

Fuzzy Set Approach to Poverty Reduction Compared with Growth Modelling

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Abstract

Econometric growth models operate under the assumption that their core economic theories of growth are explanatorily adequate. However even in growth models, non-economic variables are effective because they offer complementary explanatory power. This paper supports the hypothesis that women's labour force participation positively helps poverty reduction. But we also find that the deeper causes of economic change, such as state intervention, are critical to human development trajectories. Using realist methodology, we ask 'what would have to have been true for the fuzzy set patterns to emerge as they did during 1992-2002?' The changes in poverty over time are very diverse so fuzzy set analysis proves useful in identifying small sets of countries whose characteristics helped them to achieve poverty reduction in that decade.

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Author's field of study

Tenancy and employment trajectories in Rural South India;
Objectivity and mixed-methods realist research
Debt-bonded labour and the regulation of labour markets;
Feminist analyses of labour relations;
Methodological pluralism (especially across the qualitative-quantitative "divide");
Inter-disciplinary socio-economic analyses of social exclusion;
Globalisation, democracy and gender - a project using panel data for 150 countries.

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1. Introduction.

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Any mountain naturally has several paths to get the summit. For climbers, the skills and years of experience, the skills of one's companion, and the starting point, all are counted when deciding which pathway to take. They are all part of the conditions that determine what then happens. Even taking the same path, time and the weather conditions may alter the outcome. Yet, we have been singling out how one condition is relevant to the outcome without taking the other causes and the interim outcomes into consideration. Linear models, however complicated, have some limitations as they seek the correlational effects of individual causal factors on the outcome (Ekstrom, 1992). On the other hand, Qualitative Comparative Analysis (QCA) seeks multiple causal conditions which work together. Using QCA we study them in terms of analyzing set-theoretic relations.

This paper attempts to analyse *what has happened to the poorest people in all the countries* during the period of 1992-2002. Uniform economic policy models based on the Washington consensus have failed to bring economic growth to developing countries. The trickle-down theory suggests that growth in average incomes will gradually reduce poverty of the poor. However, many causal mechanisms in the macro socio-economy do not simply work alone. Endogenous growth theory suggests that each country may have a particular combination of causes based on technology, human capital and other social factors, along with natural resources. Human capital and other social factors are recognised causes for economic growth. It is widely agreed that raising the labour force participation of women raises women's opportunities for autonomy and empowerment. Barro's work has been important in establishing that a range of social and political institutions are relevant to explaining differences in the rate of economic growth in different countries (2000). These institutions include education, especially in its contribution to the development of human capital. However, there has so far been a neglect of assessing the macro-economic impact of HIV virus and its effects (BER, 2006). It is realistic (and philosophically 'realist') to suggest that each factor may work in conjunction with others. With the application of fsQCA, multiple causal pathways to poverty reduction emerge.

2. Review of Literature

Our aim first of all in reviewing this literature is mainly to focus attention on the issue of whether a causal mechanism in the macro socio-economy works in its own right, or in conjunction with others. We have to give some background to the debate about poverty reduction, rooted in the 'growth debate', in order to review the kinds of arguments that have already taken place. By focusing on causality, our aim is less to give an exhaustive review and much more to show how things have changed (in the minds of policy analysts) over the years 1950-2008 in the poverty reduction literature.

In the 1980s, a traditional assumption was frequently made that economic growth would trickle down economic benefits to the poorer classes. This assumption arose from the growth literature centred around Rostow (1953[1958]), dating back to the 1950s post-war recovery period, who argued that as soon as national savings exceed some minimum level a country can have a corresponding growth in investment which would cause a take-off into sustained growth. For Rostow, it could be assumed that savings would be re-invested into the domestic economy, but this assumption is now doubted. Keynesians around the 1960s thought that a lack of savings could be offset by government investment from the national debt. To this day, huge national debts are incurred by governments, and these exogenous investment funds do stimulate economies. They can cause a surge in production, and if production is not flexible then this spending can cause inflation. By the 1980s, even those who argued that supply

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needed to be stimulated opened the assumptions up more to international trade and capital flows. It was recognised after about 1975 that investment could arrive in a country from abroad (even without national savings), and that therefore the balance of payments would critically affect a country's output level. National income and per-capita income were found to roughly follow this output level upward.

The 1980s framework was known as supply-side economics and it was assumed that the causes of growth were several, within this savings-driven investment scene. The factors that lead to growth, it was then thought, included technological change, commercialisation, labour force growth, schooling, and work experience (human capital). The crucial barrier, Rostow argued, was investible funds. In agriculture, as in industry, discovering and then implementing technical change was seen as primary. The size of the agricultural sector has been a barrier for some countries. In cases like Brazil and Korea governments have contributed to creating an industrial workforce that is trained, skilled, and disciplined (Hewitt, et al., 1992). Investment was related to that. Neither Rostow nor Keynesian theories of growth answered the question of why the 'agrarian' countries had such slow growth rates in the 1960s-1980s. Historians and Marxists have argued that their 1950 starting point was shaped largely (economically) by their colonial experience, and that those which were ruthlessly exploited in terms of human and natural resources had their hands tied when the post-war race to growth began. In our statistical models, we find it useful to include a fixed starting-point (1980 Gross Domestic Product per capita) to compensate for this factor. In statistical models of growth rather poor quality results emerge. Appendix 1 shows that growth can be modelled as largely a positive function of investment (Model 1), with other factors having small effects (educational attainment being one which probably reflects the growth of human capital over time). Appendix 1 Model 2 runs a pooled time series regression instead of the usual fixed-effects model, showing that here also investment plays a strong causal role.

These models are fairly typical of the growth modelling prior to the 'endogenous growth theory' stage. Barro's (1991, 1998) work has been important in establishing that a range of social and political institutions are relevant to explaining differences in the rate of economic growth in different countries. These institutions include education, especially in its contribution to the development of human capital. Barro has also studied the role of governance, instability, the rule of law, government expenditure, and religion. Recent moves by Rama and Forteza make it possible to measure the impact of labour market regulation on growth, too (1991). Barro includes fertility in his model, finding that the higher the level of human capital, the higher the rate of economic growth and the lower the fertility rate.

Endogenous growth theory began to try to seriously explore the country-specific differences which make the statistical regressions a poor fit. Endogenous growth theory suggests that each country may have a special combination of technology and human capital, along with natural resources, and that therefore it is essential to explore the causes of change in these two major inputs to production. The roots of sluggish technological change – e.g. in patent law – and the origins of educational inequality have begun to be studied by endogenous growth theory (Aghion, et al., 1999). In general, the new theories have more of a role for institutions and are less simplistic in arguing that technology can solve economic problems. However they still use extremely over simplistic, yet complex, mathematical models which diverge from reality by making unrealistic assumptions. In general, instead of merely being macroeconomic models of countries, the new theories engage in micro-economic theoretical analysis (which is assumed to be correctly grounded) but then test the 'hypotheses' generated out of these models. This large and growing side-alley of economics suffers from the Duhem-

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Quine paradox: they are not testing their root assumptions, and they are therefore unlikely ever to falsify the fundamental assumptions in their models.

In looking at the regression models of growth, and moving forward, two sorts of analytical moves can be made. One move is to examine *whether causes work together or separately*. We are presently using fuzzy set causal analysis to find out whether, for example, investment simply “worked” to cause growth during this period –on its own- or whether in fact investment was only effective under certain conditions, known as configurations, in causing growth. The work of Ragin and Rihoux (2008) suggests that statistical tests are likely to overstate the extent to which factors are able to work separately. They suggest that it is likely that factors need to work in tandem – a point argued convincingly by Byrne (2005, 2008). Byrne goes so far as to argue that cluster analysis is more useful than statistical regression because cluster analysis puts together relevant characteristics of configurations – each group containing several similar cases – and that we need to use a mixture of theory and logic to work out what is causal among the factors that appear to occur together (see Byrne, 2002).

So for the move toward analysing ‘causes’ more carefully, there is some more work to be done. But the second possible move is to analyse *what has happened to the poorest people in all the countries*, since the crucial assumption of most growth theorists was that if growth occurred, then in the long run everyone would end up better off. That is the other move which we attempt in this paper – we focus on a different dependent variable: economic poverty reduction 1992-2002.

A long series of studies of the growth-inequality link have come up with two competing schools of thought – both consistent with the data under current methods of econometrics. (1) the Kuznets curve, also tested by Barro, is a curvilinear response of inequality to the level of GDP per capita. The inequality level (in general) tends to rise and then fall again over the levels of GDP, with the highest inequality historically centred on Latin America, some Middle Eastern and some East Asian countries. Those countries with large or successful agrarian sectors avoided the very high inequality that was found elsewhere. By arguing that this inverted U curve was a ‘tendency’, the Kuznets school suggest that a country can move *along it*. That is, a comparison across countries in a panel, over time, tells us about possible movement trajectories over time. By putting the square of the Gini coefficient in a regression, along with Gini, one can arrive at a ‘significant’ equality effect that has this shape. However, the reasons may be more historical and comparative than longitudinal or universal. (2) the second school of thought looks at how inequality influences economic output, reversing the assumed causality. Here the Kuznets curve is still relevant, but the interpretation is different. High inequality creates a small rich class who can save a lot; high equality may reflect a population whose savings rates are on average (and generally) rather low. Thus putting a measure of economic inequality into a growth regression is one way of perceiving inequality purely in causal, economic terms. In this paper, we separate out the inequality aspect for ethical scrutiny. Following Edwards (2006), we note that the huge inequality between countries should not be ignored when one is studying economic inequality within countries. We therefore use Edwards’ variable, income going to the poorest quintile of each country’s population, as the dependent variable in regression and as the outcome variable in fuzzy set causal analysis. Edwards gathered and harmonised the best Gini curve evidence across many countries in order to produce comparable estimates for both 1992 and 2002. We have used these to create an indicator ‘delta’ which is the change in income going to the poorest quintile over this ten-year period. With all incomes in real terms, $\Delta > 1$ implies that within a country the poor are better off in 2002 than in 1992. This model diverges from the kind of

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Gini coefficient analyses that we find in the economic literature. Since the literature allows for two-way causality, we also have to be aware of this possibility. In brief, summarising the relationship between GDP per capita and inequality so far, we have three relationships:

Growth = f (exogenous factors, history, savings, investment, X, and inequality)

Inequality = f (exogenous factors, history income level)

And

Poverty reduction delta = f (exogenous factors, history, growth and inequality)

Although the third equation is a reduced form we have some clear hypotheses about what factors in that equation will be causal on the outcome. We are also aware of endogeneity which makes econometricians consider it inferior to estimate equation 3 independent of equations 1 and 2.

In recent years, the theory of growth was transformed by the switch from Structural Adjustment Programmes to a post-Washington Consensus focus. SAP aimed to ensure that each country avoided balance of payments crises and could continue on its growth path. But many countries, notably in Africa and some in Latin America, were considered to have failed SAPs and the free-market supply-side consensus has been severely questioned as a result. In the post-Washington Consensus, consistent with Barro's work on the intermediate social and political factors affecting growth, institutional factors are considered relevant. Governance, government's investment in its people's human capital, and civil liberties have all come under scrutiny as possible ways to move a country to higher output trajectory. Recent studies of the quality of government spending have argued that a rational government will make strategic use of its national debt and tax revenue (Henderson, Hulme et al., 2007). You and Kaugram (2005) illustrate this type of investigation, still using statistical methods. Booth (2003) asks whether it might not make more sense to seek country-specific solutions to poverty problems, rather than approaching the countries as a set and looking for one global pattern. The universalism that is implicit in the statistical method can be shown diagrammatically. In any underlying scattergram, the econometric method is seeking to find either linear or curved 'lines of best fit' by minimising error around them; Figure 1 illustrates two of these.

Figure 1: Illustration of Lines of Best Fit [about here]

Ironically, to make matters worse, when economists delve into areas of social arrangements (e.g. religion), political systems (e.g. voting systems), and governance (e.g. corruption), they appear to assume that a concept can mean the same thing, after harmonisation, across the whole world. The real diversity of the world's societies is beyond the awareness of the modeller. For a sociologist the harmonisation is an act of putting unlike with like, forcing situations to fit one general global concept (e.g. political freedom). Many turn away from these statistical results, and use other methods instead. Fuzzy set causal analysis is potentially a method that can help them to use mixed methods to understand small groups of countries better.

After all, in the post-Washington Consensus, institutional difference makes different groups of countries really fundamentally different. An awareness of the failure of global models has made Stiglitz, for example, disassociate from the Washington Consensus (Stiglitz, 2002).

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Institutionalism has many facets. Among these, some aspects of interest are gender related, some are historically grounded, and some are structuralist. See Walby (2005) and Grown, Elson et. al. (2000) for a discussion of gender differences across countries. See Ekstrom for a general discussion of how structures create detailed nuances within cases (not just between them). Kanbur has appealed for an awareness of country diversity (2002). Institutionalism as it now exists is moving rapidly toward a serious form of realist structuralism. Its neoclassical form (new institutional economics) can be confusingly idealist and utilitarian, but other forms are emerging. A long-standing tradition of structuralist macroeconomics argued that the different sector-sizes, response-speeds, and trade-dependencies made each country almost a unique case. (e.g. j-curve debate; coffee and fair-trade experiences); see (Taylor, 1983, 1988; Harrigan, 2001 is a case-study).

Some studies in geography are of this pluralist, interdisciplinary kind that institutionalism seeks, e.g. (Norton, 2003). These are rather simple econometrically but rich in descriptive power and strong on “realism” in the sense of correspondence to local realities. The recent research tends to question the bland and blithe claims that certain authors have made, e.g. Dollar (that growth is good for the poor) is opposed by Weiss (2008); and Edwards (2006) questions the simple logic of Milanovich that poor countries can grow out of poverty.

Our movement forward is to re-explore some data using fuzzy sets. Our method is exploratory since the method is relatively new. Fuzzy set analysis has recently been entered into STATA software but is not present in SPSS software, and we have used the well-established FS QCA and TOSMANA software to implement fuzzy set analysis. We use a retroductive frame for the moment (Danermark, et al., 2001), asking what must have been the case for Delta to be high during the period 1992-2002? However hypothesis testing does come into this since there are some well-established economic claims about how capitalism works, which we do not need to challenge (rather, we are augmenting them).

In summary, in the existing theories of growth there is evidence that investment, school attainments, female labour force participation and foreign direct investment are important. We also have supplementary claims that government spending, spending on schooling, quality of governance, reduction of corruption and other social factors could improve the economic well-being of the poorest quintile. Our own research on growth showed that school attainment of adults is associated with higher growth, 1972-1992. We bring growth into our model as part of configurations that may cause for poverty reduction. But other factors can override growth, and growth is not necessary for poverty reduction in the period under consideration 1992-2002.

3. Methodology

3.1 Methods

Qualitative Comparative Analysis (QCA) is a methodology dating from about 1975 that bridges the qualitative and quantitative analysis using both in-depth knowledge of specific cases and horizontal comparative knowledge of cross-case patterns. While keeping a strong case-oriented tradition of understanding case(s) from accumulation of deep and detailed knowledge, it also benefits from the advantage of comparative cross-case studies. QCA can be applied to a small to medium number of cases (e.g. 5-50) which are too few but which for

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most conventional statistical techniques, but which can be analysed more qualitatively by comparing cases grouped by combinations of causal conditions.

The work of Ragin (1987, 2000) has recently developed QCA in the empirical scientific effort to operationalise comparative study with a set-theoretic approach. However, comparative social research has a long history, including Theda Skocpol's substantial studies of comparative historical trajectories as in his study on prior conditions for state breakdown (1979). QCA also has roots in the work of J. S. Mill (1967[1843]). Mill argued that the presence of a factor in a series of cases, all having to an outcome of interest, suggests that that factor positively contributes to Y and may be a cause of Y although one needs to be cautious of an accidental association and a spurious finding.

QCA is also grounded in the analysis of set relations, not correlations. Most theoretical arguments of social science concern set-theoretic relationships, not linear relationships between variables (Ragin, 2000: xiv). Set theoretic connections are asymmetrical. Asymmetry means if, for all a and b exist in X, if a is related to b, then b is not related to a. For example, the fact that there are many criminals who are not drug users does not in any way challenge the claim that criminals tend to use drugs. Also, there might be a claim that a higher rate of women's labour participation can be found in many developed countries. However, we do find high rate of women's labour participation in many developing countries as well. Women's labour participation is high in former socialist countries as it was part of their ideologies. Also, women's participation in the workforce in Islamic countries is relatively low. In a symmetric sense, these cases undermine the correlation between development and high women's labour participation, however. These asymmetrical arguments are very common in social inquiry and we do not discard either claim simply.

Using Boolean algebra, QCA studies multiple conjunctural causation. In other words, QCA examines cases with respect to the diversity of cases and their heterogeneity with regard to their different causally relevant conditions and contexts by comparing cases as configurations. Configuration means combinations of causal conditions including the absence of those conditions. QCA can assess configurations or multiple combinations of causal conditions which are capable of engendering the same outcome. Cases with specific combinations of causal conditions form a subset of the cases with the outcome. Focusing on causal complexity, the aim of QCA is to study causal conditions that are insufficient by themselves but are necessary parts of complex causal mechanisms. QCA can establish different sufficient configurations for the same outcome.

Fuzzy set Qualitative Comparative Analysis (fsQCA) is a computer programme that uses same set theoretic reasoning, configurational method and Boolean minimisation as QCA (<http://www.u.arizona.edu/~cragin/fsQCA/software.shtml>). With the application of probabilistic methods, fsQCA enables us to explore sufficient and necessary conditions of causal configurations. In addition to having basic features of QCA, fsQCA is a useful approach when outcomes are either not totally in or not totally out of the outcome set, such as the level of democracy or the level of poverty reduction as in the case of this paper. The outcome or causal conditions which researchers are interested cannot be clearly dichotomised as often happens in most social inquiry. With seven-value fuzzy sets, it is possible to

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transform relatively unsystematic qualitative evidence into a fuzzy set with seven levels of membership¹ (Ragin, 2002: 265).

To construct the truth table, fsQCA lays out all logically possible combinations of conditions which are considered, including those without empirical instances. The consistency score for a configuration is a measure of the subset relationship. QCA examines the extent to which particular causal factors or configurations are subsets of the outcome, and the consistency score measures this subset relationship. Consistency is thus a measure of the extent to which membership strength in the causal configuration is consistently equal to or less than membership in the outcome (Epstein et. al, 2007: 10). For each configuration (row in the truth table), minimum membership scores (causal combination intersected with outcome) are added for all cases. This number is divided by the sum of all minimum membership scores in the causal combination. The formula of consistency is:

$$\text{Consistency } (X_i \leq Y_i) = \Sigma(\min(X_i, Y_i)) / \Sigma(X_i).$$

This formula uses the Fuzzy-set mathematics. The $\min(X)$ is the intersection (“AND” or \cap) of all X . $\Sigma(X)$ is the union (“OR” or \cup) of all X . When membership in outcome Y is less than membership in causal configuration X , the numerator will be smaller than the denominator and the consistency score will decrease. “Consistency scores range from 0 to 1, with 0 indicating no subset relationship and a score of 1 denoting a perfect subset relationship (Epstein et. al, *ibid*: 10).”

These consistency scores help the researcher decide which configurations should be considered reasonable subsets of the outcome. Scores should be more than 0.8 as less than that would mean there is considerable inconsistency (Kent, 2008). Once this decision is made for a particular configuration, the researcher enters a 1 or 0 into the cell in the blank "outcome" column in the truth table, which tells the program whether or not to treat that particular configuration as an instance of the outcome.

On the other hand, coverage refers to the proportion of the sum of the membership scores in an outcome that a particular configuration explains. In other words, it explains how many cases are covered with the sufficiency configuration for outcome Y . The high coverage score indicates that the configuration is consistent with the outcome and it has many cases with the configuration outcome “in”, while low coverage scores indicate that even if the causal configuration is consistent with the outcome, it is substantively trivial. Studying coverage scores helps us in avoiding spurious configurations for the chosen outcome.

$$\text{Coverage } (X_i \geq Y_i) = \Sigma(\min(X_i, Y_i)) / \Sigma(Y_i).$$

b) The Underlying Methodology

¹ A membership score of 1.0 indicates full membership in a set; scores close to 1.0 (e.g., 0.8 or 0.9) indicate strong but not quite full membership in a set; scores less than 0.5 but greater than 0.0 (e.g., 0.2 and 0.3) indicate that objects are more “out” than “in” a set, but still weak members of the set; a score of 0.0 indicates full nonmembership in a set. The 0.5 score is also qualitatively anchored, for it indicates the point of maximum ambiguity (i.e., fuzziness) in the assessment of whether a case is more “in” or “out” of a set.

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Several methodological assumptions that are commonly made in configurational studies can be listed here. These range from the ontological to the epistemological. At the level of deep prior assumptions about what exists – ontology – two assertions are being made. Firstly we have been forced by the existing data to assume that it is meaningful to compare ‘countries’. We would prefer to weaken this assumption and use smaller regions to allow for real diversity within the large countries. But we are unable to do anything other than use ‘countries’ – as defined in the UN system –if we wish to look at growth rates. We begin with the World Development Indicators CD ROM (a World Bank product) and then argument that data with variates at national level from other sources.

The second assumption we make is that subset associations between variates are potentially evidence of real causal mechanisms. We are not simply arguing that a variates “is” a causal mechanism. There is a poor fit between several variates and their underlying real referent. (For example, school attainments as a measure of human capital ignores work experience and on-the-job learning) a variates is a binary, ordinal or categorical indicator which is recorded in a column in the country data set. We avoid the term variable here because the variates are indicators of whether countries are in particular sets (e.g. high growth set). A crisp indicator is a binary variate (0/1) while a fuzzy indicator has more ordinal detail. We might use the term “variables” where measurement was more predominantly cordinal, and where cases are more obviously comparable.

In this generally realist approach we follow Byrne in supposing that clusters of countries may have similar attributes (Byrne, 2005). For such a cluster, which Ragin calls a configuration, we are interested in the actual prevalence of poverty reduction. Since poverty reduction is indicated by a fuzzy set, with delta running over the range from 0 to 24, rescaled to the fuzzy range 0 to 1, we argue that countries with $\Delta_{\text{taf}} > 0.5$ are going to be perceived as achieving poverty reduction. Thus the outcome can be more accurately described as “in the top 3/7^{ths} of the range of levels of income improvement per capita of the lowest quintile of households”. One configuration can have a range of fuzzy data outcomes. In crisp set QCA we would see the raw truth table as shown below:

Table 1 [about here]

giving a summary table where N =instances:

Table 2 [about here]

But in fuzzy set QCA the table is more complex and the truth table reduction is only complete after a fuzzy algebra calculation is made (what is the fuzzy intersection of all X and Y?) and compared with the fuzzy union of all X. If the ratio of these two is high enough, we can deem the configuration to have fuzzy delta = 1. However we do not require absolute achievement of $D=1$ in each case within the configuration.

Consistent with realist research methods, following Danermark, et. al. (2001), this paper makes some claims which we consider to be fallible and open to revision. The claims are in the next section. The types of fallibility are several. One, what is true of a country may not apply and all regions within that country. Two, our variates may reflect proximate but not deep causes. Further research may replace our analyses with new knowledge of deeper underlying causal mechanisms. Three, the what obverse of what is true of the high delta configurations may not be true of low delta configurations. Results from fsQCA are not

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typically symmetrical. Finally, four, what we found out for 1992-2002 may not be true in earlier or later decades. Our methodology is less universalistic than most of the studies cited in the literature review. We now move onto describing the data and results.

c) Data used

The data were collected from several locations and both definitions of the variables and their sources are found in Appendix 5. The poverty reduction measure, and their underlying lowest quintile of income in terms of GDP per capita, was made available in the work of Edward (2006). Additional information was included on economic factors including government expenditure and Gini coefficient from the World Bank; on women's participation in labour force from the International Labour Office; HIV from UN data.

First, the dependent variable is Δ . Poverty reduction is expressed in terms of Δ , i.e. the change in the GDP per capita of lowest quintile of the population between 1992 and 2002. When Δ is more than one, we consider as an improvement in levels of income per capita of the lowest quintile of household. Δ_f is a fuzzified form of Δ .

Second, to ask what the case for poverty reduction, we included some variables from the growth model. For the growth model, the existing theories with experimental studies confirm that economic factors as well as gender and human capital variables are important to growth. Other factors influencing inequality are also important as part of mechanisms that may affect the outcome. As in the Weberian approach, the carefully managed articulated use of government expenditure to boost social capital could lead to growth. We therefore use a fuzzy set for government spending. Also, high levels of women's labour force participation are hindered by high HIV rate prevalence especially found in the 1990s in Africa. For that reason, the rate of HIV prevalence was included.

Thus, the five causal conditions used for the fuzzy set model are: GDP per capita rate, equality (1- GINI), women's participation in the workforce, government expenditure and HIV prevalence rate. GDP per capita rate ($gdpprate_f$) is growth of GDP measured in local units of currency, adjusted for population size (annual percentage). Equality ($equality_f$) is the reverse of gini coefficient. gini coefficient is measure of economic (income or expenditure) inequality between households, where 1 is maximum inequality and 0 is equality). Gini coefficient is extracted from 2002 data. ILOfpF ($ilolfpff$) is ILO projections and estimates of the proportion of the workforce that is female¹. Government expenditure ($govtexp1992f$) is government expenditure as percentage of GDP; HIV prevalence rate ($hivf$) is the estimated number of adults (age 15-49) living with HIV/AIDS rate (in percentage).

Due to gaps in data availability data for both Equality and HIV prevalence rate are extracted from 2002; however relative values do not change much for data for 1992. For further research, qualitative information could facilitate to fill the data gap. Appendix 2 provides all the means of the variables used and regression of the model. All the variables used in fsQCA are fuzzified using TOSMANA software's threshold setter. The fuzzy sets each place $1/7^{\text{th}}$ of the cases in each level 0, 0.16, 0.33, 0.5, 0.67, 0.83, and 1.0.

4 Findings

Now we examine the fsQCA results. First, we run few bivariate fuzzy to examine whether individual condition shows any causality to improve Δ . Then, the result of multiple fuzzy sets analysis was presented.

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4.1 Main Findings: CAUSALITY of poverty reduction

The table 1 shows the truth table and appendix 4 provides the raw data table. The number of combinations is 2^k , where k is the number of causal conditions. With five causal conditions, there are 32 logically possible combinations of conditions. However, the interim table shown below are the ones which have number of cases after omitting the combinations without cases². The “consist” shows the consistency of each causal relationship. Configurations are subsets of the outcome, these consistency helps us in deciding which configurations should be considered reasonable subsets of the outcome. The minimum level of set theoretic consistency would be achieved by setting a ‘consist’ threshold of at least .75 (Ragin, 2004), or preferably higher. For this study, we utilised minimum threshold of 0.90.

Table 3 Truth Table of Poverty Reduction Model [about here]

FsQCA presents three solutions to each truth table analysis: (1) a “complex” solution that avoids using any counterfactual cases (rows without cases - “remainders”); (2) a “parsimonious” solution, which permits the use of any remainder (for combinations of conditions which have few cases or that lack cases to be included) that will yield simpler (or fewer) recipes; and (3) an “intermediate” solution, which uses only the remainders that survive counterfactual analysis based on theoretical and substantive knowledge. Generally, intermediate solutions are considered as the best solution. Regression of this model is provided in the Appendix 1.

Our final results are as shown below (This result is the “intermediate result” from the “standard analysis” in fsQCA.

GDPPCRATEf*ILOLFPFf+

EQUALITYf*ILOLFPFf*hivf+

GDPPCRATEf*GOVTEXPf*EQUALITYf*hivf

Solution coverage: 0.90

Solution consistency: 0.75

It indicates that there are three possible path ways to reduce poverty. The first pathway is the presence of relatively high growth (gdppcrate) and high women’s labour force participation (ilolfpf) with regardless of government expenditure and rate of HIV prevalence. In other words, when there is high growth together women’s labour force participation, regardless of government expenditure and HIV prevalence, poverty reduction is occurring. The second pathway indicates that with the presence of relatively high equality and women’s presence in the workforce along with low HIV prevalence, regardless of growth and government expenditure, there is still an improvement in the income of the poorest quintile of the population. The third pathway indicates that if there is relatively high growth, high government expenditure, and high equality along with low HIV prevalence, whether presence of high women’s labour participation or not, poverty reduction occurs.

² In order to reduce number of contradictions of cases, Ragin (2006) recommends conducting counterfactual analysis using theoretical and substantive knowledge.

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In the first pathway, growth plays a role together with women's participation in the workforce. As we recall from the bivariate fuzzy analysis, GDPPCRATE was not singly a sufficient cause for poverty reduction. However, in countries where more women are participating, growth becomes a part of multiple sufficient causal conditions for poverty reduction. The driving factor for increase of GDP mainly comes from business or industry i.e. the GDP is a measure of commercial activity. Growth itself may not reduce poverty, but it can allow for more employment opportunities for both men and women. Or the causal mechanism between growth and gender could be as well working the other way around. Women's higher employment is causing higher growth rates which lead to poverty reduction. Not only in the service sector, but also women engaged in farming, small business or family businesses which are part of the GDP.

In the second pathway, the presence of equality, women's participation and the absence of HIV prevalence is a sufficient configuration for poverty reduction. As (in) equality was shaped historically by the colonization of almost all of South and Central America by Spain and Portugal, we note that those countries does not follow this configuration for poverty reduction. Also, those African countries where women's participation in the workforce is hindered by HIV infection are not in this path, either. This configuration also shows that equality was not a single sufficient factor as we discussed earlier section, but together with women's participation in the labour force without a high HIV rate it is part of multiple sufficient causal pathways to poverty reduction.

The third pathway shows presence of growth in terms of GDP annual rate, high government expenditure, presence of equality with low rate of HIV prevalent rate leads to improve income of the poorest quintile population. Here, government expenditure is a facilitating factor together with growth and equality and without suffering from HIV infection for poverty reduction. For poverty reduction, not only growth, but also together with other causal conditions of government expenditure, equality and absence of HIV infection become a multiple sufficient conditions to improve income of the poor. Notice that this configuration does not have presence of women's labour participation. Women's visible participation in labour force cannot be seen in this configuration however women's unpaid work at home or women in large agrarian countries who are not counted as part of ILOLFPF could be contributing. Finally, it is also important to note that not having high HIV prevalent rate is not sufficient itself, but as part of a multiple sufficient causal conditions, it does endogenously affect the causal mechanism.

From the findings above, one caveat might be that equality seems part of sufficient configuration to improve income going to the poorest quintile of each country's population is improving. However, there might be reverse causality between delta and equality. Since equality was generated from 2002 data of gini due to the availability of data, as much as we argue that a general trend of equality is justifiable, one might argue that equality is the outcome of the improvement of income of the poorest quintile population.

The set-theoretic sufficiency of this solution overall is 0.75 which is not really high. As this case used a seven-point fuzzy set, 19 cases of DELTA were coded 0.5. In Ragin's term, 0.5 is neither in nor out (it is the cross-over point). These are excluded from the truth table number column, but included in the consistency calculations. The same problem applies to the value of causal conditions. When we run a sensitivity analysis which included the value of 0.5 as "in", however, the cases which are in the set of configurations change the consistency level

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actually lower to 0.71. As more cases were included in the truth table, number of cases in the set relations as well as number of configurations increased which made the value of pre greater and the value of product. The result of the sensitive exercise helped to made it clear that the ordinal ranking of the fuzzy possible outcomes makes it very likely that variations in the coding of this one seventh of each causal condition will not make much difference at all.

4.2 Discussion of Coverage

a) The set-theoretic coverage

The set-theoretic coverage of this solution is 0.90. Although it is seemingly high, it is due to the fact that the coverage is that of 65 countries which have complete data for all conditions. As we mentioned in the earlier section, there are droppings of cases. There are two stages of the dropping cases. The first stage dropping of cases occurs, like any statistical analysis, those cases with missing values of the five causal conditions. Then the second stage dropping of cases occurs when condition values of 0.5 are omitted from the truth table. It could be a serious matter as fsQCA is intended to be applied to Small-, Medium-N studies.

b) Exemplars of configurations

First, we discuss cases in the configuration of $GDPPCRATE1992F * ILOLFPF1992F$. There are three subsets of cases that emerged from this configuration. In the first grouping, we have Bangladesh, China, Republic of Korea, Indonesia, Philippines, Poland, Turkey and Bolivia. Only Bolivia in the subset group had negative delta. Notably, China, Republic of Korea, Philippines, and Turkey are considered to be Newly Industrialised Countries (NICs) (Guillén, 2003; Mankiw 2007). Indonesia is included as a NIC by Bożyk (2006).

Export-oriented economic growth pushed by incipient industrialisation can increase the work opportunities in these countries. Notice that government expenditure is low in this subset of the configuration. There are a high percentage of female works in the manufacturing as well as service sector. Ideologically, women were in labour force in China and Poland at the period data was taken and they are equally contributing to countries' growth. Also, the component of women in small business is playing an important role generating urban employment (Baydas, 1994). Although small business is partly formed in the informal sector which may not appear in the ILOLFPF data, as these NICs have advanced their economic development, they acknowledge these small businesses to be counted 'in' the labour activities and they formally encourage female small business through labour regulation. For example, the Republic of Korea enacted a law establishing a Korean Women Entrepreneur's Association in 1999.

Table 4 Subset Table of the High Growth Rate, High Women's Participation Configuration – NICs [about here]

The second subset group is Bulgaria, Croatia, Finland, Germany, Hungary, Israel, Mongolia, Norway, Sri Lanka, Sweden, and United Kingdom. Among them, only Israel and Bulgaria had negative delta for the period of 1992-2002. These countries had high $gdppcrate$ and $ilolfpf$, but also government expenditure and equality. In other words, high government expenditure and equality were complementary conditions for this subset group. This subset is formed by high welfare states and former social states. Their commonality is that girl's attainment was high except Sri Lanka. The fact that Sri Lanka had the lowest membership of women's labour participation among these countries might be linked with low female attainment. Although Croatia, Mongolia and Bulgaria's female attainment values were

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missing, we can assume that girl's attainment was as equal to boy's in those social countries at that time. Among cases in this subset group, high ILOLFPF were supported by high level of female attainment.

Table 5 Subset Table of the High Growth Rate, High Women's Participation Configuration – Welfare and Social States [about here]

The third subset group is Burkina Faso, Cameroon, Colombia, Ethiopia, Ghana, India, Madagascar, Thailand, and Uganda. Only Ghana and Madagascar had negative Delta. Although these countries have high rates of HIV infection, the presence of a high GDP per capita growth rate and high female labour participation improved the income of the poorest quintile of the population. They are predominantly developing countries. However, as we see the other two configurations contains absence of HIV rate as part of the sufficient multiple causal conditions, we cannot simply discount the impact of HIV on poverty reduction.

Table 6 Subset Table of the High Growth Rate, High Women's Participation Configuration – other developing countries [about here]

Now we turn to the second configuration. Interestingly enough, the cases in the second configuration are overlapping with the first two subsets of the first configuration except Lithuania where its annual growth was low did not appear in the first configuration. Although equality is does not appear in the first configuration, equality might be the 'precondition' for the first two multiple causal conditions.

To confirm the claim that we cannot discount the presence of HIV infection rate, the table 7 shows what if HIV infection is high even when there are high equality, high women's participation in labour force. The result reveals that all countries show not improving the income of the poorest population. Interestingly, it shows that Delta is not improving even with the presence of growth and government expenditure although the table was constructed in consistent with the other conditions of the second configuration where high equality and high ilolfpf were present.

Table 7 Subset Table of the High Equality, High Women's Participation and High HIV Rate Configuration [about here]

Finally, the cases in the third configuration which did not appear in the first and second configurations are Egypt, Ireland, and Tunisia. These countries have made an improvement of Delta without the presence of women's participation. The commonality of this group is that they are traditionally conservative as they were religious countries. Egypt and Tunisia are predominantly Islamic and Ireland is traditionally Catholic. Women are not expectedly seen in workforce. However, contribution of women's unpaid labour, family labour could be great. Also, there might be government expenditure which could be driving to improve Delta. The interpretation of this configuration requires further analysis.

Table 8 Subset Table of High GDP per capita growth, High Government Expenditure, High Equality and Low HIV rate [about here]

5. Discussion

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With retroductive thinking, in this section we are asking what must be the case in order for this set of configurations to have occurred. A retroductive approach can avoid spurious association because we explicitly work through what causal mechanisms may be represented by the variates. It is not neither positivist reductive approach nor it is a traditional qualitative inductive approach. For this paper, we asked the question of “what must have been the case for improving income of the poorest population” and we do for each configuration.

When we simply run cross sectional regression, equality alone appeared to be significant (Table 9). Equality would appear to have been a uniformly important causal factor for poverty reduction. However, there are multiple causal conditions in which each pathway may lead to improving the income of the poorest part of the population. It is almost the same as having many paths to climb up the mountain. Asking in a pluralist context and applying fsQCA, these pathways emerged.

Table 9 [about here]

The configurations were growth with women’s participation in workforce; equality, women’s labour participation with low HIV rate, and finally growth, government expenditure and equality with low HIV rate. The result of fsQCA tended to support the existing theories that human capital and other social factors improve the income of the poorest population of countries considered. Female labour force participation became part of a sufficient multiple causal condition in some cases for poverty reduction, while some countries had other conditions leading the same outcome. We brought growth into our model as part of multiple causal conditions for poverty reduction; however growth was nowhere itself sufficient for poverty reduction in the period of 1992-2002.

Overall, there are two interpretations that are this paper’s contribution to the poverty reduction debate. The first competing interpretation of the poverty reduction model is that female participation in labour force plays a significant factor to improve the poorest population’s income. That could be present either with economic growth or equality. It could be hindered by high HIV infection rate.

There are two main subsets of the cases. One was those countries where there is high female labour participation which are supported by high female school attainment. Another was those countries not necessarily supported by high female attainment; however females were in active labour force. The Scandinavian countries and U.K are in the former configuration and China and Bangladesh are part of the latter configuration. Educational policy interweaves with employment policy when it comes to girl’s school careers and work trajectories (Olsen and Nomura, 2007). We can study further the education policies of these countries at the micro level. The hypothesis could be then further tested those countries these subset groups by adding variants of educational policies with fsQCA.

Also, we could improve our analysis by taking a counterfactual approach to those countries with missing data. Data is limited especially for Commonwealth of Independent States together with Turkmenistan, the Ukraine, Moldova of the former USSR, and other new states that emerged after 1992. FsQCA enables us to include these countries as it helps us to analyse those cases with missing data. We can input our theoretical and substantive knowledge of both qualitative and quantitative types into the fsQCA results. Thus the results given here are subject to further future research and revision.

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The application of fsQCA has an advantage to overcome the problem of the collection of data on the gendered characteristics behind workforce culture. Recorded women's labour force participation rate is just the tip of iceberg of the actual female participation in the workforce. For example, females in small business are often invisible, especially if they are engaged in the agricultural sector or informal sector. They are actually 'in' the labour force rather than out of it. Women using micro-finance would be another example (Berger, 1989). They may not be found from quantitative data as they are not a well-established part of national programmes of data collection and tabulation (Unifem, 2005). However, they could be fuzzified to become part of fsQCA truth tables by collecting qualitative information about the policies that influence women's employment.

The second major competing interpretation would be less gender oriented. Here we concentrate on the fact that there are also some countries where female participation in the workforce is not part of the conditions for poverty reduction as long as there are both high government expenditure and high income equality. These countries are traditionally religious countries and the absence of female labour participation is socially constructed as a predominant norm in the societies of the cases with such a configuration. To avoid making a spurious claim, however, we must study whether government expenditure is being spent on pro-poor policies. Further research will be needed to explore the interaction of the governmental measurements that specifically target to improve the poor in these countries. The results shown here relate only to economic poverty. Other research would be needed to study outcomes on social, political, happiness or human capabilities dimensions of poverty.

Finally, we must not neglect the impact of HIV infection. Sub-Saharan Africa is suffering from HIV infection and there is a neglect of assessing the macro-economic impact of HIV (BER, 2006). Gendered variants of labour markets suggests that there would be greater impacts on the labour as a result of HIV, as male and female may not perfectly substitute their divisions of labour.

6. Conclusion

Our application of fuzzy sets was temporally very specific and deliberately limited. Instead of using lags or pooling of a panel, we have done cross-sectional fsQCA with the time-point 1992 for most of the causal variates, and change from 1992 to 2002 as the measurement period for the outcome. Many variations of this theme will be possible. Other authors are exploring the use of fsQCA to study time-sequenced change, e.g. a QCA version of hazard models and marginal change models. We have merely opened up this broad avenue by taking a first step with fsQCA '992-1001.

NOTE:

1. According to the definition, women in family agricultural production or small family enterprises are not counted or women in a country with a large informal sector are underreported (Pampel and Tanaka, 198). Each female is considered as economically active if she is employed or seeking employment in the formal economy. We took into account of this data limitation in our discussion section.

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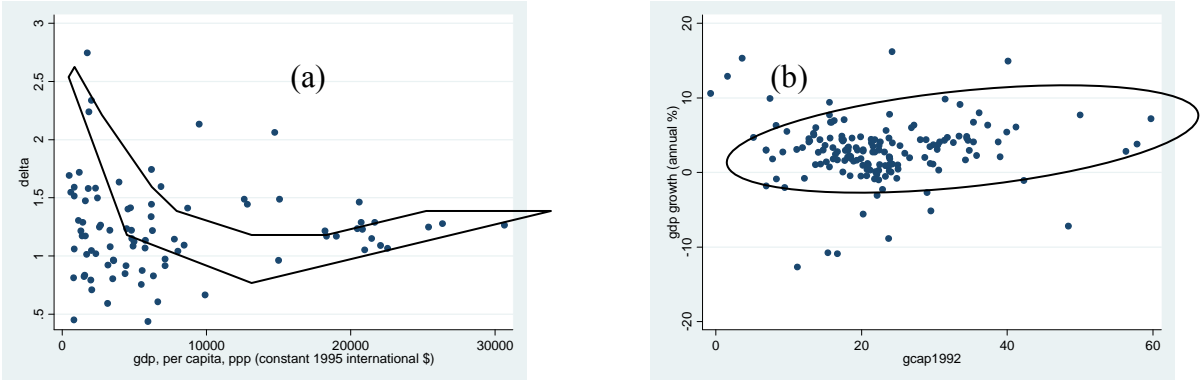
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Figure 1: Illustration of Lines of Best Fit



Note: Panel (a) shows poverty reduction 1992-2002 by GDP per capita in 1992. Using the log of GDP, one may try to fit a curve to the data. Panel (b) shows the GDP growth rate 1992-2002 by the investment rate in 1992. The positive slope shown emerges as significant in panel data fixed-effects regressions in spite of the looseness of its fit. See appendix 1 for details of variables and sources.

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Table 1

	X1	X2	X3	Y
A	1	0	1	1
B	1	0	1	0

Table 2

X1	X2	X3	N
1	0	1	1

Table 3 Truth Table of Poverty Reduction Model

gdppcratef	govtexpf	equalityf	ilolfpf	hivf	number	deltaf	consist
0	0	1	1	0	1	1	0.971619
1	0	1	1	0	4	1	0.948679
1	1	1	0	0	3	1	0.948222
1	0	0	1	1	2	1	0.91777
1	0	1	1	1	1	1	0.911953
1	1	1	1	0	7	1	0.904245
1	1	1	1	1	1	1	0.90106
1	0	0	0	1	4	0	0.825121

Notes: 21 cases appear on the truth table. An explanation of the dropped cases in the truth table is provided in the main text.

Table 4 Subset Table of the High Growth Rate, High Women's Participation Configuration –NICs

Country	delta	deltaf	gdppcratef	govtexpf	equalityf	hivf	ilolfpff
Bangladesh	1.305	.5	.83	0	.83	.33	.83
Bolivia	.793	.33	.83	.33	.5	.33	.5
China	1.581	.67	1	.17	.5	.33	1
Indonesia	1.247	.5	.83	.33	.67	.33	.67
Korea (Rep. of)	2.132	.83	.83	.33	.83	0	.67
Philippines	1.080	.5	.67	.33	.5	0	.5
Poland	1.743	.67	.83	0	.83	.33	.83
Turkey	1.124	.5	.83	.33	.67	0	.5

Table 5 Subset Table of the High Growth Rate, High Women's Participation Configuration – Welfare and Social States

Country	delta	deltaf	gdppcratef	govtexpf	equalityf	hivf	ilolfpff
Bulgaria	.757	.33	.67	.67	.83	0	.83
Croatia	1.220	.5	.5	.67	.83	0	.67
Finland	1.216	.5	.67	.67	1	0	.83
Germany	1.149	.5	.83	.67	.83	.33	.83
Hungary	1.412	.67	.67	.83	1	.33	.67
Israel	.962	.33	.83	.83	.67	.33	.5

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Mongolia	1.214	.5	.5	.5	.5	0	.83
Norway	1.249	.5	.83	.67	1	.33	.83
Sri Lanka	1.583	.67	.83	.5	.67	0	.5
Sweden	1.168	.5	.67	.67	1	.33	1

Table 6 Subset Table of the High Growth Rate, High Women's Participation Configuration – other developing countries

Country	delta	deltaf	gdppcratef	govtexpf	equalityf	hivf	ilolfpff
Burkina Faso	1.515	.67	.67	.33	.33	.83	.83
Cameroon	1.013	.5	.67	.33	.5	1	.5
Colombia	.875	.33	.83	.33	.17	.67	.5
Ethiopia	1.692	.67	.5	.33	.83	.83	.67
Ghana	.835	.33	.83	.33	.83	.83	.83
India	1.474	.67	.83	.33	.83	.67	.5
Madagascar	.813	.33	.83	.33	.33	.67	.83
Thailand	1.413	.67	.83	.33	.5	.67	1

Table 7 Subset Table of the High Equality, High Women's Participation and High HIV Rate Configuration

Country	delta	deltaf	gdppcratef	govtexpf	equalityf	hivf	ilolfpff
Burundi	.451	0	.67	.67	.83	1	1
Jamaica	.961	.33	.83	.5	.67	.67	.83
Gambia	.824	.33	.83	.5	.67	.67	.83
Uruguay	.972	.33	.83	.5	.5	.5	.67
Belarus	.848	.33	.5	.67	0.83	.5	.83

Table 8 Subset Table of High GDP per capita growth, High Government Expenditure, High Equality and Low HIV rate

Country	delta	deltaf	gdppcratef	govtexpf	equalityf	hivf	ilolfpff
Ireland	2.063	.83	.83	.67	.67	.33	.33
Tunisia	1.404	.67	.83	.67	.67	0	.17
Egypt	1.264	.5	.83	.67	.67	0	.17

Table 9 the regression result of the poverty reduction model

N=56		
	Coefficient	t value
gdpprate	.02	1.56
govtexp	.00	-0.50
equality	.01	1.94*
ilolfpf	.00	-0.70
attain	.02	1.03
hiv	.0061581	0.42
consist	.5416689	1.77*

Notes: *p < .10 **p < .05 ***p < .01