.

Bronkhorst, Q. (2014) The world's biggest drinking nations, *Business Tech*. Available at: https://businesstech.co.za/news/general/57317/the-worlds-biggest-drinking-nations/ (Accessed: 20 July 2018).

Bump, J.B., 2010. The long road to universal health coverage: a century of lessons for development strategy. Rockefeller foundation.

Murray, C. and Evans, D. (2003) World Health Survey 2003. Geneva, Switzerland. Available at: http://health.govmu.org/English/Documents/whs/chap6.pdf.

Campagnolo, L., Carraro, C., Eboli, F. and Farnia, L., 2016. Assessing SDGs: a new methodology to measure sustainability. International Center for Climate Governance.

Campbell, D. T. (1975) 'III. 'Degrees of freedom' and the case study', *Comparative Political Studies*, 8, pp. 178–193. doi: https://doi.org/10.1177/001041407500800204.

Chappin, E.J. and Ligtvoet, A., 2014. Transition and transformation: A bibliometric analysis of two scientific networks researching socio-technical change. Renewable and sustainable energy reviews, 30, pp.715-723.

Cheli, Bruno, and A. L. (1995) ‘A ‘totally’ fuzzy and relative approach to the multidimensional analysis of poverty’, *Economic Notes* 1, pp. 115–34.

Chen, M., Zhang, H., Liu, W. and Zhang, W., 2014. The global pattern of urbanization and economic growth: evidence from the last three decades. PloS one, 9(8), p.e103799.

Cotlear, D., Nagpal, S. and Smith, O., How 24 developing countries are implementing universal health coverage reforms from the bottom up. Washington, DC: World Bank, 2015. doi: http://documents.worldbank.org/curated/en/2015/09/25018544/going-universal-24- developing-countries-implementing-universal-health-coverage-reforms-bottom-up

Crawley MJ: The R book. Chichester: Wiley Publishing; 2007.

Deming W. Edwards. The new economics for industry, government, education. 2nd. MIT Press, 2000.

Devers, K. J. (2013). Using Qualitative Comparative Analysis (QCA) to Study Patient-Centered Medical Homes. Washington D.C.: The Urban Institute. Available at: http://www.urban.org/sites/default/files/alfresco/publication-pdfs/412969-Using-Qualitative-Comparative-Analysis-QCA-to-Study-Patient-Centered-Medical-Homes.PDF.

Dmytraczenko, T. and Almeida, G. eds., 2015. Toward universal health coverage and equity in Latin America and the Caribbean: evidence from selected countries. The World Bank.

Duşa, Adrian. 2018. QCA with R. A comprehensive resource . New York: Springer International Publishing. Available at: https://bookdown.org/dusadrian/QCAbook/ (Accessed: 27 December 2017).

Dusa, A. (2007) ‘User manual for the QCA (GUI) package in R’, *Journal of Business Research* 60(5), pp. 576–586.

Dusa, A., Dinkov, V., Baranovskiy, D., Quentin, E., Breck-McKye, J., Thiem, A. and Dusa, M.A., 2018. Package ‘QCA’.

Dusa, A. (2018b) *QCA package in R*. New York: Springer International Publishing.

Econex (2011) ‘National health systems: Public service vs insurance-based models’, Health Reform Note 15, pp. 1–9.

European Observatory on Health Systems and Policies (2017) *State of health in the EU: Luxembourg country health profile 2017*. Luxembourg: EU Commission.

Evans, B. D., Beyeler, N. and Beith, A. (2015) ‘What Steps Countries Are Taking To Implement Pro-Poor Universal Health Coverage ?’ Italy: USAID.

Evans, D. B. (2012) ‘Universal Health Coverage: Concepts and Principles’, Health Systems Financing. World Health Organisation, pp. 1–35. Available at: http://www.paho.org/forocoberturagt2014/wp-content/uploads/2014/08/FIN-Evans-WHO-UHC-Concepts-and-Principles.pdf.

Feigl, A. B. and Ding, E. L. (2013) ‘Evidenced formal coverage index and universal healthcare enactment: A prospective longitudinal study of economic, social, and political predictors of 194 countries’, *Health Policy*, 113(1–2), pp. 50–60. doi: 10.1016/j.healthpol.2013.06.009.

Gaál, P. *et al*. (2011) ‘Hungary: Health system review’, *Health Systems in Transition*, 13(5), pp. 1–266. Available at: http://www.euro.who.int/__data/assets/pdf_file/0019/155044/e96034.pdf.

Gerkens, S. and Merkur, S. M. (2010) ‘Belgium: Health system review article (published version) (refereed)’, *Health Systems in Transition,* 12(5), pp. 1–266. Available at: http://eprints.lse.ac.uk/29128/.

Hofmarcher, M. M. and Quentin, W. (2013) 'Austria: Health system review', *Health Systems in Transition*, 15(7), pp. 1–292. doi: 10.1167/iovs.10-5756.

Hogan, D., Hosseinpoor, A. R. and Boerma, T. (2016) 'Developing an index for the coverage of essential health services', pp. 1–136. doi: ISBN 978 92 4 156526 4.

Hsu, J., 2010. The relative efficiency of public and private service delivery. World Health Report Background Paper, 39, pp.1-9.

Hubacher, D. and Trussell, J. (2015) 'A definition of modern contraceptive methods', *Contraception*, 92(5), pp. 420–421. doi: 10.1016/j.contraception.2015.08.008.

Human Development Unit (2012) *Republic of Uruguay integrated national health system: Analysis of the governability of the SNIS Benefit Plan (PIAS)*, The World Bank (80084), pp. 1–172. Available at: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2013/09/23/000442464_20130923100243/Rendered/PDF/800840ESW0Urug000PUBLIC00Box379829B.pdf.

International Labour Organization (2017) *Employment to population ratio, ILOSTAT database*. Available at: https://data.worldbank.org/indicator/SL.EMP.TOTL.SP.ZS.

Investopedia (2017) *GDP*. Available at: https://www.investopedia.com/terms/g/gdp.asp (Accessed: 11 August 2018).

IQWiG (2015) *Health care in Germany: The German health care system*. Available at: https://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0078019/ (Accessed: 18 July 2018).

ITEP (2015) *Who pays?* 5th edition. Available at: https://itep.org/whopays/.

Jamison, D. T. *et al*. (2006) 'Cost-effectiveness analysis', *Priorities in Health*, pp. 39–58. doi: 10.1007/978-0-387-48740-3_21.

Jowett, M., Kutzin, J. and World Health Organization, 2015. Raising revenues for health in support of UHC: strategic issues for policy makers (No. WHO/HIS/HGF/PolicyBrief/15.1). World Health Organization.

Kinkorová, J. and Topolčan, O. (2012) 'Overview of healthcare system in the Czech Republic', *EPMA Journal*, 3(1), pp. 1–8. doi: 10.1007/s13167-012-0139-9.

Kutzin, J., 2008. Health financing policy: a guide for decision-makers. Health financing policy paper. Copenhagen, WHO Regional Office for Europe, 24.

Kutzin J, Bismarck vs. Beveridge: is there increasing convergence between health financing systems. In: 1st Annual Meeting of SBO Network on Health Expenditure. Paris (2011). Available online at: http://www.oecd.org/governance/budgeting/49095378.pdf (Accessed July 17, 2018).

Lange, M. (2013) *Comparative-historical methods*, SAGE Publications Ltd, pp. 1–21. doi: 10.4135/9781473914223.

Legewie, N. (2013) 'An introduction to applied data analysis with qualitative comparative analysis (QCA)', *Forum: Qualitative Social Research*, 14(3), pp. 1–45. Available at: http://www.qualitative-research.net/index.php/fqs/article/view/1961/3594.

Leischnig, A., Kasper-Brauer, K. and Thornton, S. C. (2018) 'Spotlight on customization: An analysis of necessity and sufficiency in services', *Journal of Business Research*, 89 (December 2017), pp. 385–390. doi: 10.1016/j.jbusres.2017.12.038.

Lijphart, A. (1975) 'II. The comparable-cases strategy in comparative research', *Comparative Political Studies*, 8, pp. 158–177.

Little, D. (2005) 'Western Philosophy of Social Science.' Michigan: Understanding Society research gateway. Available at: http://www-personal.umd.umich.edu/~delittle/WPSS syllabus.html.

Mackie, J. L. (1965) 'Causes and conditions', *American Philosophical Quarterly*. JSTOR, 2(4), pp. 245–264. doi: 10.2307/20009173.

Marten, R. *et al*. (2014) 'An assessment of progress towards universal health coverage in Brazil, Russia, India, China, and South Africa (BRICS)', *The Lancet*, 384(9960), pp. 2164–2171. doi: 10.1016/S0140-6736(14)60075-1.

McKee, M. *et al*. (2013) 'Universal health coverage: A quest for all countries but under threat in some', *Value in Health,* 16(1), pp. S39–S45. doi: 10.1016/j.jval.2012.10.001.

McLuskey, E. J. (1956) 'Minimization of Boolean functions', *Bell System Technical Journal*, (35), pp. 1417–1444.

Missoni, E. et al. (2010) 'Attaining universal health coverage - A research initiative to support evidence-based advocacy and policy-making.' Milano: Egea, pp. 1–163.

Mossialos E, Wenzl M, Osborn R, Sarnak D, editors. International profiles of health care systems. 2015. The Commonwealth Fund, January 2016. Available at: http://www.commonwealthfund.org/~/media/files/publications/fund-report/2016/jan/1857_mossialos_intl_profiles_2015_v7.pdf. Accessed 6 Jul 2018.

Murchú, N. Ó. (2011) 'Comparative historical analysis, Frank Wright, and Northern Ireland', *Irish Political Studies*, 26(3), pp. 283–299. doi: 10.1080/07907184.2011.593734.

Murtagh, F. and Contreras, P. (2012) 'Algorithms for hierarchical clustering: An overview', *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, 2(1), pp. 86–97.

NHS (2008) *History of the NHS*. Available at: https://www.nhs.uk/Tools/Documents/HistoryNHS.html (Accessed: 17 July 2018).

Nicholson D, Yates R, Warburton W, Fontana G. 2015. "Delivering Universal Health Coverage: A Guide for Policymakers." Report of the WISH Universal Health Coverage Forum 2015, World Innovation Summit for Health (WISH), Doha, Qatar.

OECD/World Health Organization . Health at a Glance: Asia/Pacific 2014: Measuring Progress towards Universal Health Coverage . Paris : OECD Publishing , 2014 .

Van Olmen, J. *et al*. (2012) 'The health system dynamics framework: The introduction of an analytical model for health system analysis and its application to two case-studies', *Health, Culture and Society*, 2(1), pp. 1–21. doi: 10.5195/HCS.2012.71.

Physicians for a national health program (2016) *Health care systems – Four basic models: The out-of-pocket model*. Available at: http://www.pnhp.org/single_payer_resources/health_care_systems_four_basic_models.php.

Quine (1952) 'The problem of simplifying truth functions', *The American Mathematical Monthly*, 59, pp. 521–531. doi: 10.2307/2308219.

Ragin, C. (2000) *Fuzzy-set social science*. Chicago: University of Chicago Press. doi: 10.2307/3089736.

Ragin, C. C. (2008) 'Redesigning Social Inquiry', Social Forces. Chicago and London: University of Chicago Press., pp. 1934–1936. doi: 10.7208/chicago/9780226702797.001.0001.

Ragin, C. C. (2008) ‘Redesigning social inquiry’, *Social Forces*, 88, pp. 1934–1936. doi: 10.7208/chicago/9780226702797.001.0001.

Ragin, C. C. (2014) *The comparative method: Moving beyond qualitative and quantitative strategies*. Stanford: University of California Press.

Ragin, C. C. (2015) *Qualitative comparative analysis workshop*. Stanford: University of California. Available at: https://gpc.stanford.edu/publications/qualitative-comparative-analysis-workshop.

Ragin, C.C. and Sonnett, J., 2005. Between complexity and parsimony: Limited diversity, counterfactual cases, and comparative analysis. In Vergleichen in der Politikwissenschaft (pp. 180-197). VS Verlag für Sozialwissenschaften.

Rihoux, B., and Ragin, C.C 2009, Configurational comparative methods: qualitative comparative analysis (qca) and related techniques, Applied social research methods, vol. 51, SAGE Publications, Inc., Thousand Oaks, California, [Accessed 18 November 2018], doi: 10.4135/9781452226569.

Rihoux, R. (2009) ‘Qualitative Comparative Analysis Using Fuzzy Sets (fsQCA).’, Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and Related Techniques. Frankfurt: Goethe University, pp. 87–121. doi: http://dx.doi.org/10.4135/9781452226569.n5 Print.

Rohwer, G. (2011) ‘Qualitative comparative analysis: A discussion of interpretations’, *European Sociological Review*, 27(6), pp. 728–740. doi: 10.1093/esr/jcq034.

Røttingen, J., Ottersen, T., Ablo, A., Arhin-Tenkorang, D., Benn, C., Elovainio, R., Evans, D., Fonseca, L., Frenk, J., McCoy, D. and McIntyre, D. (2014) *Shared responsibilities for health: A coherent global framework for health financing*. Final Report of the Centre on Global Health Security Working Group on Health Financing. Available at: https://www.chathamhouse.org/sites/files/chathamhouse/field/field_document/20140521HealthFinancing.pdf.

Schneider, C.Q. and Grofman, B., 2006, July. It might look like a regression equation… but its not! An intuitive approach to the presentation of QCA and fs/QCA results. In Conference on “Comparative Politics: Empirical Applications of Methodological Innovations”, Sophia University, Tokyo (Japan) (pp. 15-17).

Schneider, C. Q. and Rohlfing, I. (2016) ‘Case studies nested in fuzzy-set QCA on sufficiency: Formalizing case selection and causal inference’, *Sociological Methods and Research*, 45(3), pp. 526–568. doi: 10.1177/0049124114532446.

Schneider, C. Q. and Wagemann, C. (2006) ‘Reducing complexity in qualitative comparative analysis (QCA): Remote and proximate factors and the consolidation of democracy’, *European Journal of Political Research*, 45(5), pp. 751–786. doi: 10.1111/j.1475-6765.2006.00635.x.

Schneider, C. Q. and Wagemann, C. (2010) ‘Standards of good practice in qualitative comparative analysis (QCA) and fuzzy-sets’, *Comparative Sociology*, 9(3), pp. 397–418. doi: 10.1163/156913210X12493538729793.

Schneider, C. and Wagemann, C. (2012) *Set-theoretic methods for the social sciences: A guide to qualitative comparative analysis*. Cambridge: Cambridge University Press. doi: 10.1080/13645579.2013.762611.

Scopus (2017). Available at: https://www.elsevier.com/__data/assets/pdf_file/0007/69451/0597-Scopus-Content-Coverage-Guide-US-LETTER-v4-HI-singles-no-ticks.pdf (Accessed: 7 April 2018).

Shannon, C. E. (1940) ‘A symbolic analysis of relay and switching circuits’, *Transactions of the American Institute of Electrical Engineers*, 57, pp. 713–723. doi: 10.1109/T-AIEE.1938.5057767.

Siebrits, F. K. (2014) *The influence of fiscal policymaking frameworks on fiscal outcomes : Evidence from the European Union*. Doctoral dissertation, Stellenbosch: Stellenbosch University.

Sigurgeirsdóttir, S., Waagfjörð, J. and Maresso, A. (2014) 'Iceland: health system review', *Health Systems in Transition*, 16(6), p. 1. Available at: http://uq.summon.serialssolutions.com/2.0.0/link/0/eLvHCXMwjV3LCsIwEFx8XLz4wPeL_IC1ibG23kQUPQgevEvTblDQqP9_MWmsaEHwvLAEsuwOm5kJwIQ57ijTEzw-FX7oc0pnEcYopyFlgrN45sboSpFdf6S22wmFPxJnR12ujjqfEqalHRRjXWsJwSAPRWps2cynl_udMfd9BTJAMRkY6wqk4u6UKPJ-PX58am--_Bj_OUYV.

Skocpol, T. (1979) *States and social revolutions: A comparative analysis of France, Russia, and China.* Cambridge and New York: Cambridge University Press.

Smelser, N. J. (1973) 'The methodology of comparative analysis.', Comparative research methods, 6(2–3), pp. 7–21. doi: https://doi.org/10.1177/053901846700600201.

Social Protection and Universal Health Coverage (UHC) (2017). Available at: https://thl.fi/fi/web/thlfi-en/research-and-expertwork/projects-and-programmes/eu-social-protection-systems-programme-eu-sps/research-on-social-protection/social-protection-and-universal-health-coverage-uhc- (Accessed: 18 July 2018).

Stokke, O. S. (2007) 'Qualitative comparative analysis, shaming, and international regime effectiveness', *Journal of Business Research*, 60, pp. 501–511. doi: 10.1016/j.jbusres.2007.01.003.

Striessnig, E. and Lutz, W. (2014) 'How does education change the relationship between fertility and age-dependency under environmental constraints? A long-term simulation exercise', *Demographic Research*, 30(1), pp. 465–492. doi: 10.4054/DemRes.2014.30.16.

Stuckler, D., Feigl, A.B., Basu, S. and McKee, M., 2010, November. The political economy of universal health coverage. In Background paper for the global symposium on health systems research. Geneva: World Health Organization.

Suppes, P. (1970) 'A probabilistic theory of causality', *Journal of the American Statistical Association*, 67, p. 245. doi: 10.2307/2284742.

Tacq, J. (2011) 'Causality in qualitative and quantitative research', *Quality and Quantity*, 45(2), pp. 263–291. doi: 10.1007/s11135-009-9293-0.

Teperi, J. *et al*. (2009) *The Finnish health care system: A value-based perspective*. Available at: https://www.sitra.fi/julkaisut/raportti82.pdf%5Cnhttp://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Finnish+Health+Care+System:+A+Value-Based+Perspective#0.

Thiem, A. and Dusa, A. (2013) 'QCA: A package for qualitative comparative analysis', *The R Journal*, 5(1), pp. 87–97.

Thomann, E., Oana, I. E. and Wittwer, S. (2018a) *Performing fuzzy- and crisp-set QCA with R: A user-oriented beginner's guide*. Version 07.03.2018. Available at: http://www.evathomann.com/links/qca-r-manual.

Timberlake, M. and Ragin, C. C. (1987) 'The comparative method: Moving beyond qualitative and quantitative strategies', *Social Forces*, 67, p. 827. Available at: https://doi.org/10.2307/2579563.

TV Households, Percent all Households (2012). Available at: https://www.nakono.com/tekcarta/databank/tv-households-percent-all-households/ (Accessed: 14 April 2018).

UHC Service Coverage Index (2015) *World Health Organization*. Available at: http://apps.who.int/gho/cabinet/uhc-service-coverage.jsp (Accessed: 7 May 2018).

UN (2014) *Classification of world economies*. Available at: www.un.org/en/development/desa/policy/.../2014wesp_country_classification.pdf%0A (Accessed: 18 July 2018).

UNESCO Institute for Statistics (2014) *Adult literacy rate as % of total population, World Bank Data*. Available at: http://databank.worldbank.org/data/reports.aspx?source=education-statistics-~-all-indicators# (Accessed: 21 April 2018).

United Nations (2000) *Category: Millennium Development Goals*. Available at: http://www.mdgmonitor.org/millennium-development-goals/ (Accessed: 18 July 2018).

United Nations (2014) Country classification Data. Data sources, country classifications and aggregation methodology. doi: http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20421402~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html#Low_income (Accessed February 5, 2007).

United Nations Population Division (2014) *Urban population as % of total, World Urbanization Prospects*. Available at: https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS (Accessed: 21 April 2018).

United Nations Population Division (2017) *Fertility rate total births per woman, World Population Prospects: 2017 revision*. Available at: https://data.worldbank.org/indicator/SP.DYN.TFRT.IN (Accessed: 6 May 2018).

United Nations Sustainable Development Solutions Network (2015) 'Financing universal health coverage in the post-2015 agenda', *Thematic Group on Health for All*, (February 24), pp. 1–11. Available at: http://unsdsn.org/wp-content/uploads/2015/02/150224-Financing-for-UHC.pdf.

Vis, B. (2010) 'The comparative advantages of fsQCA and regression analysis for moderately large-N analyses', *Sociological Methods & Research*, 41(1), pp. 168–198.

Wagemann, C. (2013) 'Qualitative Comparative Analysis (QCA) and Fuzzy Sets Pros and Cons of Crisp-Sets', in. Frankfurt: Goethe-Universität.

WHO (2000) *The world health report*. Available at: http://www.who.int/whr/2000/en/whr00_en.pdf (Accessed: 17 July 2018).

WHO (2015a) *GDP per capita (current US$)*. Available at: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD (Accessed: 11 August 2018).

WHO (2015b) *Malaria, Global Health Observatory (GHO) data*. Available at: http://www.who.int/gho/malaria/en/ (Accessed: 6 October 2018).

WHO (2017) *GDP ranking*. Available at: https://datacatalog.worldbank.org/dataset/gdp-ranking (Accessed: 11 August 2018).

Wiley, M. M. (2005) 'The Irish health system: Developments in strategy, structure, funding and delivery since 1980', *Health Economics*, 14(SUPPL. 1), pp. 169–186. doi: 10.1002/hec.1034.

World Bank (2014) 'Gross enrolment ratio, tertiary, both sexes (%)', UNESCO Institute for Statistics. Montreal.

World Bank (2015) *Female population % of total*. Available at: https://data.worldbank.org/indicator/SP.POP.TOTL.FE.ZS (Accessed: 14 April 2018).

World Economic Forum (2015) *Network Readiness Index, Global Information Technology Forum*. Available at: http://reports.weforum.org/global-information-technology-report-2015/network-readiness-index/ (Accessed: 14 April 2018).

World Health Assembly (2005) 'Social health insurance: sustainable health financing, universal coverage and social health insurance: report by the Secretariat.', World Health Assembly Resolution 58.33. Geneva, Switzerland. Available at: http://apps.who.int/iris/bitstream/10665/20302/1/A58_20-en.pdf?ua=1.

World Health Organization (2016) *Prevalence of obesity among adults*, Geneva: World Health Organization. Available at: http://apps.who.int/gho/data/view.main.CTRY2450A?lang=en (Accessed: 21 April 2018).

World Health Organization (2014) *Current health expenditure % of GDP*, Global Health Expenditure database.

World Health Organization (2010) *World Health Report, 2010: Health systems financing the path to universal coverage*. Geneva: World Health Organization. Available at: http://apps.who.int/iris/bitstream/handle/10665/44371/9789241564021_eng.pdf?sequence=1.

World Health Organization. Making fair choices on the path to universal health coverage. Geneva: World Health Organization; 2014.

World Health Organization (2015) *Health in 2015: From MDGs, Millennium Development Goals to SDGs, Sustainable Development Goals*. Geneva: World Health Organization. doi: 978 92 4 156511 0.

World Health Organization (2016a) *Total alcohol consumption per capita*, Global Health Observatory Data Repository.

World Health Organization (2016b) *World health statistics 2016: Monitoring health for the SDG's sustainable development goals*, Geneva: World Health Organization. doi: 10.1017/CBO9781107415324.004.

World Health Organization (2017) *Tracking universal health coverage: 2017 global monitoring report*. Geneva: World Health Organization. doi: Licence: CC BY-NC-SA 3.0 IGO.

World Health Organization (2018) *WHO meeting: Universal health coverage*. Geneva: World Health Organization. Available at: https://transactivists.org/who-meeting-universal-health-coverage/ (Accessed: 9 June 2018).

World Health Organization (WHO) (2015) *Tracking universal health coverage: First global monitoring report*. Geneva: World Health Organization.

Zikmund, W.G., Babin, B.J., Carr, J.C. and Griffin, M. (2013) *Business research methods*. Orlando: The Dryer Press/.

APPENDIX A CONDITIONS INFLUENCING UHC OUTCOMES

'Access to essential medicines' AND improving	**'Antiretroviral treatment coverage'**	**'Prevalence of raised blood glucose'**
data utilisation	Services Access	alcohol use
national guidelines	age population	control programs
research development	managed governance	doesn't eat enough fruit
training programs	sex workers_fm	education level
education level	parity level	gender
generic availability	gender split	overweight
information system	gender violence	rural/urban
health spending	guideline simplification	**'safely managed drinking-water'**
supply systems	health spending	education level
inflation growth	literacy level	type sanitiation
innovative regulation	MWSM percentage	type water source
international pricing policies	peer support	economic status
'Cervical Cancer screening coverage'	political will	**'IHR compliance'**
median age	poverty extent	health spending
car ownership	stigma management	**'Antenatal Coverage'**
control programmes	**'Child immunization coverage'**	pregnancy age
education level	concentration index	control programmes
embarrassment cliché	control programs	economic status
employment status	birth order	education
health education	children age	delivery model
medical insurance	hospital delivery	lack of privacy
health spending	economic status	literacy
economic status	cultural status	midwife to population
population married	data collection	minority ethnicity
public transport	employment rate	negative staff attitudes
self-sampling	gender split	non-westernised
'Health-worker density'	health education	own television
career planning	health spending	parity
female literacy	household structure (parent, two-parent, cohabiting and extended)	quality of service delivery
information system	logistical access	regulated/policy
health spending	media access	**'Health-seeking behaviour for child pneumonia'**
worker incentives	mother's age	air pollution
'Health-worker density' (continued)	**'Child immunization coverage' (continued)**	**'Health-seeking behaviour for child pneumonia' (continued)**

poverty level	mother's literacy	community-based health
private public	own television	economic status
rural urban	gender parity	education level
land typography	**‘Child immunization coverage’**	exclusive breastfeeding
doctors gender	quality assurance	health spending
working conditions	rural urban	industrialisation
‘Prevalence of raised blood pressure’	school attendance	malnutrition extent
ageing	secondary education	smoking prevalence
alcohol use	communities values	**‘Tuberculosis treatment coverage’**
car accidents	working mothers	age TB
control programs	**‘Family planning coverage’**	asylum seekers
education level	abortion legal	control programs
gender with raised blood pressure	age at first marriage	gender TB
not married	economic status	health spending
overweight	Education	service quality
fertility rate	employment status	patient support
‘Non-use of tobacco’	Ethnicity	rural urban
control programs	formal/informal	**‘hospital access’ AND basic**
curiosity phenomenon	Investment	24 hour
health education	Married	electrical infrastructure
overweight %	media access	ethnic minority
peer pressure	partner education	generator provision
‘OOP spending’ OR ‘OOP expenses’ AND ‘protection’	fertility rate	health spending
population age	regulated/policy	rural urban
big families	rural/urban	
health spending	sexually active	
in-patient days	**‘safely managed sanitation services’**	
income level	faecal energy	
Kakwani index	decentralized sanitation	
public private	low-flush toilets	
rural urban	economic parity	
	Fertility rate	
	separate waste	
	reuse treatment	

APPENDIX B CONDITION VARIABLES – FOR ANALYSIS

Country	UHC_OUT	ALC_IN	EMP_IN	GEN_IN	HEA_IN	OBE_IN	CLA_IN	URB_IN	FAM_IN
ARG	76.00	9.80	55.87	51.07	4.79	27.80	2.00	91.75	2.31
ARM	67.00	5.50	48.88	53.01	4.48	19.70	1.00	62.67	1.62
AUS	80.00	10.60	61.11	50.16	9.42	28.40	3.00	89.42	1.81
AUT	80.00	11.60	56.66	51.04	11.21	19.70	3.00	65.97	1.49
BLR	74.00	11.20	63.94	53.48	5.69	24.10	2.00	76.67	1.72
BEL	80.00	12.10	48.91	50.84	10.59	21.70	3.00	97.86	1.70
BIH	57.00	6.40	34.47	50.92	9.57	17.50	2.00	39.77	1.35
BRA	77.00	7.80	58.69	50.82	8.32	21.60	2.00	85.69	1.74
BGR	64.00	12.70	49.23	51.37	8.44	24.50	2.00	73.95	1.53
CAN	80.00	8.90	61.01	50.40	10.45	28.80	3.00	81.83	1.60
CHL	70.00	9.30	58.21	50.48	7.79	27.50	3.00	89.53	1.79
CRI	75.00	4.80	56.41	49.97	9.31	25.00	2.00	76.82	1.80
HRV	69.00	8.90	44.33	51.82	7.80	23.90	2.00	58.96	1.40
CZE	73.00	14.40	56.61	50.86	7.41	25.60	3.00	72.99	1.57
DNK	80.00	10.40	58.20	50.27	10.80	19.30	3.00	87.68	1.71
EST	76.00	11.60	58.35	53.23	6.38	20.90	3.00	67.54	1.58
FIN	79.00	10.70	53.31	50.79	9.68	21.80	3.00	84.22	1.65
DEU	79.00	13.40	57.49	50.82	11.30	21.90	3.00	75.30	1.50
GRC	70.00	10.40	39.87	50.76	8.08	24.40	3.00	78.01	1.33
HUN	70.00	11.40	51.08	52.47	7.40	25.90	3.00	71.23	1.45
ISL	80.00	9.10	73.95	49.83	8.86	21.50	3.00	94.14	1.80
IRL	78.00	13.00	54.57	50.40	7.78	24.70	3.00	63.24	1.92
ITA	80.00	7.50	42.61	51.33	9.25	19.60	3.00	68.96	1.35
JPN	80.00	8.00	57.99	51.14	10.23	4.10	3.00	93.50	1.45
LVA	64.00	12.90	54.30	54.10	5.88	23.30	3.00	67.38	1.70
LUX	80.00	13.00	55.40	49.81	6.94	22.20	3.00	90.16	1.47
MNG	63.00	7.40	57.40	50.49	4.73	19.90	1.00	72.04	2.79
NOR	80.00	7.50	62.10	49.65	9.72	22.60	3.00	80.47	1.72
OMN	72.00	0.80	58.58	35.16	3.55	26.30	3.00	77.64	2.74
PAN	75.00	7.90	63.48	49.86	8.03	22.20	2.00	66.59	2.54
PRT	80.00	12.30	51.34	52.62	9.50	20.40	3.00	63.47	1.31
KOR	80.00	10.20	60.19	49.94	7.20	4.50	3.00	82.47	1.24
ROU	72.00	12.60	50.62	51.53	5.57	22.10	2.00	54.56	1.58
RUS	63.00	11.70	60.11	53.54	7.07	22.80	2.00	74.01	1.75
SRB	65.00	11.10	42.69	51.13	10.37	21.10	2.00	55.55	1.46
SVK	76.00	11.50	52.76	51.40	8.05	20.10	3.00	53.60	1.40
SVN	78.00	12.60	52.23	50.39	9.23	19.80	3.00	49.65	1.57
ESP	77.00	10.00	45.47	50.93	9.03	23.40	3.00	79.58	1.33
SWE	80.00	9.20	59.21	50.02	11.93	20.20	3.00	85.82	1.85
CHE	80.00	11.50	64.94	50.51	11.66	19.10	3.00	73.91	1.54
THA	75.00	8.30	68.65	51.17	4.12	9.40	2.00	50.37	1.50
TUN	65.00	1.90	40.02	50.59	7.00	26.30	1.00	66.84	2.22
UKR	63.00	8.60	49.58	53.79	7.10	23.70	1.00	69.70	1.51
GBR	80.00	11.40	58.94	50.71	9.12	27.20	3.00	82.59	1.80
URY	79.00	10.80	60.08	51.73	8.58	27.50	3.00	95.31	2.01

APPENDIX C CALIBRATION DETAILS

Table 39: Calibration of equal population, female (% of total)

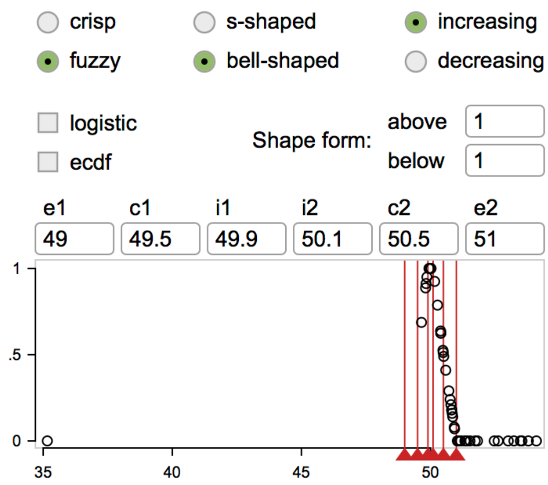
<table>
<tr><td>Variable description</td><td colspan="2">Equal population, female (% of total)</td></tr>
<tr><td>Threshold selection reasoning</td><td colspan="2">The aim is to have a close to equal population, selected inclusion was therefore selected as 49.9% and 50.1%, cross-over as 49.5% and 50.5% and exclusion as 49% and 51% .</td></tr>
<tr><td>Calibration technique</td><td colspan="2">Direct method for bell-shaped functions was used because of this variable's distribution that causes it to be more included in membership as it increases up to a point and then then becomes less included as it increases past that point.</td></tr>
<tr><td>Remote/Proximate</td><td>Remote</td><td rowspan="4">
</td></tr>
<tr><td>Abbreviation</td><td>GEN_NEW</td></tr>
<tr><td>Variable type</td><td>Ratio</td></tr>
<tr><td>Thresholds</td><td>E1 = 49
C1 = 49.5
I1 = 49.9
I2 = 50.1
C2 = 50.5
E2 = 51</td></tr>
</table>

Table 40: Calibration of high health expenditure

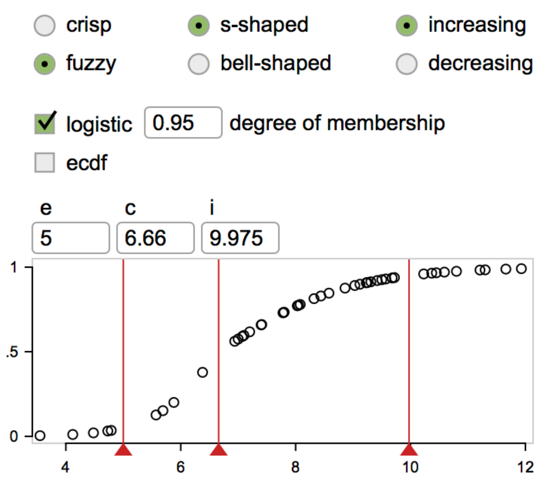
Variable description	High health expenditure, total (% of GDP)	
Threshold selection reasoning	McIntyre, Meheus and Rottingen (2017) suggested governments should spend at least 5%, which was used as the exclusion point. The rest of the thresholds were selected with r's threshold selector. the assumption also is that spending too much on health would never be bad for UHC outcomes.	
Calibration technique	Direct method for increasing s-shaped functions was used because of this variable's distribution that causes it to be more included in membership as the variable's value increases.	
Remote/Proximate	Proximate	
Abbreviation	HEA_NEW	
Variable type	Ratio	
Thresholds	E=5 C=6.66 I=9.975	

Table 41: Calibration of sustainable fertility rate

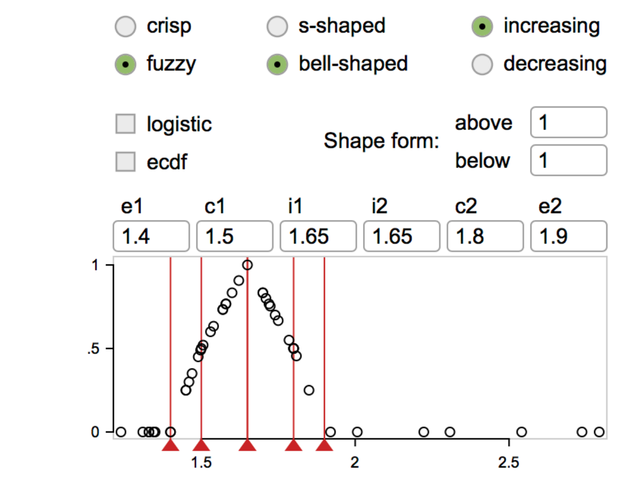
<table>
<tr><td>Variable description</td><td colspan="2">Sustainable fertility rate (annual %)</td></tr>
<tr><td>Threshold selection reasoning</td><td colspan="2">According to Striessnig and Lutz (2014) optimal fertility rate is between 1.5 and 1.8 when considering environmental constraints. These were used as the cross-over points, the mid-point between them, was selected as both inclusions and exclusion was selected 0.1 outside of these cross-over points.</td></tr>
<tr><td>Calibration technique</td><td colspan="2">Direct method for bell-shaped functions was used because of this variable's distribution that causes it to be more included in membership as it increases up to a point and then then becomes less included as it increases past that point.</td></tr>
<tr><td>Remote/Proximate</td><td>Remote</td><td rowspan="4">
</td></tr>
<tr><td>Abbreviation</td><td>FAM_NEW</td></tr>
<tr><td>Variable type</td><td>Ratio</td></tr>
<tr><td>Thresholds</td><td>E1 = 1.4
c1 = 1.5
i1 = 1.65
i2 = 1.65
c2 = 1.8
e2 = 1.9</td></tr>
</table>

Table 42: Calibration of high country classification

Variable description	High country classification	
Threshold selection reasoning	According to the United Nations (2014) country development can be classified into Low, Lower middle, Upper middle, High. A crisp value was simply allocated to these variables.	
Calibration technique	Crisp recoding because this is a categorical variable.	
Remote/Proximate	Remote	
Abbreviation	CLA_NEW	
Variable type	Ordinal variable	
Thresholds	'Upper middle income'=2 ' High income '=3 ' Lower middle income'=1 and 'Low' = 0	

Table 43: Calibration of high urban population

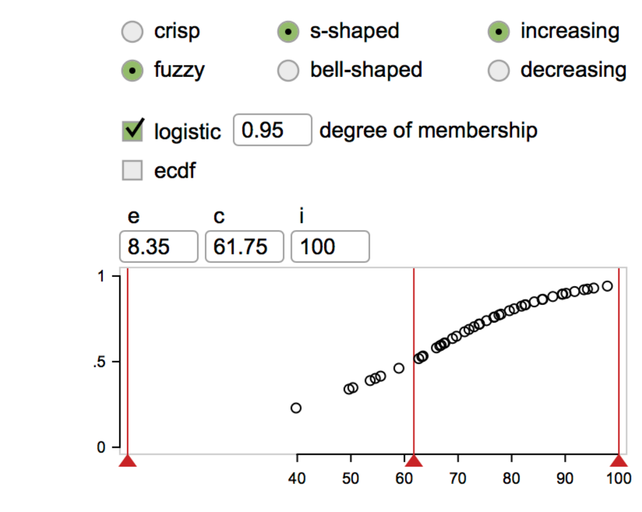
Variable description	High urban population (% of total)	
Threshold selection reasoning	R's threshold selector was used to find c on the global dataset. As well as max and min for I and e. The assumption was that the more urban a country is the more 'in' it will be in the membership scores and therefore an increasing s-shape selection was used.	
Calibration technique	Direct method for increasing s-shaped functions was used because of this variable's distribution that causes it to be more included in membership as the variable's value increases.	
Remote/Proximate	Remote	
Abbreviation	URB_NEW	
Variable type	Ratio	
Thresholds	e = 8.35 c = 61.75 i = 100	

Table 44: Calibration of low prevalence of obesity among adults

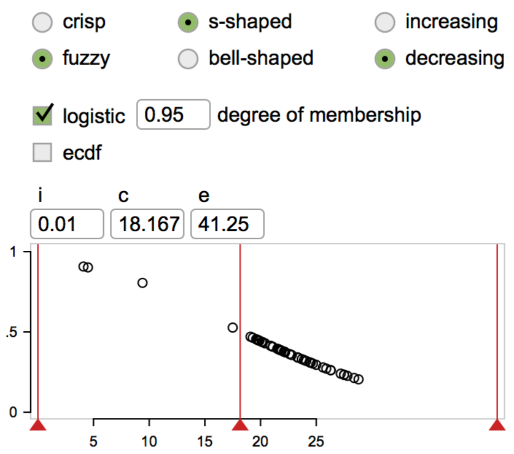
<table>
<tr><td>Variable description</td><td colspan="2">Low prevalence of obesity among adults, BMI &>=18+ years</td></tr>
<tr><td>Threshold selection reasoning</td><td colspan="2">The assumption was that the aim is to drive this measure to 0 and therefore I is set to 0.01. The other thresholds were selected with R's thresholds selector.</td></tr>
<tr><td>Calibration technique</td><td colspan="2">Direct method for decreasing s-shaped functions was used because of this variable's distribution that causes it to be less included in membership as the variable's value increases.</td></tr>
<tr><td>Remote/Proximate</td><td>Proximate</td><td rowspan="4">
</td></tr>
<tr><td>Abbreviation</td><td>OBE_NEW</td></tr>
<tr><td>Variable type</td><td>Ratio</td></tr>
<tr><td>Thresholds</td><td>e = 41.25
c = 18.167
i = 0.01</td></tr>
</table>

Table 45: Calibration of low total alcohol consumption

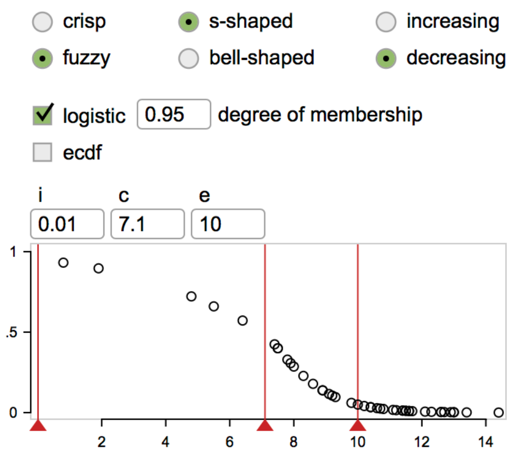
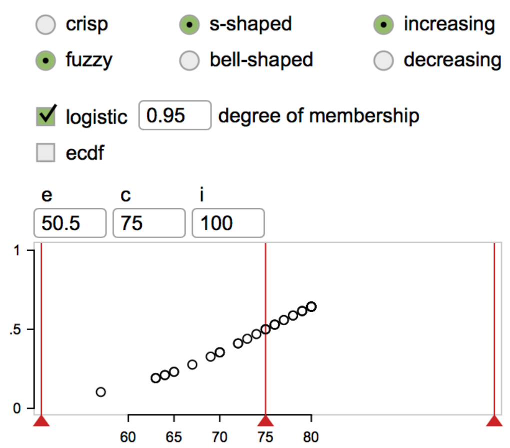
Variable description	Low total alcohol consumption per capita (liters of pure alcohol, projected estimates, 15+ years of age)	
Threshold selection reasoning	The assumption was that the aim is to drive this measure to 0 and therefore I is set to 0.01. The exclusion had to be close to 10 because according to Bronkhorst (2014) this is a negatively high consumption. R's threshold selector was used to select the cross-over.	
Calibration technique	Direct method for decreasing s-shaped functions was used because of this variable's distribution that causes it to be less included in membership as the variable's value increases.	
Remote/Proximate	Proximate	
Abbreviation	ALC_NEW	
Variable type	Continuous	
Thresholds	e = 10 c = 7.1 i = 0.01	

Table 46: Calibration of high Universal Health Coverage Service Coverage Index

Variable description	High universal Health Coverage Service Coverage Index	
Threshold selection reasoning	R's threshold selector was used to find all the exclusion. For the other 2, it was assumed that it would be ideal to have 100% UHC coverage so this was set for the inclusion. A mid-point was manually chosen for the cross-over thresholds.	
Calibration technique	Direct method for increasing s-shaped functions was used because of this variable's distribution that causes it to be more included in membership as the variable's value increases.	
Remote/Proximate	NA	
Abbreviation	UHC_NEW	
Variable type	Ratio	
Thresholds	e = 29 c = 62.28 i = 83.3	

APPENDIX D CALIBRATED DATASET

Country	EMP_NEW	GEN_NEW	HEA_NEW	FAM_NEW	CLA_NEW	URB_NEW	OBE_NEW	ALC_NEW	UHC_NEW
ARG	0.69	0	0.03	0	2	0.91	0.23	0.06	0.53
ARM	0.54	0	0.02	0.91	1	0.52	0.45	0.66	0.28
AUS	0.78	0.93	0.92	0.46	3	0.89	0.21	0.03	0.64
AUT	0.7	0	0.98	0.45	3	0.58	0.45	0.01	0.64
BLR	0.82	0	0.15	0.75	2	0.76	0.32	0.02	0.47
BEL	0.54	0.16	0.97	0.83	3	0.94	0.39	0.01	0.64
BIH	0.01	0.08	0.93	0	2	0.23	0.53	0.57	0.1
BRA	0.74	0.18	0.81	0.7	2	0.86	0.39	0.33	0.56
BGR	0.55	0	0.83	0.6	2	0.72	0.31	0	0.21
CAN	0.78	0.63	0.97	0.83	3	0.82	0.2	0.14	0.64
CHL	0.73	0.53	0.73	0.55	3	0.89	0.23	0.1	0.35
CRI	0.7	1	0.91	0.501	2	0.76	0.29	0.72	0.501
HRV	0.24	0	0.73	0	2	0.46	0.32	0.14	0.33
CZE	0.7	0.14	0.66	0.73	3	0.7	0.28	0	0.44
DNK	0.73	0.79	0.98	0.8	3	0.88	0.46	0.03	0.64
EST	0.73	0	0.38	0.77	3	0.61	0.41	0.01	0.53
FIN	0.63	0.21	0.94	1	3	0.85	0.39	0.03	0.62
DEU	0.72	0.18	0.98	0.501	3	0.74	0.38	0	0.62
GRC	0.05	0.24	0.78	0	3	0.78	0.31	0.03	0.35
HUN	0.59	0	0.66	0.25	3	0.67	0.27	0.01	0.35
ISL	0.92	0.91	0.88	0.501	3	0.92	0.4	0.12	0.64
IRL	0.66	0.63	0.73	0	3	0.53	0.3	0	0.59
ITA	0.13	0	0.91	0	3	0.64	0.45	0.4	0.64
JPN	0.73	0	0.96	0.25	3	0.92	0.91	0.29	0.64
LVA	0.65	0	0.2	0.83	3	0.61	0.34	0	0.21
LUX	0.68	0.89	0.56	0.35	3	0.9	0.37	0	0.64
MNG	0.71	0.51	0.03	0	1	0.69	0.44	0.42	0.19
NOR	0.79	0.69	0.94	0.77	3	0.81	0.36	0.4	0.64
OMN	0.74	0	0	0	3	0.77	0.26	0.93	0.41
PAN	0.81	0.95	0.77	0	2	0.59	0.37	0.31	0.501
PRT	0.59	0	0.93	0	3	0.53	0.43	0.01	0.64
KOR	0.76	1	0.62	0	3	0.83	0.9	0.04	0.64
ROU	0.58	0	0.13	0.77	2	0.4	0.38	0	0.41
RUS	0.76	0	0.59	0.67	2	0.72	0.36	0.01	0.19
SRB	0.14	0	0.96	0.3	2	0.42	0.41	0.02	0.23
SVK	0.62	0	0.77	0	3	0.39	0.44	0.01	0.53
SVN	0.61	0.64	0.91	0.73	3	0.34	0.45	0	0.59
ESP	0.33	0.07	0.89	0	3	0.8	0.34	0.05	0.56
SWE	0.75	1	0.99	0.25	3	0.86	0.44	0.11	0.64
CHE	0.83	0.49	0.99	0.63	3	0.72	0.47	0.01	0.64
THA	0.87	0	0.01	0.49	2	0.35	0.81	0.23	0.501
TUN	0.05	0.41	0.57	0	1	0.6	0.26	0.9	0.23
UKR	0.55	0	0.6	0.52	1	0.65	0.33	0.18	0.19
GBR	0.74	0.29	0.9	0.501	3	0.83	0.24	0.01	0.64
URY	0.76	0	0.85	0	3	0.93	0.23	0.02	0.62

APPENDIX E RAW TRUTH TABLE

The truth table was compiled by running the code in R Studio below, inputting the calibrated data listed in APPENDIX D:

```
TT_RAW=truthTable(TT_REV_5, outcome = 'UHC_NEW', conditions = 'EMP_NEW, GEN_NEW, HEA_NEW, FAM_NEW, CLA_NEW, URB_NEW, OBE_NEW, ALC_NEW', incl.cut=0.85, complete=TRUE, show.cases = TRUE, sort.by = 'n', details = TRUE)
```

	EMP_NEW	GEN_NEW	HEA_NEW	FAM_NEW	CLA_NEW	URB_NEW	OBE_NEW	ALC_NEW	OUT	n	incl	PRI	cases
381	1	0	1	1	3	1	0	0	1	6	0.949	0.731	BEL,CZE,FIN,DEU,CHE,GBR
509	1	1	1	1	3	1	0	0	1	5	0.968	0.855	CAN,CHL,DNK,ISL,NOR
349	1	0	1	0	3	1	0	0	1	4	0.937	0.644	AUT,HUN,PRT,URY
477	1	1	1	0	3	1	0	0	1	4	0.981	0.895	AUS,IRL,LUX,SWE
93	0	0	1	0	3	1	0	0	1	3	0.929	0.419	GRC,ITA,ESP
373	1	0	1	1	2	1	0	0	0	3	0.638	0.132	BRA,BGR,RUS
81	0	0	1	0	2	0	0	0	0	2	0.609	0.000	HRV,SRB
317	1	0	0	1	3	1	0	0	0	2	0.836	0.115	EST,LVA
78	0	0	1	0	1	1	0	1	0	1	0.575	0.000	TUN
84	0	0	1	0	2	0	1	1	0	1	0.547	0.000	BIH
275	1	0	0	0	2	0	1	0	1	1	0.950	0.020	THA
277	1	0	0	0	2	1	0	0	1	1	0.874	0.167	ARG
286	1	0	0	0	3	1	0	1	0	1	0.761	0.000	OMN
302	1	0	0	1	1	1	0	1	0	1	0.657	0.000	ARM
305	1	0	0	1	2	0	0	0	0	1	0.841	0.000	ROU
309	1	0	0	1	2	1	0	0	0	1	0.793	0.000	BLR
345	1	0	1	0	3	0	0	0	1	1	0.994	0.885	SVK
351	1	0	1	0	3	1	1	0	1	1	0.989	0.865	JPN
365	1	0	1	1	1	1	0	0	0	1	0.389	0.000	UKR
397	1	1	0	0	1	1	0	0	0	1	0.429	0.000	MNG
469	1	1	1	0	2	1	0	0	1	1	0.916	0.022	PAN
479	1	1	1	0	3	1	1	0	1	1	1.000	1.000	KOR
502	1	1	1	1	2	1	0	1	1	1	1.000	1.000	CRI
505	1	1	1	1	3	0	0	0	1	1	1.000	1.000	SVN

APPENDIX F TRUTH TABLE FOR REMOTE CONDITIONS

The truth table containing only remote conditions was compiled by running the code in R Studio below, inputting the calibrated data listed in APPENDIX D:

```
TT_REM <- truthTable(TT_REV_5, outcome='UHC_NEW', conditions = 'EMP_NEW, GEN_NEW, FAM_NEW, CLA_NEW, URB_NEW', incl.cut=0.85, sort.by='incl, n', decreasing=TRUE, show.cases=TRUE)
```

	EMP_NEW	GEN_NEW	FAM_NEW	CLA_NEW	URB_NEW	OUT	n	incl	PRI	cases
62	1	1	1	2	1	1	1	1.000	1.000	CRI
63	1	1	1	3	0	1	1	0.992	0.900	SVN
39	1	0	0	3	0	1	1	0.985	0.742	SVK
64	1	1	1	3	1	1	5	0.946	0.790	CAN,CHL,DNK,ISL,NOR
56	1	1	0	3	1	1	5	0.946	0.791	AUS,IRL,LUX,KOR,SWE
54	1	1	0	2	1	1	1	0.930	0.022	PAN
8	0	0	0	3	1	1	3	0.924	0.437	GRC,ITA,ESP
37	1	0	0	2	0	1	1	0.924	0.012	THA
40	1	0	0	3	1	1	6	0.900	0.561	AUT,HUN,JPN,OMN,PRT,URY
48	1	0	1	3	1	1	8	0.884	0.533	BEL,CZE,EST,FIN,DEU,LVA,CHE,GBR
45	1	0	1	2	0	0	1	0.847	0.000	ROU
38	1	0	0	2	1	0	1	0.836	0.109	ARG
46	1	0	1	2	1	0	4	0.652	0.088	BLR,BRA,BGR,RUS
5	0	0	0	2	0	0	3	0.582	0.000	BIH,HRV,SRB
4	0	0	0	1	1	0	1	0.493	0.000	TUN
44	1	0	1	1	1	0	2	0.452	0.000	ARM,UKR
52	1	1	0	1	1	0	1	0.429	0.000	MNG

APPENDIX G NECESSITY CALCULATION FOR REMOTE CONDITIONS

The necessity conditions of the truth table containing the remote conditions was calculated by running the code in R Studio below, inputting the calibrated data listed in APPENDIX D:

```
nec=superSubset(TT_REV_5, outcome = 'UHC_NEW', conditions = 'EMP_NEW, GEN_NEW, FAM_NEW, CLA_NEW, URB_NEW', incl.cut = 0.85, cov.cut = 0.6, ron.cut = 0.6)
```

```
> nec

                                  inclN  RoN    covN
----------------------------------------------------
1  EMP_NEW{1}                     0.925  0.695  0.727
2  EMP_NEW{1}*URB_NEW{1}          0.891  0.759  0.759
3  GEN_NEW{1}+FAM_NEW{1}+URB_NEW{0}  0.864  0.632  0.662
----------------------------------------------------
```

APPENDIX H CONSERVATIVE CALCULATION FOR REMOTE CONDITIONS

Using the truth table calculated in APPENDIX F the conservative solutions is calculated as well as the calculation for the XY plot for the prime implicants using the in R Studio code below. The results for the minimisation is shown below:

```
###minimise truth table using conservative solution
TT_REM_conserv <- minimize(TT_REM, outcome = 'UHC_NEW', incl.cut = 0.5, details = TRUE)
##plot the XY plot for the prime implicants
pimplot(data = TT_REM, results = TT_REM_conserv, outcome = 'UHC_NEW', sol = 1, case_labels=TRUE)
```

```
> TT_REM_conserv

n OUT = 1/0/C: 32/13/0
  Total      : 45

Number of multiple-covered cases: 11

M1: EMP_NEW{1}*CLA_NEW{3}*URB_NEW{1} + EMP_NEW{1}*GEN_NEW{0}*FAM_NEW{0}*CLA_NEW{3} + EMP_NEW{1}*GEN_NEW{1}*FAM_NEW{1}*CLA_NEW{3} +
    EMP_NEW{1}*GEN_NEW{1}*CLA_NEW{2}*URB_NEW{1} + GEN_NEW{0}*FAM_NEW{0}*CLA_NEW{3}*URB_NEW{1} + EMP_NEW{1}*GEN_NEW{0}*FAM_NEW{0}*CLA_NEW{2}*URB_NEW{0} => UHC_NEW{1}

                                                           inclS  PRI    covS   covU
-------------------------------------------------------------------------------------
1  EMP_NEW{1}*CLA_NEW{3}*URB_NEW{1}                        0.817  0.581  0.670  0.162
2  EMP_NEW{1}*GEN_NEW{0}*FAM_NEW{0}*CLA_NEW{3}             0.893  0.562  0.379  0.009
3  EMP_NEW{1}*GEN_NEW{1}*FAM_NEW{1}*CLA_NEW{3}             0.945  0.802  0.270  0.011
4  EMP_NEW{1}*GEN_NEW{1}*CLA_NEW{2}*URB_NEW{1}             0.805  0.014  0.055  0.046
5  GEN_NEW{0}*FAM_NEW{0}*CLA_NEW{3}*URB_NEW{1}             0.831  0.456  0.418  0.048
6  EMP_NEW{1}*GEN_NEW{0}*FAM_NEW{0}*CLA_NEW{2}*URB_NEW{0}  0.924  0.012  0.094  0.084
-------------------------------------------------------------------------------------
   M1                                                      0.800  0.523  0.878

                                                           cases
----------------------------------------------------------------
1  EMP_NEW{1}*CLA_NEW{3}*URB_NEW{1}                        AUT,HUN,JPN,OMN,PRT,URY; BEL,CZE,EST,FIN,DEU,LVA,CHE,GBR; AUS,IRL,LUX,KOR,SWE; CAN,CHL,DNK,ISL,NOR
2  EMP_NEW{1}*GEN_NEW{0}*FAM_NEW{0}*CLA_NEW{3}             SVK; AUT,HUN,JPN,OMN,PRT,URY
3  EMP_NEW{1}*GEN_NEW{1}*FAM_NEW{1}*CLA_NEW{3}             SVN; CAN,CHL,DNK,ISL,NOR
4  EMP_NEW{1}*GEN_NEW{1}*CLA_NEW{2}*URB_NEW{1}             PAN; CRI
5  GEN_NEW{0}*FAM_NEW{0}*CLA_NEW{3}*URB_NEW{1}             GRC,ITA,ESP; AUT,HUN,JPN,OMN,PRT,URY
6  EMP_NEW{1}*GEN_NEW{0}*FAM_NEW{0}*CLA_NEW{2}*URB_NEW{0}  THA
----------------------------------------------------------------
```

APPENDIX I PARSIMONIOUS CALCULATION FOR REMOTE CONDITIONS

Using the truth table calculated in APPENDIX F the parsimonious solutions is calculated as well as the calculation for the XY plot for the prime implicants in the in R Studio shown below. The results for the minimisation is shown below:

```
###minimise truth table using parsimonious solution
TT_REM_min_pars<- minimize(TT_REM, outcome = 'UHC_NEW', include = '?', incl.cut = 0.5, details = TRUE)
##plot the XY plot for the prime implicants
pimplot(data = TT_REM, results = TT_REM_min_pars, outcome = 'UHC_NEW', sol = 1, case_labels=TRUE)
```

```
> TT_REM_min_pars

n OUT = 1/0/C: 32/13/0
  Total      : 45

Number of multiple-covered cases: 1

M1: CLA_NEW{3} + GEN_NEW{1}*CLA_NEW{2} + EMP_NEW{1}*FAM_NEW{0}*URB_NEW{0} => UHC_NEW{1}

                                      inclS   PRI    covS   covU
----------------------------------------------------------------
1  CLA_NEW{3}                         0.564  0.304  0.751  0.481
2  GEN_NEW{1}*CLA_NEW{2}              0.571  0.004  0.058  0.021
3  EMP_NEW{1}*FAM_NEW{0}*URB_NEW{0}   0.945  0.356  0.415  0.108
----------------------------------------------------------------
   M1                                 0.588  0.283  0.917

                                      cases
------------------------------------------
1  CLA_NEW{3}                         GRC,ITA,ESP; SVK; AUT,HUN,JPN,OMN,PRT,URY; BEL,CZE,EST,FIN,
DEU,LVA,CHE,GBR; AUS,IRL,LUX,KOR,SWE; SVN; CAN,CHL,DNK,ISL,NOR
2  GEN_NEW{1}*CLA_NEW{2}              PAN; CRI
3  EMP_NEW{1}*FAM_NEW{0}*URB_NEW{0}   THA; SVK
------------------------------------------
```

APPENDIX J INTERMEDIATE CALCULATION FOR REMOTE CONDITIONS

Using the truth table calculated in APPENDIX F the intermediate solutions is calculated as well as the calculation for the XY plot for the prime implicants in the in R Studio code below. The findRows() function finds all the expressions in the truth table that contains contradictions. The results for the minimisation is shown below:

```
#find contradictory rows
typeALL=findRows('EMP_NEW{0}, EMP_NEW{0}*URB_NEW{0}, GEN_NEW{0}+FAM_NEW{0}+URB_NEW{1}', obj = TT_REM, type = 0)
###minimise truth table using intermediate solution
TT_REM_min_inter <- minimize(TT_REM, exclude = typeALL, show.cases = TRUE, include = '?', details = TRUE, dir.exp = c(1,1,1,3,1))
##plot the XY plot for the prime implicants
pimplot(data = TT_REM, results = TT5_min_inter, outcome = 'UHC_NEW', sol = 1)
```

```
> TT_REM_min_inter

n OUT = 1/0/C: 32/13/0
  Total      : 45

From C1P1:

Number of multiple-covered cases: 0

M1:    EMP_NEW{1}*CLA_NEW{3}*URB_NEW{1} => UHC_NEW{1}

                                     inclS   PRI    covS   covU
---------------------------------------------------------------
1  EMP_NEW{1}*CLA_NEW{3}*URB_NEW{1}  0.817  0.581  0.670    -
---------------------------------------------------------------
   M1                                0.817  0.581  0.670

                                     cases
------------------------------------------
1  EMP_NEW{1}*CLA_NEW{3}*URB_NEW{1}  AUT,HUN,JPN,OMN,PRT,URY; BEL,CZE,EST,FIN,DEU,LVA,CHE,GBR;
                                     AUS,IRL,LUX,KOR,SWE; CAN,CHL,DNK,ISL,NOR
------------------------------------------
```

APPENDIX K TRUTH TABLE FOR COMBINED CONDITIONS

The truth table containing the remaining remote conditions added to the proximate conditions was compiled by running the code in R Studio below, inputting the calibrated data listed in APPENDIX D:

```
TT_REM <- truthTable(TT_REV_5, outcome=‘UHC_NEW’, conditions = ‘ EMP_NEW, HEA_NEW, CLA_NEW, URB_NEW, OBE_NEW, ALC_NEW’, ‘, incl.cut=0.85,
sort.by=‘incl, n’, decreasing=TRUE, show.cases=TRUE)
```

```
  OUT: output value
    n: number of cases in configuration
 incl: sufficiency inclusion score
  PRI: proportional reduction in inconsistency

      EMP_NEW HEA_NEW CLA_NEW URB_NEW OBE_NEW ALC_NEW   OUT    n   incl  PRI   cases
121      1       1       3       0       0       0       1     2   0.995 0.935 SVK,SVN
127      1       1       3       1       1       0       1     2   0.993 0.939 JPN,KOR
 61      0       1       3       1       0       0       1     3   0.942 0.479 GRC,ITA,ESP
 83      1       0       2       0       1       0       1     1   0.907 0.008 THA
125      1       1       3       1       0       0       1     19  0.902 0.717 AUS,AUT,BEL,CAN,CHL
,CZE,DNK,FIN,DEU,HUN,ISL,IRL,LUX,NOR,PRT,SWE,CHE,GBR,URY
 93      1       0       3       1       0       0       1     2   0.896 0.233 EST,LVA
 81      1       0       2       0       0       0       1     1   0.887 0.000 ROU
118      1       1       2       1       0       1       1     1   0.874 0.010 CRI
 85      1       0       2       1       0       0       0     2   0.823 0.092 ARG,BLR
 94      1       0       3       1       0       1       0     1   0.779 0.000 OMN
117      1       1       2       1       0       0       0     4   0.736 0.122 BRA,BGR,PAN,RUS
 52      0       1       2       0       1       1       0     1   0.677 0.000 BIH
 49      0       1       2       0       0       0       0     2   0.659 0.000 HRV,SRB
 78      1       0       1       1       0       1       0     1   0.598 0.000 ARM
 46      0       1       1       1       0       1       0     1   0.575 0.000 TUN
 77      1       0       1       1       0       0       0     1   0.526 0.000 MNG
109      1       1       1       1       0       0       0     1   0.446 0.000 UKR
```

APPENDIX L NECESSITY CALCULATION FOR COMBINED CONDITIONS

The necessity conditions of the truth table containing the combined conditions was calculated by running the code in R Studio below, inputting the calibrated data listed in APPENDIX D:

```
nec2=superSubset(TT_REV_5, outcome = 'UHC_NEW', conditions = 'EMP_NEW, HEA_NEW, CLA_NEW, URB_NEW, OBE_NEW, ALC_NEW', incl.cut = 0.85, cov.cut = 0.6, ron.cut = 0.6)
```

```
                                         inclN  RoN    covN
------------------------------------------------------------
 1  EMP_NEW{1}                           0.925  0.695  0.727
 2  OBE_NEW{0}                           0.905  0.693  0.717
 3  EMP_NEW{1}*URB_NEW{1}                0.891  0.759  0.759
 4  EMP_NEW{1}*ALC_NEW{0}                0.897  0.756  0.759
 5  HEA_NEW{1}*ALC_NEW{0}                0.857  0.642  0.665
 6  URB_NEW{1}*OBE_NEW{0}                0.884  0.750  0.750
 7  URB_NEW{1}*ALC_NEW{0}                0.929  0.660  0.706
 8  OBE_NEW{0}*ALC_NEW{0}                0.871  0.751  0.746
 9  EMP_NEW{1}*URB_NEW{1}*ALC_NEW{0}     0.864  0.806  0.788
10  URB_NEW{1}*OBE_NEW{0}*ALC_NEW{0}     0.850  0.798  0.776
------------------------------------------------------------
```

APPENDIX M INTERMEDIATE SOLUTION CALCULATION FOR COMBINED CONDITIONS

The intermediate solution containing the combined conditions was calculated by running the code in R Studio below, inputting the calibrated data listed in APPENDIX D:

```
##find contradictory rows

typeALL2=findRows('EMP_NEW{0}, OBE_NEW{1}, EMP_NEW{0}*URB_NEW{0}, EMP_NEW{0}*ALC_NEW{1}, HEA_NEW{0}*ALC_NEW{1}, URB_NEW{0}*OBE_NEW{1}, URB_NEW{0}*ALC_NEW{1}, OBE_NEW{1}*ALC_NEW{1}, EMP_NEW{0}*URB_NEW{0}*ALC_NEW{1}, URB_NEW{0}*OBE_NEW{1}*ALC_NEW{1}', obj = TT_COMB, type = 0)

##find intermediate solution

TT_COMBO_min_inter <- minimize(TT_COMB,exclude = typeALL2, show.cases = TRUE, include = '?', details = TRUE, dir.exp = c(1,1,3,1,1,1))

##XY plot prime implicants

pimplot(data = TT_COMB, results = TT_COMBO_min_inter, outcome = 'UHC_NEW', sol = 1)
```

```
M1:    EMP_NEW{1}*HEA_NEW{1}*CLA_NEW{3}*URB_NEW{1}*OBE_NEW{0} => UHC_NEW{1}

                                                      inclS   PRI    covS   covU
------------------------------------------------------------------------------------
1  EMP_NEW{1}*HEA_NEW{1}*CLA_NEW{3}*URB_NEW{1}*OBE_NEW{0}  0.902  0.719  0.574   -
------------------------------------------------------------------------------------
   M1                                                  0.902  0.719  0.574

                                                      cases
------------------------------------------------------------------
1  EMP_NEW{1}*HEA_NEW{1}*CLA_NEW{3}*URB_NEW{1}*OBE_NEW{0}  AUS,AUT,BEL,CAN,CHL,CZE,DNK,FIN,DEU,HUN,ISL,IRL,LUX,NOR,PRT,SWE,CHE,GBR,URY
------------------------------------------------------------------
```

APPENDIX N INTERMEDIATE SOLUTION CALCULATION FOR COMBINED CONDITIONS WITH NEGATED OUTCOME

The intermediate solution containing the combined conditions and negated outcome was calculated by running the code in R Studio below, inputting the calibrated data listed in APPENDIX D:

```
##find contradictory rows
typeALL2_neg=findRows('EMP_NEW{1}, OBE_NEW{1}, HEA_NEW{1}, CLA_NEW{3}, OBE_NEW{0}, ALC_NEW{0}, URB_NEW{1} ', obj = TT_COMB_neg, type = 0)
##find intermediate solution
TT_COMBO_min_inter_neg <- minimize(TT_COMB_neg, exclude = typeALL2_neg, show.cases = TRUE, include = '?', details = TRUE, dir.exp = c(0,0,1,0,0,0))
```

```
                                                                  inclS  PRI    covS   covU
------------------------------------------------------------------------------------------
1  EMP_NEW{1}*HEA_NEW{0}*CLA_NEW{1}*URB_NEW{1}*OBE_NEW{0}            1.000  1.000  0.066  0.008
2  EMP_NEW{1}*CLA_NEW{1}*URB_NEW{1}*OBE_NEW{0}*ALC_NEW{0}            1.000  1.000  0.065  0.006
3  EMP_NEW{1}*CLA_NEW{2}*URB_NEW{1}*OBE_NEW{0}*ALC_NEW{0}            0.874  0.574  0.189  0.112
4  EMP_NEW{0}*HEA_NEW{1}*CLA_NEW{1}*URB_NEW{1}*OBE_NEW{0}*ALC_NEW{1} 1.000  1.000  0.034  0.022
5  EMP_NEW{0}*HEA_NEW{1}*CLA_NEW{2}*URB_NEW{0}*OBE_NEW{0}*ALC_NEW{0} 1.000  1.000  0.128  0.032
6  EMP_NEW{1}*HEA_NEW{0}*CLA_NEW{3}*URB_NEW{1}*OBE_NEW{0}*ALC_NEW{1} 0.899  0.545  0.058  0.058
7  EMP_NEW{0}*HEA_NEW{1}*CLA_NEW{2}*URB_NEW{0}*OBE_NEW{1}*ALC_NEW{1} 1.000  1.000  0.057  0.004
------------------------------------------------------------------------------------------
   M1                                                                0.922  0.810  0.396

                                                                  cases
--------------------------------------------------------------------------
1  EMP_NEW{1}*HEA_NEW{0}*CLA_NEW{1}*URB_NEW{1}*OBE_NEW{0}            MNG; ARM
2  EMP_NEW{1}*CLA_NEW{1}*URB_NEW{1}*OBE_NEW{0}*ALC_NEW{0}            MNG; UKR
3  EMP_NEW{1}*CLA_NEW{2}*URB_NEW{1}*OBE_NEW{0}*ALC_NEW{0}            ARG,BLR; BRA,BGR,PAN,RUS
4  EMP_NEW{0}*HEA_NEW{1}*CLA_NEW{1}*URB_NEW{1}*OBE_NEW{0}*ALC_NEW{1} TUN
5  EMP_NEW{0}*HEA_NEW{1}*CLA_NEW{2}*URB_NEW{0}*OBE_NEW{0}*ALC_NEW{0} HRV,SRB
6  EMP_NEW{1}*HEA_NEW{0}*CLA_NEW{3}*URB_NEW{1}*OBE_NEW{0}*ALC_NEW{1} OMN
7  EMP_NEW{0}*HEA_NEW{1}*CLA_NEW{2}*URB_NEW{0}*OBE_NEW{1}*ALC_NEW{1} BIH
--------------------------------------------------------------------------
```

APPENDIX O SELECTED HEALTH SYSTEM CHARACTERISTICS BY COUNTRY

Country	Health system type	Revenue raising	Out-of-Pocket Expenditure (OOPS) as % of Total Health Expenditure (THE)	Financial protection
Australia (Mossialos *et al.*, 2016)	Universal public medical insurance program. Primary care private ownership, hospitals public and private ownership.	General tax revenue; earmarked income tax.	19%	Low-income people and elderly get discounted rates.
Austria (Hofmarcher and Quentin, 2013)	Statutory health insurance with regional planning. Primary care private ownership, hospitals private ownership.	Mostly compulsory contribution from income tax.	16%	There are caps on OOPs for chronic drugs and financial assistance for low-income and when it reaches a 2% of the patient's income.
Belgium (Gerkens and Merkur, 2010)b	Compulsory health insurance	Mostly compulsory contribution from income tax.	18%	Once OOPs goes over a threshold for the year there are exemptions.
Canada (Mossialos *et al.*, 2016)	Regionally administered universal public insurance program that plans and funds. Primary care private ownership, hospitals public and private ownership.	Provincial/federal general tax revenue.	14%	Some drugs initiate OOPs which is covered if it is for a low-income person.
Chile (Bossert and Leisewitz, 2016)	Bismarckian social security system that provides white-collar workers with health insurance. Hospitals public and private ownership. Primary care public and private ownership, hospitals public and private ownership.	Income tax.	32%	Limited protection for vulnerable groups.
Czech Republic (Kinkorová and Topolčan, 2012)	Compulsory health insurance model which is administered by private insurers.	Compulsory contribution, state budgets and private sourcing	14%	Limited protection for vulnerable groups.

Country	Health system type	Revenue raising	Out-of-Pocket Expenditure (OOPS) as % of Total Health Expenditure (THE)	Financial protection
Denmark (Mossialos *et al.*, 2016)	National health care system that regulated, plans and funds. Primary care private ownership, hospitals public ownership.	Earmarked income tax	13%	There are caps on OOPs for chronic drugs and financial assistance for low-income and terminally ill.
Finland (Teperi *et al.*, 2009)	Regionally administered universal public insurance program that plans and funds	Tax revenues; partly municipal, partly state tax	18%	Once OOPs goes over a threshold for the year there are exemptions.
Germany (Mossialos *et al.*, 2016)	Statutory health insurance (SHI) system, with universally mandated private insurance. Primary care private ownership, hospitals public and private ownership.	Employer/employee earmarked payroll tax; general tax revenue	13%	Children and adolescents are exempt of OOPs.
Hungary (Gaál *et al.*, 2011)	National health care system that regulated, plans and funds. Primary care public ownership, hospitals public ownership.	Earmarked income tax.	27%	Limited protection for vulnerable groups.
Iceland (Sigurgeirsdóttir, Waagfjörð and Maresso, 2014)	Publicly funded system with national centralised control. Primary care public and private ownership, hospitals public and private ownership.	Income tax.	17%	There are OOPs exemptions for vulnerable groups.
Ireland (Wiley, 2005)	Public healthcare system with voluntary health care payments.	General taxation.	18%	There are OOPs exemptions for vulnerable groups.
Luxembourg (European Observatory on Health Systems and Policies, 2017)	National statutory health insurance with voluntary health care payments.	General taxation mostly from income tax.	11%	Children, adolescents, pregnant women, are exempt of OOPs.

Country	Health system type	Revenue raising	Out-of-Pocket Expenditure (OOPS) as % of Total Health Expenditure (THE)	Financial protection
Norway (Mossialos *et al.*, 2016)	National health care system with regional and national planning and funding. Primary care private ownership, hospitals public ownership.	General tax revenue, national and municipal taxes.	14%	Children, adolescents psychiatric, pregnant women, work-related injuries and low income groups are exempt of OOPs.
Portugal (De Almeida *et al.*, 2017)	National health care system. Primary care private ownership, hospitals public ownership.	Tax-financed system.	27%	There are OOP exemptions for vulnerable groups.
Sweden (Mossialos *et al.*, 2016)	National health care system with national planning and funding. Primary care public and private ownership, hospitals public ownership.	General tax revenue raised by county councils; some national tax revenue.	14%	Children, adolescents, pregnant women and elderly are exempt of OOPs.
Switzerland (Mossialos *et al.*, 2016)	Statutory health insurance system, with universally mandated private insurance. Primary care private ownership, hospitals public ownership.	Community-rated insurance premiums; general tax Revenue.	27%	Children, adolescents, low-income and pregnant women are exempt of OOPs.
United Kingdom (Mossialos *et al.*, 2016)	National Health System. Primary care private ownership, hospitals mostly public ownership.	General tax revenue (includes employment-related insurance contributions).	10%	Children, adolescents chronic, pregnant women, work-related injuries and low income groups are exempt of OOPs.
Uruguay (Human Development Unit, 2012)	Integrated national health system.	Income tax.	16%	Once OOPs goes over a threshold for the year there are exemptions.