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## 1. Calibration

### 1.1 Set labels and calibration points

* PR = high prison rate
* IN = high inequality
* WS = weak social protection;
* TR = high level of trust;
* MV = majoritarian voting system;
* EC = high economic co-ordination;

#### 1.1.1 Calibration of PR Set (high prison rate)

This set captures high punitiveness using average values of the prison population rate per 100,000 people across the period 1997-2021. Data are drawn from World Prison Brief. For each case, data was available on a biennial basis from 2000-2020. World Prison Brief does not report data for the UK as a whole, we used England & Wales figures as a proxy for UK (see below for more on this).

|  |  |  |
| --- | --- | --- |
|  | **Prison population rate / 100,000 (World Prison Brief)** | **Rationale for calibration** |
| United States | 706 | **Crossover**: the placement of the 0.5 crossover point is key decision is determining which cases fall into the more punitive group. The United States (706) is an extreme outlier and its high rate distorts the mean which is some way above the median (126 v 94). We aim to capture high punitiveness here and we judge that this falls somewhere between American exceptionalism and the median score (Italy and Greece are at the median), so look for a breakpoint between a mean inflated by US exceptionalism and median. The midpoint of these two would be 110, which is very close to the rate for Korea (109). There is a ‘natural’ breakpoint between Korea (109) and France (99), so we place the cross-over at the nearest round number between these two cases (105).  In terms of the top and bottom of the sets, the United States is a clear outlier at the top end, but New Zealand (182) is some distance from the third placed case (UK, 143). We set the top end of the set at the nearest round number above UK (145). At the bottom of the set Japan (53) is some way from other cases. Finland has a rate (61) some way below three other Scandinavian cases that cluster together Denmark (67), Norway (67) and Sweden (69) but that are themselves some distance from the median and from all other cases, as well as being seen as exemplars of a welfarist approach in the literature. We place the bottom of the set at the nearest round number between these four cases (65) to capture they are essentially fully-in the set and that the variation below the Scandinavian cases (i.e. Japan) is quantitative rather than qualitative in nature. |
| New Zealand | 182 |
| SET MAX | 145 |
| United Kingdom | 143 |
| Australia | 137 |
| Spain | 137 |
| MEAN | 126 |
| Portugal | 123 |
| Canada | 114 |
| Korea | 109 |
| SET CROSSOVER | 105 |
| France | 99 |
| Austria | 98 |
| Italy | 94 |
| MEDIAN | 94 |
| Greece | 94 |
| Belgium | 93 |
| Netherlands | 87 |
| Germany | 83 |
| Ireland | 81 |
| Switzerland | 79 |
| Sweden | 69 |
| Denmark | 67 |
| Norway | 67 |
| SET MIN | 65 |
| Finland | 61 |
| Japan | 53 |

The small multiples data visualisation below displays the raw time series data by case with a dashed line at the chosen crossover point. This shows that set membership for some cases would adjust with a snapshot of a single year and we pick up some of this variation in our case discussion.

Chart

Description automatically generated

As noted above, World Prison Brief does not report data for the UK as a whole, we used England & Wales figures as a proxy for UK; for completeness, we manually compiled World Prison Brief data for England & Wales, Northern Ireland and Scotland, compiled UK Office for National Statistics population data for each, and calculated a UK wide incarceration rate figure. Given the potential for this to add noise to our figures we did not use this in our analysis, but present the data below, which underline the differences between the England and Wales data and the overall UK rates are likely very small and, moreover, do not in any instance move the UK rate below our high punitiveness threshold.

|  |  |  |
| --- | --- | --- |
| **Year** | **Prison population rate (England & Wales)**  **(World Prison Brief)** | **Prison population rate (UK)**  **(Author estimated)** |
| 2000 | 124 | 122 |
| 2002 | 135 | 132 |
| 2004 | 141 | 139 |
| 2006 | 145 | 143 |
| 2008 | 152 | 150 |
| 2010 | 153 | 151 |
| 2012 | 153 | 152 |
| 2014 | 149 | 147 |
| 2016 | 146 | 144 |
| 2018 | 140 | 138 |
| 2020 | 133 | 131 |
| **Average** | **143** | **141** |

#### 1.1.2 Calibration of IN Set (high inequality)

This set captures high market inequality using average values of the Gini coefficient of pre-tax national income data across the period 1997-2021. Data are drawn from the World Inequality Database (WID). Values are available for all cases for all years. Conventional benchmarks in the conceptual literature consider income inequality after tax and benefits, where coefficients are much lower, but we aim capture market inequality and social policy in separate sets, so need to be partly guided by the distribution of the scores also.

|  |  |  |
| --- | --- | --- |
| **Row Labels** | **Gini coefficient pre-tax national income data (WID)** | **Rationale for calibration** |
| United States | 0.566 | Conceptual debates about classification of countries do not tend to use figures before tax and benefits (e.g. see ILO TRAVAIL POLICY BRIEF 3, [*Inequality, income shares and poverty: The practical meaning of Gini coefficients*](https://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---travail/documents/publication/wcms_145695.pd)), meaning we lack clear conceptually based guidelines. Accordingly, we calibrate the set with reference to distributional measures and the position of key cases in our set.  **Crossover**: location of the 0.5 crossover point is the key decision is determining which cases fall into the high inequality group. We place this around median but, chose a score just below the median, (0.45 rather than 0.455) for several reason: (i) to avoid over specifying our sets throughout we have aimed to use round members for the key anchors, (ii) there is a ‘natural break’ in the series between New Zealand at 0.453 and Belgium at 0.444, placing the crossover at 0.45 reflects this, (iii) in key theoretical literature on welfare regimes New Zealand is commonly seen as an example of a more unequal liberal regime, Belgium an example of the corporatist/conservative regime where status differentials are maintained but corporatist structures play a key role in developing a stronger social minimum.  At the bottom of the set we placed the minimum at 0.40, the nearest round number to the scores found in the Scandinavian countries that are seen as exemplars of the more egalitarian social democratic welfare regime; this is also the nearest round number to the bottom value in the set.  At the top of the set, we place the max score for the set at 0.50; this creates an evenly distributed set of calibration anchors (0.4, 0.45 and 0.5), but also places some of the most unequal cases above the anchor point, judging all cases from Canada upwards to fully in the unequal set. We judged that the wider dispersal of scores above the median than below reflected quantitative rather than qualitative difference, particularly as key exemplars of the unequal liberal regime (UK, Australia) fell below the 0.5 upper score. Our approach has the advantage of creating a simple set of evenly spaced calibration anchors, but could be seen as inconsistent in its treatment of the most commonly cited exemplars of Social Democratic (Sweden) and Liberal (USA) welfare regimes. |
| Japan | 0.538 |
| Korea | 0.533 |
| Canada | 0.523 |
| SET MAX | 0.500 |
| Portugal | 0.493 |
| Greece | 0.483 |
| United Kingdom | 0.482 |
| Australia | 0.478 |
| Germany | 0.470 |
| MEAN | 0.463 |
| Ireland | 0.458 |
| Spain | 0.457 |
| MEDIAN | 0.455 |
| New Zealand | 0.453 |
| SET CROSSOVER | 0.450 |
| Belgium | 0.444 |
| Austria | 0.444 |
| France | 0.436 |
| Finland | 0.435 |
| Italy | 0.432 |
| Switzerland | 0.427 |
| Denmark | 0.416 |
| Netherlands | 0.404 |
| Norway | 0.403 |
| Sweden | 0.402 |
| SET MIN | 0.400 |

The small multiples data visualisation below displays the raw time series data by case with a dashed line at the chosen crossover point. This shows that set membership for some cases would adjust with a snapshot of a single year.

Timeline

Description automatically generated with low confidence

#### 1.1.3 Calibration of WS Set (weak social protection)

The weak social protection set is based on two separate sets (one capturing income protection, the other capturing employment protection) that are combined using the Boolean AND operator. The underlying indicators for each set are such that high scores relate to stronger social protection, so for both of the underlying sets the set cores are inverted before they are combined to from the weak social protection set, i.e. for both the income protection and the employment protection set a high score indicates weak social protection. Using the Boolean AND operator to combine the two means countries only join the weak social protection set if they are members of both the (weak) income protection and (weak) employment protection sets.

The tables and charts below show the scores and calibration for the two underlying sets. The weak income protection set is based on average values for the OECD’s net replacement rate indicator for a single person with no children, previously earning average wage, after 12 months of unemployment and including housing benefits & social assistance; data cover 2001-2021, except for Australia, Canada, Korea, New Zealand, Switzerland that cover 2001-2020. The weak employment protection set is based on average values for the OECD’s employment protection legislation (EPL) index Version 1 (dismissal regular workers); we utilise the older version 1 of this index because it covers a larger number of years than the more recent variants; the data cover the years 1997-2019.

|  |  |  |
| --- | --- | --- |
| **Row Labels** | **Net replacement rate, single no children, avg wage, 12 months, inc housing bens & social assist (OECD)** | **Rationale for calibration** |
| SET MIN | 80.0 | Kvist (2006) used the net replacement rate for a single person with previous earnings at the level of the Average Production Worker (APW) as an empirical indicator for benefit generosity, with below 20% deemed fully not-generous, 90% and more as fully generous and crossover point: 54.5-55.5%.  We follow this approach here, with the exception of dropping the fully generous replacement rate to 80%, reflecting (i) that no cases have a replacement rate about 76.7%, in turn reflecting (ii) that we focus purely on longer-term unemployment, with many countries having support that becomes less generous after an initial period of unemployment.  Reference: Kvist, J. (2006) "Diversity, Ideal Types and Fuzzy Sets in Comparative Welfare State Research," in: Benoît Rihoux & Heike Grimm (ed.), Innovative Comparative Methods for Policy Analysis, pages 167-184, Springer Books. |
| Portugal | 76.7 |
| Switzerland | 70.9 |
| Netherlands | 69.2 |
| France | 67.2 |
| Norway | 64.0 |
| Denmark | 62.1 |
| Belgium | 60.0 |
| Germany | 59.9 |
| Spain | 58.9 |
| Austria | 55.8 |
| Finland | 55.3 |
| SET CROSSOVER | 55.0 |
| MEDIAN | 52.5 |
| Sweden | 49.6 |
| MEAN | 47.6 |
| Ireland | 45.0 |
| Japan | 41.6 |
| United Kingdom | 38.4 |
| New Zealand | 38.0 |
| Greece | 31.9 |
| Australia | 29.9 |
| SET MAX | 20.0 |
| United States | 19.1 |
| Canada | 18.6 |
| Korea | 18.3 |
| Italy | 17.6 |

The small multiples data visualisation below displays the raw time series data by case with a dashed line at the chosen crossover point. Note: Italy may appear to have no data for most years but this reflects a recorded score of 0 in the OECD data set that in turn reflected the structure of their benefits system in those years.

Timeline

Description automatically generated

|  |  |  |
| --- | --- | --- |
| **Row Labels** | **EPL Version 1 (dismissal regular workers)** | **Rationale for calibration** |
| Portugal | 4.03 | Vis (2007) used the OECD EPL to capture the strength of employment protection, setting fully out of the set of employment protection at 0.5 and fully in at 3.0. We follow this approach, the cross-over being the midpoint between the two (1.75).  Reference: Vis, Barbara (2007), States of Welfare or States of Workfare? Welfare State Restructuring in 16 Advanced Capitalist Democracies, 1985-2002, Policy & Politics, 35(1): 105-122 |
| Netherlands | 3.31 |
| SET MIN | 3.00 |
| Italy | 2.91 |
| Greece | 2.87 |
| Germany | 2.60 |
| France | 2.57 |
| Sweden | 2.46 |
| Korea | 2.45 |
| Austria | 2.39 |
| Norway | 2.33 |
| Spain | 2.23 |
| MEDIAN | 2.17 |
| Finland | 2.10 |
| MEAN | 2.04 |
| Belgium | 1.78 |
| SET CROSSOVER | 1.75 |
| New Zealand | 1.70 |
| Japan | 1.51 |
| Denmark | 1.49 |
| Australia | 1.49 |
| United Kingdom | 1.44 |
| Switzerland | 1.43 |
| Ireland | 1.21 |
| Canada | 0.59 |
| SET MAX | 0.50 |
| United States | 0.09 |

The small multiples data visualisation below displays the raw time series data by case with a dashed line at the chosen crossover point.

Timeline

Description automatically generated

#### 1.1.4 Calibration of TR Set (high level of trust)

This set captures social trust using 25-year averages of the World Values Survey/European Values Survey generalised trust question (the proportion agreeing most people can be trusted). The years covered vary somewhat by case and the survey is not an annual one; our set draws on multiple waves that cover our target time period (1997-2021). In a small number of cases we have values for just two time points. In some cases we used values for 1995 or 1996 as a proxy for 1997.

The years covered by case are:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Australia** | | | | **Austria** | | | **Belgium** | |  |
| 1997 (1995 data) | 2005 | 2012 | 2018 | 1999 | 2008 | 2018 | 1999 | 2009 |  |
|  |  |  |  |  |  |  |  |  |  |
| **Canada** | | | **Denmark** | | |  |  |  |  |
| 2000 | 2006 | 2020 | 1999 | 2008 | 2017 |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| **Finland** | | | | | **France** | | | |  |
| 1997 (1996 data) | 2000 | 2005 | 2009 | 2017 | 1999 | 2006 | 2008 | 2018 |  |
|  |  |  |  |  |  |  |  |  |  |
| **Germany** | | | | | | |  |  |  |
| 1997 | 1999 | 2006 | 2008 | 2013 | 2017 | 2018 |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| **Greece** | | | **Ireland** | |  |  |  |  |  |
| 1999 | 2008 | 2017 | 1999 | 2008 |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| **Italy** | | | | **Japan** | | | | |  |
| 1999 | 2005 | 2009 | 2018 | 1997 (1995 data) | 2000 | 2005 | 2010 | 2019 |  |
|  |  |  |  |  |  |  |  |  |  |
| **Korea** | | | | | **Netherlands** | | | | |
| 1997 (1996 data) | 2001 | 2005 | 2010 | 2018 | 1999 | 2006 | 2008 | 2012 | 2017 |
|  |  |  |  |  |  |  |  |  |  |
| **New Zealand** | | | | **Norway** | | | |  |  |
| 1998 | 2004 | 2011 | 2020 | 1997 (1996 data) | 2007 | 2008 | 2018 |  |  |
|  |  |  |  |  |  |  |  |  |  |
| **Portugal** | | | **Spain** | | | | | | |
| 1999 | 2008 | 2020 | 1997 (1995 data) | 1999 | 2000 | 2007 | 2008 | 2011 | 2017 |
|  |  |  |  |  |  |  |  |  |  |
| **Sweden** | | | | | | **Switzerland** | | | |
| 1997 (1996 data) | 1999 | 2006 | 2009 | 2011 | 2017 | 1997 (1996 data) | 2007 | 2008 | 2017 |
|  |  |  |  |  |  |  |  |  |  |
| **United Kingdom** | | | | | **United States** | | | | |
| 1998 | 1999 | 2005 | 2009 | 2018 | 1997 (1995 data) | 1999 | 2006 | 2011 | 2017 |

|  |  |  |
| --- | --- | --- |
| **Row Labels** | **A165 'Most can be trusted' / 'Total'** | **Rationale for calibration** |
| Denmark | 72.0% | We found no prior examples of calibration in the literature, so were guided by the distribution of the data and key cases.  **Crossover**: We looked to place the crossover at a point that was guided by the mean and median and chose 40% (i) as the nearest round number between the two and (ii) on the bases there is quite a distance between Canada (42.4%) and and Austria (37.8%), so 40% was a rounded number at the midpoint of this ‘natural break’ in the data.  At the top of the set, Denmark and Norway are outliers with scores some way above the third ranked case, so we set fully in the set as the nearest round number below them (70%). Similarly, at the bottom of the set Greece and Portugal are outliers so we set fully out of the set at the nearest round number above them. |
| Norway | 71.6% |
| SET MAX | 70.0% |
| Sweden | 63.1% |
| Finland | 58.8% |
| Netherlands | 58.0% |
| New Zealand | 52.0% |
| Switzerland | 49.2% |
| Australia | 48.6% |
| Canada | 42.4% |
| MEAN | 41.4% |
| SET CROSSOVER | 40.0% |
| Austria | 37.8% |
| Germany | 37.8% |
| MEDIAN | 37.7% |
| United States | 37.6% |
| Japan | 37.1% |
| Ireland | 36.5% |
| United Kingdom | 33.4% |
| Belgium | 31.1% |
| Spain | 30.1% |
| Korea | 30.0% |
| Italy | 29.2% |
| France | 23.5% |
| SET MIN | 20.0% |
| Greece | 16.4% |
| Portugal | 15.2% |

The small multiples data visualisation below displays the raw time series data by case with a dashed line at the chosen crossover point.

A picture containing timeline

Description automatically generated

#### 1.1.5 EC Set (high economic co-ordination)

This set captures the extent of economic co-ordination using Witt and Jackson (2016)’s economic coordination index as a contemporary measure of Hall and Soskice (2001)’s Varieties of Capitalism framework. Their index captures economic co-ordination in five key institutional domains – corporate governance, inter-firm relations, employment relations, firm hierarchy and occupational training – summarising them in a single indicator that was designed as a fsQCA set, so is already calibrated. We compute an average for all years of their index, which covers 1997-2003.

The small multiples data visualisation below displays the raw time series data by case with a dashed line at the chosen crossover point.

Timeline

Description automatically generated

#### 1.1.6 MV Set (Majoritarian Voting System)

This set captures the nature of the voting system using qualitative descriptions mapped against fuzzy set anchors. We use OECD Government at a Glance electoral system classification data that breaks systems into a small number of types and we map these against a four point fuzzy set scheme (see Rihoux and Ragin, 2007) with following anchors on the basis of how far they match the characteristics of a majoritarian voting system (left hand side) and the following set scores for each case (right hand side):

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | | **Set Score** | **Qualitative Descriptor of Score** | **OECD Government at Glance categories** | | 1.0 | Fully in the set | Single member, first past the post vote | | 0.67 | More in than out the set | Single member, preferential vote  Single member, two rounds of voting | | 0.33 | More out than in the set | Multi-member, semi-proportional | | 0 | Fully out the set | Multi member, proportional | | |  |  |  | | --- | --- | --- | | **Country** | **OECD *Government at a Glance* electoral system classification** | **Calibration** | | Australia | Single - preferential | 0.67 | | Austria | Multi member - proportional | 0 | | Belgium | Multi member - proportional | 0 | | Canada | Single -First Past the Post | 1 | | Denmark | Multi member - proportional | 0 | | Finland | Multi member - proportional | 0 | | France | Single - Two rounds | 0.67 | | Germany | Multi member - proportional | 0 | | Greece | Multi member - proportional | 0 | | Ireland | Multi member - proportional | 0 | | Italy | Multi member - proportional | 0 | | Japan | Multi member - semi-proportional | 0.33 | | Korea | Multi member - semi-proportional | 0.33 | | Netherlands | Multi member - proportional | 0 | | New Zealand | Multi member - semi-proportional | 0.33 | | Norway | Multi member - proportional | 0 | | Portugal | Multi member - proportional | 0 | | Spain | Multi member - proportional | 0 | | Sweden | Multi member - proportional | 0 | | Switzerland | Multi member - semi-proportional | 0.33 | | United Kingdom | Single - First Past the post | 1 | | United States | Single - First Past the post | 1 | |

### 1.2 Calibration scores by case for each set

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Case label** | **Country name** | **PR** | **IN** | **WS** | **EC** | **TR** | **MV** |
| AUS | Australia | 0.91 | 0.84 | 0.65 | 0.17 | 0.71 | 0.67 |
| AUT | Austria | 0.38 | 0.41 | 0.18 | 0.63 | 0.43 | 0.00 |
| BEL | Belgium | 0.29 | 0.41 | 0.36 | 0.74 | 0.21 | 0.00 |
| CAN | Canada | 0.66 | 0.99 | 0.94 | 0.13 | 0.55 | 1.00 |
| DNK | Denmark | 0.06 | 0.12 | 0.30 | 0.59 | 0.96 | 0.00 |
| FIN | Finland | 0.04 | 0.29 | 0.30 | 0.54 | 0.87 | 0.00 |
| FRA | France | 0.39 | 0.30 | 0.13 | 0.56 | 0.08 | 0.67 |
| DEU | Germany | 0.17 | 0.76 | 0.12 | 0.80 | 0.43 | 0.00 |
| GRC | Greece | 0.31 | 0.87 | 0.07 | 0.57 | 0.03 | 0.00 |
| IRE | Ireland | 0.15 | 0.62 | 0.70 | 0.27 | 0.39 | 0.00 |
| ITA | Italy | 0.31 | 0.26 | 0.06 | 0.66 | 0.17 | 0.00 |
| JPN | Japan | 0.02 | 0.99 | 0.64 | 0.35 | 0.39 | 0.33 |
| KOR | Korea | 0.57 | 0.99 | 0.16 | 0.37 | 0.19 | 0.33 |
| NLD | Netherlands | 0.21 | 0.06 | 0.02 | 0.68 | 0.85 | 0.00 |
| NZL | New Zealand | 1.00 | 0.54 | 0.53 | 0.17 | 0.76 | 0.33 |
| NOR | Norway | 0.06 | 0.06 | 0.20 | 0.60 | 0.96 | 0.00 |
| PRT | Portugal | 0.79 | 0.93 | 0.00 | 0.47 | 0.02 | 0.00 |
| ESP | Spain | 0.91 | 0.60 | 0.24 | 0.37 | 0.19 | 0.00 |
| SWE | Sweden | 0.07 | 0.06 | 0.16 | 0.62 | 0.91 | 0.00 |
| CHE | Switzerland | 0.13 | 0.21 | 0.13 | 0.53 | 0.71 | 0.33 |
| GBR | United Kingdom | 0.94 | 0.87 | 0.67 | 0.03 | 0.26 | 1.00 |
| USA | United States | 1.00 | 1.00 | 0.95 | 0.09 | 0.43 | 1.00 |

### 1.3 Calibration diagnostics: skew checks

|  |  |  |
| --- | --- | --- |
| Chart, histogram  Description automatically generated  Cases > 0.5 / Total number of cases: 8 / 22 = 36.36 % | Chart, histogram  Description automatically generated  Cases > 0.5 / Total number of cases: 12 / 22 = 54.55 % | Chart, histogram  Description automatically generated  Cases > 0.5 / Total number of cases: 7 / 22 = 31.82 % |
| Chart, histogram  Description automatically generated  Cases > 0.5 / Total number of cases: 9 / 22 = 40.91 % | Chart, histogram  Description automatically generated  Cases > 0.5 / Total number of cases: 5 / 22 = 22.73 % | Chart, histogram  Description automatically generated  Cases > 0.5 / Total number of cases: 12 / 22 = 54.55 % |

### 1.4 Calibration diagnostics: ambiguous cases

There are no cases with fuzzy-set scores of 0.5

### 1.5 Summary

Following the loose rules of thumb in Oona et al (2021) we judge none of the sets to be problematically skewed; MV is close but represents the empirical reality. All avoid ambiguous cases.

## 2. Tests of necessary conditions

### 2.1 Necessary conditions: PR set

*Commentary: we treat ~EC as a necessary condition for PR because* ***Cons.Nec*** *exceeds our threshold of 0.9 and both Cov.Nec and RoN exceed our threshold of 0.6.*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  | | --- | --- | --- | --- | |  | **Cons.Nec** | **Cov.Nec** | **RoN** | | IN | 0.870 | 0.669 | 0.709 | | WS | 0.562 | 0.699 | 0.865 | | TR | 0.519 | 0.465 | 0.673 | | MV | 0.478 | 0.792 | 0.933 | | EC | 0.468 | 0.441 | 0.685 | | ~IN | 0.387 | 0.369 | 0.663 | | ~WS | 0.635 | 0.412 | 0.469 | | ~TR | 0.741 | 0.603 | 0.696 | | ~MV | 0.618 | 0.355 | 0.349 | | ~EC | 0.903 | 0.702 | 0.734 | | *Chart, scatter chart  Description automatically generated* |

### 2.2 Necessary conditions: ~PR set

*Commentary: though ~MV has* ***Cons.Nec*** *exceeding 0.9, the RoN is relatively low, so we do not treat it as a necessary condition for ~PR.*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  | | --- | --- | --- | --- | |  | **Cons.Nec** | **Cov.Nec** | **RoN** | | IN | 0.510 | 0.528 | 0.631 | | WS | 0.326 | 0.546 | 0.809 | | TR | 0.637 | 0.768 | 0.826 | | MV | 0.165 | 0.367 | 0.820 | | EC | 0.715 | 0.908 | 0.930 | | ~IN | 0.681 | 0.876 | 0.909 | | ~WS | 0.821 | 0.716 | 0.647 | | ~TR | 0.556 | 0.609 | 0.699 | | ~MV | 0.907 | 0.701 | 0.536 | | ~EC | 0.560 | 0.586 | 0.666 | |  |

### 2.3 Test for SUIN conditions for PR

*Commentary: no SUIN conditions identified.*

### 2.4 Test for SUIN conditions for ~PR

|  |  |
| --- | --- |
| **inclN RoN covN**  ~IN + WS + EC 0.914. 0.602. 0.735  **Skewcheck for ~IN + WS + EC**:  Cases > 0.5 / Total number of cases: 19 / 22 = 86.36 % | Chart, scatter chart  Description automatically generated |

*Commentary: ~IN + WS + EC is a potential SUIN condition for ~PR, but we do not treat is a such on the basis that (i) the RoN very close to our 0.6 threshold, raising questions about whether it is trivial and (ii) the skewcheck suggests it is problematic too with just three cases not members of ~IN + WS + EC.*

## 3. Tests of sufficient conditions: PR

### 3.1 Truth table membership of PR set

===========================================================

IN WS TR MV EC OUT n incl PRI cases

-----------------------------------------------------------

27 1 1 0 1 0 1 2 0.895 0.848 GBR,USA

31 1 1 1 1 0 1 2 0.893 0.848 AUS,CAN

17 1 0 0 0 0 1 3 0.837 0.620 KOR,PRT,ESP

4 0 0 0 1 1 0 1 0.737 0.426 FRA

18 1 0 0 0 1 0 2 0.724 0.353 DEU,GRC

29 1 1 1 0 0 0 1 0.722 0.482 NZL

2 0 0 0 0 1 0 3 0.695 0.284 AUT,BEL,ITA

25 1 1 0 0 0 0 2 0.663 0.342 IRE,JPN

6 0 0 1 0 1 0 6 0.415 0.095 DNK,FIN,NLD,NOR,SWE,CHE

1 0 0 0 0 0 ? 0

3 0 0 0 1 0 ? 0

5 0 0 1 0 0 ? 0

7 0 0 1 1 0 ? 0

8 0 0 1 1 1 ? 0

9 0 1 0 0 0 ? 0

10 0 1 0 0 1 ? 0

11 0 1 0 1 0 ? 0

12 0 1 0 1 1 ? 0

13 0 1 1 0 0 ? 0

14 0 1 1 0 1 ? 0

15 0 1 1 1 0 ? 0

16 0 1 1 1 1 ? 0

19 1 0 0 1 0 ? 0

20 1 0 0 1 1 ? 0

21 1 0 1 0 0 ? 0

22 1 0 1 0 1 ? 0

23 1 0 1 1 0 ? 0

24 1 0 1 1 1 ? 0

26 1 1 0 0 1 ? 0

28 1 1 0 1 1 ? 0

30 1 1 1 0 1 ? 0

32 1 1 1 1 1 ? 0

-----------------------------------------------------------

### 3.2 Minimisation of truth table, standard analysis, conservative solution: PR

**Standard Analysis, Conservative Solution: PR**

===================================================================

inclS PRI covS covU cases

-------------------------------------------------------------------

IN\* WS\* MV\* ~ EC 0.876 0.842 0.391 0.288 GBR,USA; AUS,CAN

IN\* ~ WS\* ~ TR\* ~ MV\* ~ EC 0.837 0.620 0.474 0.371 KOR,PRT,ESP

Solution 0.869 0.776 0.762

-------------------------------------------------------------------

### 3.3 Minimisation of truth table, standard analysis, parsimonious solution: PR

**Standard Analysis, Parsimonious Solution, Model 1: PR**

===================================================

inclS PRI covS covU cases

---------------------------------------------------

IN\* MV 0.860 0.812 0.461 0.005 GBR,USA; AUS,CAN

~ WS\* ~ EC 0.677 0.437 0.591 0.379 KOR,PRT,ESP

Solution 0.728 0.586 0.849

---------------------------------------------------

**Standard Analysis, Parsimonious Solution, Model 2: PR**

===================================================

inclS PRI covS covU cases

---------------------------------------------------

~ WS\* ~ EC 0.677 0.437 0.591 0.379 KOR,PRT,ESP

WS\* MV 0.864 0.826 0.396 0 GBR,USA; AUS,CAN

Solution 0.725 0.574 0.821

---------------------------------------------------

**Standard Analysis, Parsimonious Solution, Model 3: PR**

===================================================

inclS PRI covS covU cases

---------------------------------------------------

~ WS\* ~ EC 0.677 0.437 0.591 0.379 KOR,PRT,ESP

MV\* ~ EC 0.848 0.794 0.469 0.008 GBR,USA; AUS,CAN

Solution 0.734 0.592 0.847

---------------------------------------------------

### 3.4 Minimisation of truth table, standard analysis, intermediate solution: PR

**Standard Analysis, Intermediate Solution: PR**

=============================================================

inclS PRI covS covU cases

-------------------------------------------------------------

IN\* ~ WS\* ~ TR\* ~ EC 0.849 0.666 0.521 0.371 KOR,PRT,ESP

IN\* WS\* MV\* ~ EC 0.876 0.842 0.391 0.242 GBR,USA; AUS,CAN

Solution 0.869 0.776 0.762

-------------------------------------------------------------

### 3.5 Commentary on standard analysis

Standard analysis is presented for completeness but we use it merely as step towards the enhanced standard analysis we report in the paper.

### 3.6 Enhanced standard analysis, intermediate solution – introduction (PR)

ESA intermediate solutions requires identify all untenable assumptions:

* contradictory simplifying assumptions (CSA)
  + CSA identifies rows "20" "24" "28" "32"
* contradicting necessity claims
  + We assume ~EC necessary for PR
* assumptions on impossible remainders

And intermediate solution requires state theoretical expectations of direction.

* Theoretical expectations of direction for PR:
  + IN associated with membership of PR set
  + WS associated with membership of PR set
  + MV associated with membership of PR set
  + Non-membership of EC associated with membership of PR set
  + Non-membership of TR associated with membership of PR set

### 3.7 Enhanced standard analysis– Truth Table (PR)

**Truthtable for PR, ESA**

===========================================================

IN WS TR MV EC OUT n incl PRI cases

-----------------------------------------------------------

27 1 1 0 1 0 1 2 0.895 0.848 GBR,USA

31 1 1 1 1 0 1 2 0.893 0.848 AUS,CAN

17 1 0 0 0 0 1 3 0.837 0.620 KOR,PRT,ESP

4 0 0 0 1 1 0 1 0.737 0.426 FRA

18 1 0 0 0 1 0 2 0.724 0.353 DEU,GRC

29 1 1 1 0 0 0 1 0.722 0.482 NZL

2 0 0 0 0 1 0 3 0.695 0.284 AUT,BEL,ITA

25 1 1 0 0 0 0 2 0.663 0.342 IRE,JPN

6 0 0 1 0 1 0 6 0.415 0.095 DNK,FIN,NLD,NOR,SWE,CHE

8 0 0 1 1 1 0 0

10 0 1 0 0 1 0 0

12 0 1 0 1 1 0 0

14 0 1 1 0 1 0 0

16 0 1 1 1 1 0 0

20 1 0 0 1 1 0 0

22 1 0 1 0 1 0 0

24 1 0 1 1 1 0 0

26 1 1 0 0 1 0 0

28 1 1 0 1 1 0 0

30 1 1 1 0 1 0 0

32 1 1 1 1 1 0 0

1 0 0 0 0 0 ? 0

3 0 0 0 1 0 ? 0

5 0 0 1 0 0 ? 0

7 0 0 1 1 0 ? 0

9 0 1 0 0 0 ? 0

11 0 1 0 1 0 ? 0

13 0 1 1 0 0 ? 0

15 0 1 1 1 0 ? 0

19 1 0 0 1 0 ? 0

21 1 0 1 0 0 ? 0

23 1 0 1 1 0 ? 0

-----------------------------------------------------------

### 3.8 Enhanced standard analysis, conservative solution: PR

**Enhanced Standard Analysis, Conservative Solution: PR**

===================================================================

inclS PRI covS covU cases

-------------------------------------------------------------------

IN\* WS\* MV\* ~ EC 0.876 0.842 0.391 0.288 GBR,USA; AUS,CAN

IN\* ~ WS\* ~ TR\* ~ MV\* ~ EC 0.837 0.620 0.474 0.371 KOR,PRT,ESP

Solution 0.869 0.776 0.762

-------------------------------------------------------------------

### 3.9 Enhanced standard analysis, parsimonious solution: PR

**Enhanced Standard Analysis, Parsimonious Solution: PR**

===================================================

inclS PRI covS covU cases

---------------------------------------------------

~ WS\* ~ EC 0.677 0.437 0.591 0.379 KOR,PRT,ESP

MV\* ~ EC 0.848 0.794 0.469 0.256 GBR,USA; AUS,CAN

Solution 0.734 0.592 0.847

---------------------------------------------------

### 3.10 Enhanced standard analysis, intermediate solution: PR

**Enhanced Standard Analysis, Intermediate Solution: PR**

=============================================================

inclS PRI covS covU cases

-------------------------------------------------------------

IN\* ~ WS\* ~ TR\* ~ EC 0.849 0.666 0.521 0.371 KOR,PRT,ESP

IN\* WS\* MV\* ~ EC 0.876 0.842 0.391 0.242 GBR,USA; AUS,CAN

Solution 0.869 0.776 0.762

-------------------------------------------------------------

|  |  |  |
| --- | --- | --- |
| **Sufficiency Plots: Enhanced standard analysis, intermediate solution: PR** | | |
|  |  |  |

## 4. Tests of sufficient conditions: ~PR

### 4.1 Truth table membership of ~PR set

**Truthtable for ~PR**

===========================================================

IN WS TR MV EC OUT n incl PRI cases

-----------------------------------------------------------

27 1 1 0 1 0 1 2 0.895 0.848 GBR,USA

31 1 1 1 1 0 1 2 0.893 0.848 AUS,CAN

17 1 0 0 0 0 1 3 0.837 0.620 KOR,PRT,ESP

4 0 0 0 1 1 0 1 0.737 0.426 FRA

18 1 0 0 0 1 0 2 0.724 0.353 DEU,GRC

29 1 1 1 0 0 0 1 0.722 0.482 NZL

2 0 0 0 0 1 0 3 0.695 0.284 AUT,BEL,ITA

25 1 1 0 0 0 0 2 0.663 0.342 IRE,JPN

6 0 0 1 0 1 0 6 0.415 0.095 DNK,FIN,NLD,NOR,SWE,CHE

1 0 0 0 0 0 ? 0

3 0 0 0 1 0 ? 0

5 0 0 1 0 0 ? 0

7 0 0 1 1 0 ? 0

8 0 0 1 1 1 ? 0

9 0 1 0 0 0 ? 0

10 0 1 0 0 1 ? 0

11 0 1 0 1 0 ? 0

12 0 1 0 1 1 ? 0

13 0 1 1 0 0 ? 0

14 0 1 1 0 1 ? 0

15 0 1 1 1 0 ? 0

16 0 1 1 1 1 ? 0

19 1 0 0 1 0 ? 0

20 1 0 0 1 1 ? 0

21 1 0 1 0 0 ? 0

22 1 0 1 0 1 ? 0

23 1 0 1 1 0 ? 0

24 1 0 1 1 1 ? 0

26 1 1 0 0 1 ? 0

28 1 1 0 1 1 ? 0

30 1 1 1 0 1 ? 0

32 1 1 1 1 1 ? 0

-----------------------------------------------------------

### 4.2 Minimisation of truth table, standard analysis, conservative solution: ~PR

**Standard Analysis, Conservative Solution: ~PR**

=====================================================================================

inclS PRI covS covU cases

-------------------------------------------------------------------------------------

~ IN\* ~ WS\* ~ TR\* EC 0.886 0.739 0.322 0.022 AUT,BEL,ITA; FRA

~ IN\* ~ WS\* ~ MV\* EC 0.927 0.885 0.524 0.224 AUT,BEL,ITA; DNK,FIN,NLD,NOR,SWE,CHE

~ WS\* ~ TR\* ~ MV\* EC 0.874 0.744 0.434 0.094 AUT,BEL,ITA; DEU,GRC

IN\* WS\* ~ TR\* ~ MV\* ~ EC 0.825 0.658 0.222 0.047 IRE,JPN

Solution 0.904 0.855 0.727

-------------------------------------------------------------------------------------

### 4.3 Minimisation of truth table, standard analysis, parsimonious solution: PR

**Standard Analysis, Parsimonious Solution: ~PR**

=========================================================================================

inclS PRI covS covU cases

-----------------------------------------------------------------------------------------

EC 0.908 0.858 0.715 0.529 AUT,BEL,ITA; FRA; DNK,FIN,NLD,NOR,SWE,CHE; DEU,GRC

WS\* ~ TR\* ~ MV 0.832 0.677 0.233 0.047 IRE,JPN

Solution 0.897 0.848 0.762

-----------------------------------------------------------------------------------------

### 4.4 Minimisation of truth table, standard analysis, intermediate solution: ~PR

**Standard Analysis, Intermediate Solution: ~PR**

====================================================================================

inclS PRI covS covU cases

------------------------------------------------------------------------------------

~ IN\* ~ WS\* EC 0.929 0.889 0.546 0.022 AUT,BEL,ITA; FRA; DNK,FIN,NLD,NOR,SWE,CHE

~ WS\* ~ MV\* EC 0.915 0.869 0.679 0.115 AUT,BEL,ITA; DNK,FIN,NLD,NOR,SWE,CHE; DEU,GRC

WS\* ~ TR\* ~ MV 0.832 0.677 0.233 0.047 IRE,JPN

Solution 0.905 0.860 0.748

------------------------------------------------------------------------------------

### 4.5 Commentary on standard analysis

Standard analysis is presented for completeness but we use it merely as step towards the enhanced standard analysis we report in the paper.

### 4.6 Enhanced standard analysis, intermediate solution – introduction (~PR)

ESA intermediate solutions requires identify all untenable assumptions:

* contradictory simplifying assumptions (CSA)
  + CSA identifies rows "20" "24" "28" "32"
* contradicting necessity claims
  + We assume no necessary or SUIN conditions for ~PR
* assumptions on impossible remainders

And intermediate solution requires state theoretical expectations of direction.

* Theoretical expectations of direction for ~PR:
  + Non-membership of IN associated with membership of ~PR set
  + Non-membership of MV associated with membership of ~PR set
  + Non-membership of WS associated with membership of ~PR set
  + Membership of EC associated with membership of ~PR set
  + Membership of TR associated with membership of ~PR set

### 4.7 Enhanced standard analysis– Truth Table (~PR)

**Truthtable for Enhanced Standard Analysis, ~PR**

===========================================================

IN WS TR MV EC OUT n incl PRI cases

-----------------------------------------------------------

6 0 0 1 0 1 1 6 0.938 0.905 DNK,FIN,NLD,NOR,SWE,CHE

2 0 0 0 0 1 1 3 0.879 0.716 AUT,BEL,ITA

18 1 0 0 0 1 1 2 0.849 0.647 DEU,GRC

25 1 1 0 0 0 1 2 0.825 0.658 IRE,JPN

4 0 0 0 1 1 1 1 0.804 0.574 FRA

29 1 1 1 0 0 0 1 0.741 0.518 NZL

17 1 0 0 0 0 0 3 0.723 0.355 KOR,PRT,ESP

27 1 1 0 1 0 0 2 0.415 0.152 GBR,USA

31 1 1 1 1 0 0 2 0.406 0.152 AUS,CAN

20 1 0 0 1 1 0 0

24 1 0 1 1 1 0 0

28 1 1 0 1 1 0 0

32 1 1 1 1 1 0 0

1 0 0 0 0 0 ? 0

3 0 0 0 1 0 ? 0

5 0 0 1 0 0 ? 0

7 0 0 1 1 0 ? 0

8 0 0 1 1 1 ? 0

9 0 1 0 0 0 ? 0

10 0 1 0 0 1 ? 0

11 0 1 0 1 0 ? 0

12 0 1 0 1 1 ? 0

13 0 1 1 0 0 ? 0

14 0 1 1 0 1 ? 0

15 0 1 1 1 0 ? 0

16 0 1 1 1 1 ? 0

19 1 0 0 1 0 ? 0

21 1 0 1 0 0 ? 0

22 1 0 1 0 1 ? 0

23 1 0 1 1 0 ? 0

26 1 1 0 0 1 ? 0

30 1 1 1 0 1 ? 0

-----------------------------------------------------------

### 4.8 Enhanced standard analysis, conservative solution: ~PR

**Enhanced Standard Analysis, Conservative Solution: ~PR**

=====================================================================================

inclS PRI covS covU cases

-------------------------------------------------------------------------------------

~ IN\* ~ WS\* ~ TR\* EC 0.886 0.739 0.322 0.022 AUT,BEL,ITA; FRA

~ IN\* ~ WS\* ~ MV\* EC 0.927 0.885 0.524 0.224 AUT,BEL,ITA; DNK,FIN,NLD,NOR,SWE,CHE

~ WS\* ~ TR\* ~ MV\* EC 0.874 0.744 0.434 0.094 AUT,BEL,ITA; DEU,GRC

IN\* WS\* ~ TR\* ~ MV\* ~ EC 0.825 0.658 0.222 0.047 IRE,JPN

Solution 0.904 0.855 0.727

-------------------------------------------------------------------------------------

### 4.9 Enhanced standard analysis, parsimonious solution: ~PR

**Enhanced Standard Analysis, Parsimonious Solution: ~PR**

====================================================================================

inclS PRI covS covU cases

------------------------------------------------------------------------------------

~ IN 0.876 0.828 0.681 0.147 AUT,BEL,ITA; FRA; DNK,FIN,NLD,NOR,SWE,CHE

~ MV\* EC 0.913 0.867 0.684 0.120 AUT,BEL,ITA; DNK,FIN,NLD,NOR,SWE,CHE; DEU,GRC

WS\* ~ TR\* ~ MV 0.832 0.677 0.233 0.038 IRE,JPN

Solution 0.871 0.824 0.879

------------------------------------------------------------------------------------

### 4.10 Enhanced standard analysis, intermediate solution: ~PR

**Enhanced Standard Analysis, Intermediate Solution: ~PR: Model 1**

====================================================================================

inclS PRI covS covU cases

------------------------------------------------------------------------------------

~ IN\* ~ WS\* EC 0.929 0.889 0.546 0.022 AUT,BEL,ITA; FRA; DNK,FIN,NLD,NOR,SWE,CHE

~ WS\* ~ MV\* EC 0.915 0.869 0.679 0.021 AUT,BEL,ITA; DNK,FIN,NLD,NOR,SWE,CHE; DEU,GRC

WS\* ~ TR\* ~ MV 0.832 0.677 0.233 0.047 IRE,JPN

Solution 0.905 0.860 0.748

------------------------------------------------------------------------------------

**Enhanced Standard Analysis, Intermediate Solution: ~PR: Model 2**

================================================================================

inclS PRI covS covU cases

--------------------------------------------------------------------------------

~ IN\* ~ WS\* EC 0.929 0.889 0.546 0.022 AUT,BEL,ITA; FRA; DNK,FIN,NLD,NOR,SWE,CHE

WS\* ~ TR\* ~ MV 0.832 0.677 0.233 0.047 IRE,JPN

~ TR\* ~ MV\* EC 0.872 0.744 0.440 0.006 AUT,BEL,ITA; DEU,GRC

Solution 0.902 0.853 0.732

--------------------------------------------------------------------------------

|  |  |
| --- | --- |
| **Sufficiency Plots: Enhanced standard analysis, intermediate solution: ~PR, Model 1** | |
|  |  |
|  |  |

|  |  |
| --- | --- |
| **Sufficiency Plots: Enhanced standard analysis, intermediate solution: ~PR, Model 2** | |
|  |  |
|  |  |

### 4.11 Commentary on enhanced standard analysis, intermediate solutions

In this instance the minimisation of the truth table using the enhanced intermediate approach resulted in model ambiguity, whereby by two potential solutions are identified. QCA good practice recommends that model ambiguity is always reported and a clear justification for choosing one model over another provided (Oana et al, 2021; Koivu et al., 2020). The table below provides on overview of the two models; there were three pathways in each, two of which were common to each overall solution (1a/2a and 1b,2b), but with a diverging third pathway (1c versus 2c), and the consistency and coverage of each of overall solution reported towards the bottom of the table.

A white sheet with black squares and black text

Description automatically generated

Pathway 1a/2a to low punitiveness combine low inequality, stronger social protection and high economic co-ordination (i.e. a CME) and cover a large number of cases: Austria, Belgium, Denmark, Finland, France, Italy, the Netherlands, Norway, Sweden and Switzerland. This fits well with key theoretical arguments about varieties of capitalism and covers the key cases usually cited in discussions of low punitiveness; indeed, arguably, it represents what we would expect to find based on core arguments in the literature. By contrast, pathway 2a/2b cover just two cases; moreover, they are cases less commonly cited as exemplars of welfarist approaches – Ireland and Japan – and the pathway fits uneasily with the dominant theoretical expectations, combining weak social protection, low levels trust and non-majoritarian voting system. This pathway may be more troubling for the dominant arguments in the literature.

Models 1 and 2 diverge in terms of the third pathway they produce to cover some of the remaining cases (Germany and Greece) but with clusters of countries whose membership overlaps with pathway 1a/2a. In each cases the pathway includes high economic co-ordination and the absence of a majoritarian voting system, but in model 1 (pathway 1c) this is combined with strong social protection while in model 2 (pathway 2c) it is combined with a low level of social trust. We judge that pathway 1c is more credible than 2c on the basis (i) social protection/welfare regimes features more prominently than social trust/societal values in the political economy literature, (ii) the wider number of cases covered by 1c, and (iii) the slightly higher coverage and consistency of model 1 over model 2. In other words, in resolving the model ambiguity we select model 1.

## 5. Robustness Tests

### 5.1 Sensitivity Ranges, PR

At the time of writing we could only identify a small number of papers deploying the most recent version of the robustness protocol fully, and the sensitivity ranges tests present challenge for us (i) because the procedure cannot not easily handle sets based on combination of two sets such as our WS set, (ii) it doesn’t work well for our voting system set because it is based on qualitative data and a four point set and (iii) we also do not have the underlying data for one of our continuous sets (the EC set) because we use the Witt Jackson set data. Moreover, with just 22 cases, the n.cut test arguably adds little; we have deployed an n.cut at 1 because of our sample size, reflecting Ragin’s (2008) suggestion that “When the total number of cases included in an analysis is large (e.g., hundreds), it is important to establish a frequency threshold for the relevance or viability of causal combinations. […] By contrast, when the total number of cases is small, it is possible for the researcher to gain familiarity with each case, which in turn mitigates the measurement and coding errors that motivate use of a higher threshold”; we report, nonetheless, what the n.cut test produces.

|  |  |
| --- | --- |
| **Sensitivity Ranges (PR): Calibration Anchors** | |
| **Condition** | **Ranges** |
| PR | * Exclusion: Lower bound 54 Threshold 65 Upper bound 70 * Crossover: Lower bound 102 Threshold 105 Upper bound 108 * Inclusion: Lower bound NA Threshold 145 Upper bound NA |
| IN | * Exclusion: Lower bound NA Threshold 0.4 Upper bound 0.49 * Crossover: Lower bound 0.41 Threshold 0.45 Upper bound 0.45 * Inclusion: Lower bound 0.46 Threshold 0.5 Upper bound NA |
| TR | * Exclusion: Lower bound NA Threshold 0.2 Upper bound 0.35 * Crossover: Lower bound 0.31 Threshold 0.4 Upper bound 0.48 * Inclusion: Lower bound 0.58 Threshold 0.7 Upper bound NA |
| WSa | * Exclusion: Lower bound NA Threshold 0 Upper bound NA * Crossover: Lower bound 0.36 Threshold 0.5 Upper bound 0.64 * Inclusion: Lower bound NA Threshold 1 Upper bound NA |
| ECb | * Exclusion: Lower bound NA Threshold 0 Upper bound NA * Crossover: Lower bound 0.38 Threshold 0.5 Upper bound 0.62 * Inclusion: Lower bound NA Threshold 1 Upper bound NA |
| MVc | * Exclusion: Lower bound -2.2 Threshold 0 Upper bound 0.3 * Crossover: Lower bound 2.77555756156289e-17 Threshold 0.5 Upper bound 0.6 * Inclusion: Lower bound 0.5 Threshold 1 Upper bound NA |
| a note: because ‘raw data’ for this set is a combination of sets this is an approximation of the exercise  b note: no underlying data, so utilises fuzzy scores, meaning this is an approximation of the exercise  c note: the set us based in qualitative data coverted into a four point set, so the test has limited utility | |

|  |  |
| --- | --- |
| **Sensitivity Ranges (PR): Parameters** | |
| **Parameter** | **Ranges** |
| Raw consistency | * Lower bound 0.74 * Threshold 0.8 * Upper bound 0.8 |
| Frequency (n.cut) | * Lower bound 1 * Threshold 1 * Upper bound 2 |

### 5.2 Fit-oriented robustness, PR

Three alternative test solutions informed by the abpve:

* TS1: altered the incl.cut consistency to 0.85
* TS2: calibrate crossover of PR to 98
* TS3: calibrate crossover of PR to 110

**Test solution 1 (TS1):**

inclS PRI covS covU cases

-------------------------------------------------------------

1 IN\*WS\*MV\*~EC 0.876 0.842 0.391 - GBR,USA; AUS,CAN

-------------------------------------------------------------

M1 0.876 0.842 0.391

**Test solution 2 (TS2):**

inclS PRI covS covU cases

---------------------------------------------------------------

1 ~TR\*MV 0.847 0.763 0.321 0.027 FRA; GBR,USA

2 IN\*~WS\*~TR\*~EC 0.892 0.757 0.497 0.325 KOR,PRT,ESP

3 IN\*WS\*MV\*~EC 0.893 0.866 0.362 0.104 GBR,USA; AUS,CAN

---------------------------------------------------------------

M1 0.886 0.807 0.750

**Test solution 3 (TS3):**

inclS PRI covS covU cases

-------------------------------------------------------------

1 IN\*WS\*MV\*~EC 0.856 0.811 0.407 - GBR,USA; AUS,CAN

-------------------------------------------------------------

M1 0.856 0.811 0.407

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Robustness Parameters (PR)** | | | | |
| **Fit oriented** | *RFcons:* 0.992 | *RFcov:* 0.513 | *RFSC\_minTS:* 0.509 | *RFSC\_maxTS:* 0.509 |
| **Case oriented** | *RCRtyp:* 0.571 | *RCRtyp:* NaN | *RCC\_Rank:* 3 |  |
| **Worst Performing Model** | | | | |
| **Model** | ***RCC\_Rank*** | ***SC*** |  |  |
| IN\*MV | *3* | 0.509 |  |  |

### 5.3 Case-oriented robustness, PR

|  |  |
| --- | --- |
| **Case-Oriented Robustness (PR)** | |
|  | |
| **Robust Typical Cases (IS\*MIN\_TS and Y > 0.5) :** | Boolean Expression: ~EC\*IN\*MV\*WS  Cases in the intersection/Total number of cases: 4 / 22 = 18.18 %  Cases in the intersection/Total number of cases Y > 0.5: 4 / 8 = 50 %  Case Names: --- AUS, GBR, CAN, USA |
| **Robust Deviant Cases (IS\*MIN\_TS and Y < 0.5) :** | Boolean Expression: ~EC\*IN\*MV\*WS  Cases in the intersection/Total number of cases: 0 / 22 = 0 %  Cases in the intersection/Total number of cases Y < 0.5: 0 / 14 = 0 % |
| **Shaky Typical Cases (IS\*~MIN\_TS and Y > 0.5) :** | Boolean Expression: ~EC\*IN\*~TR\*~WS  Cases in the intersection/Total number of cases: 3 / 22 = 13.64 %  Cases in the intersection/Total number of cases Y > 0.5: 3 / 8 = 37.5 %  Case Names: KOR, PRT, ESP |
| **Shaky Deviant Cases (IS\*~MIN\_TS and Y < 0.5) :** | Boolean Expression: ~EC\*IN\*~TR\*~WS  Cases in the intersection/Total number of cases: 0 / 22 = 0 %  Cases in the intersection/Total number of cases Y < 0.5: 0 / 14 = 0 % |
| **Possible Typical Cases (~IS\*MAX\_TS and Y > 0.5) :** | Boolean Expression: EC\*MV + ~IN\*MV + ~EC\*~IN\*~WS + ~EC\*TR\*~WS  Cases in the intersection/Total number of cases: 0 / 22 = 0 %  Cases in the intersection/Total number of cases Y > 0.5: 0 / 8 = 0 % |
| **Possible Deviant Cases (~IS\*MAX\_TS and Y < 0.5) :** | Boolean Expression: EC\*MV + ~IN\*MV + ~EC\*~IN\*~WS + ~EC\*TR\*~WS  Cases in the intersection/Total number of cases: 0 / 22 = 0 %  Cases in the intersection/Total number of cases Y < 0.5: 0 / 14 = 0 % |
| **Extreme Deviant Coverage Cases (~IS\*~MAX\_TS and Y > 0.5) :** | Boolean Expression: EC\*~MV + ~MV\*WS  Cases in the intersection/Total number of cases: 1 / 22 = 4.55 %  Cases in the intersection/Total number of cases Y > 0.5: 1 / 8 = 12.5 %  Case Names: NZL |
| **Irrelevant Cases (~IS\*~MAX\_TS and Y < 0.5) :** | Boolean Expression: EC\*~MV + ~MV\*WS  Cases in the intersection/Total number of cases: 14 / 22 = 63.64 %  Cases in the intersection/Total number of cases Y < 0.5: `14 / 14 = 100 %  Case Names: NOR, DNK, SWE, NLD, FIN, DEU, ITA, BEL, IRE, AUT, GRC, CHE, FRA, JPN |

### 5.5 Sensitivity Ranges, ~PR

|  |  |
| --- | --- |
| **Sensitivity Ranges (~PR): Calibration Anchors** | |
| **Condition** | **Ranges** |
| PR | * Exclusion: Lower bound 30 Threshold 65 Upper bound 100 * Crossover: Lower bound 105 Threshold 105 Upper bound 115 * Inclusion: Lower bound 145 Threshold 145 Upper bound 165 |
| IN | * Exclusion: Lower bound 0.14 Threshold 0.4 Upper bound 0.43 * Crossover: Lower bound 0.44 Threshold 0.45 Upper bound 0.45 * Inclusion: Lower bound 0.46 Threshold 0.5 Upper bound NA |
| TR | * Exclusion: Lower bound NA Threshold 0.2 Upper bound 0.39 * Crossover: Lower bound 0.38 Threshold 0.4 Upper bound 0.45 * Inclusion: Lower bound 0.67 Threshold 0.7 Upper bound 1.05 |
| WSa | * Exclusion: Lower bound NA Threshold 0 Upper bound 0.25 * Crossover: Lower bound 0.31 Threshold 0.5 Upper bound 0.52 * Inclusion: Lower bound NA Threshold 1 Upper bound NA |
| ECb | * Exclusion: Lower bound -0.09 Threshold 0 Upper bound NA * Crossover: Lower bound 0.43 Threshold 0.5 Upper bound 0.53 * Inclusion: Lower bound 0.68 Threshold 1 Upper bound NA |
| MVc | * Exclusion: Lower bound NA Threshold 0 Upper bound 0.5 * Crossover: Lower bound 0.35 Threshold 0.5 Upper bound 0.65 * Inclusion: Lower bound 0.55 Threshold 1 Upper bound 1.15 |
| a note: because ‘raw data’ for this set is a combination of sets this is an approximation of the exercise  b note: no underlying data, so utilises fuzzy scores, meaning this is an approximation of the exercise  c note: the set us based in qualitative data coverted into a four point set, so the test has limited utility | |

|  |  |
| --- | --- |
| **Sensitivity Ranges (~PR): Parameters** | |
| **Parameter** | **Ranges** |
| Raw consistency | * Lower bound 0.75 * Threshold 0.8 * Upper bound 0.8 |
| Frequency (n.cut) | * Lower bound 1 * Threshold 1 * Upper bound 1 |

### 5.6 Fit-oriented robustness, ~PR

Four alternative test solutions informed by the above:

* TS1: altered the incl.cut consistency to 0.75
* TS2: altered the incl.cut consistency to 0.85
* TS3: calibrate crossover of PR to 98
* TS4: calibrate crossover of PR to 115

**Test solution 1 (TS1):**

M1: ~IN\*~WS\*EC + WS\*~TR\*~MV + (~WS\*~MV\*EC) -> ~PR

M2: ~IN\*~WS\*EC + WS\*~TR\*~MV + (~TR\*~MV\*EC) -> ~PR

-------------------

inclS PRI covS covU (M1) (M2) cases

------------------------------------------------------------------------------------------------------

1 ~IN\*~WS\*EC 0.929 0.889 0.546 0.022 0.022 0.245 AUT,BEL,ITA; FRA; DNK,FIN,NLD,NOR,SWE,CHE

2 WS\*~TR\*~MV 0.832 0.677 0.233 0.047 0.047 0.047 IRE,JPN

------------------------------------------------------------------------------------------------------

3 ~WS\*~MV\*EC 0.915 0.869 0.679 0.021 0.115 AUT,BEL,ITA; DNK,FIN,NLD,NOR,SWE,CHE; DEU,GRC

4 ~TR\*~MV\*EC 0.872 0.744 0.440 0.006 0.099 AUT,BEL,ITA; DEU,GRC

------------------------------------------------------------------------------------------------------

M1 0.905 0.860 0.748

M2 0.902 0.853 0.732

**Test solution 2 (TS2):**

inclS PRI covS covU cases

-----------------------------------------------------------------------------------

1 ~IN\*~WS\*~MV\*EC 0.927 0.885 0.524 - AUT,BEL,ITA; DNK,FIN,NLD,NOR,SWE,CHE

-----------------------------------------------------------------------------------

M1 0.927 0.885 0.524

**Test solution 3 (TS3):**

inclS PRI covS covU cases

----------------------------------------------------------------------------------------

1 ~WS\*~MV\*EC 0.888 0.829 0.677 0.487 AUT,BEL,ITA; DNK,FIN,NLD,NOR,SWE,CHE; DEU,GRC

2 WS\*~TR\*~MV 0.829 0.701 0.239 0.049 IRE,JPN

----------------------------------------------------------------------------------------

M1 0.878 0.822 0.726

**Test solution 4 (TS4):**

M1: ~IN\*~WS\*EC + WS\*~TR\*~MV + (~WS\*~MV\*EC) -> ~PR

M2: ~IN\*~WS\*EC + WS\*~TR\*~MV + (~TR\*~MV\*EC) -> ~PR

-------------------

inclS PRI covS covU (M1) (M2) cases

------------------------------------------------------------------------------------------------------

1 ~IN\*~WS\*EC 0.934 0.913 0.486 0.019 0.019 0.217 AUT,BEL,ITA; FRA; DNK,FIN,NLD,NOR,SWE,CHE

2 WS\*~TR\*~MV 0.841 0.743 0.209 0.042 0.042 0.042 IRE,JPN

------------------------------------------------------------------------------------------------------

3 ~WS\*~MV\*EC 0.930 0.907 0.611 0.019 0.109 AUT,BEL,ITA; DNK,FIN,NLD,NOR,SWE,CHE; DEU,GRC

4 ~TR\*~MV\*EC 0.897 0.838 0.401 0.007 0.097 AUT,BEL,ITA; DEU,GRC

------------------------------------------------------------------------------------------------------

M1 0.919 0.895 0.672

M2 0.918 0.893 0.660

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Robustness Parameters (~PR)** | | | | |
| **Fit oriented** | *RFcons:* 0.976 | *RFcov:* 0.701 | *RFSC\_minTS:* 1 | *RFSC\_maxTS:* 1 |
| **Case oriented** | *RCRtyp: 1* | *RCRtyp:* NaN | *RCC\_Rank: 1* |  |
| **Worst Performing Model** | | | | |
| **Model** | ***RCC\_Rank*** | ***SC*** |  |  |
| ~IN\*~MV | *3* | 0.685 |  |  |

### 5.7 Case-oriented robustness, ~PR

|  |  |
| --- | --- |
| **Case-Oriented Robustness (~PR)** | |
|  | |
| **Robust Typical Cases**  **(IS\*MIN\_TS and Y > 0.5) :** | Boolean Expression: EC\*~IN\*~WS  Cases in the intersection/Total number of cases: 14 / 22 = 63.64 %  Cases in the intersection/Total number of cases Y > 0.5: 14 / 14 = 100 %  Case Names: NOR, DNK, SWE, NLD, FIN, DEU, ITA, BEL, IRE, AUT, GRC, CHE, FRA, JPN |
| **Robust Deviant Cases (IS\*MIN\_TS and Y < 0.5) :** | Boolean Expression: EC\*~IN\*~WS  Cases in the intersection/Total number of cases: 0 / 22 = 0 %  Cases in the intersection/Total number of cases Y < 0.5: 0 / 8 = 0 % |
| **Shaky Typical Cases (IS\*~MIN\_TS and Y > 0.5) :** | Boolean Expression: ~MV\*~TR\*WS + EC\*IN\*~MV\*~WS  Cases in the intersection/Total number of cases: 0 / 22 = 0 %  Cases in the intersection/Total number of cases Y > 0.5: 0 / 14 = 0 % |
| **Shaky Deviant Cases (IS\*~MIN\_TS and Y < 0.5) :** | Boolean Expression: ~MV\*~TR\*WS + EC\*IN\*~MV\*~WS  Cases in the intersection/Total number of cases: 0 / 22 = 0 %  Cases in the intersection/Total number of cases Y < 0.5: 0 / 8 = 0 % |
| **Possible Typical Cases (~IS\*MAX\_TS and Y > 0.5) :** | Boolean Expression: EC\*IN\*MV + EC\*MV\*WS + EC\*TR\*WS + ~EC\*~IN\*~MV\*TR + ~EC\*~IN\*~MV\*~WS  Cases in the intersection/Total number of cases: 0 / 22 = 0 %  Cases in the intersection/Total number of cases Y > 0.5: 0 / 14 = 0 % |
| **Possible Deviant Cases (~IS\*MAX\_TS and Y < 0.5) :** | Boolean Expression: EC\*IN\*MV + EC\*MV\*WS + EC\*TR\*WS + ~EC\*~IN\*~MV\*TR + ~EC\*~IN\*~MV\*~WS  Cases in the intersection/Total number of cases: 0 / 22 = 0 %  Cases in the intersection/Total number of cases Y < 0.5: 0 / 8 = 0 % |
| **Extreme Deviant Coverage Cases (~IS\*~MAX\_TS and Y > 0.5) :** | Boolean Expression: ~EC\*MV + ~EC\*IN\*TR + ~EC\*IN\*~WS  Cases in the intersection/Total number of cases: 0 / 22 = 0 %  Cases in the intersection/Total number of cases Y > 0.5: 0 / 14 = 0 % |
| **Irrelevant Cases (~IS\*~MAX\_TS and Y < 0.5) :** | Boolean Expression: ~EC\*MV + ~EC\*IN\*TR + ~EC\*IN\*~WS  Cases in the intersection/Total number of cases: 8 / 22 = 36.36 %  Cases in the intersection/Total number of cases Y < 0.5: 8 / 8 = 100 %  Case Names: USA, CAN, GBR, NZL, AUS, ESP, KOR, PRT |

## 6. Case-oriented theoretical reflections

QCA encourages case-based reflection after completing the initial analysis, not least because reflection across cases can strengthen the explanatory potential of QCA-generated solutions by offering insights into causal mechanisms associated with a given pathway, or highlight factors omitted from the QCA (Oana et al, 2021: 181-182). This section of our technical appendix provides more details case-oriented reflections than is possible in the main paper, unpacking the following key tables from the paper:

A screenshot of a test

Description automatically generated

***A table with black and white text

Description automatically generated***

### Political Institutions

Our QCA provides good support for claims that majoritarian voting systems drive punitive penal policy: Pathway 1a to high punitiveness fits well, as do Pathways 2b and 2c to low punitiveness. However, there are challenges to this thesis: Pathway 1b features three punitive cases not classed as majoritarian (Korea, Portugal and Spain); the overall solution for high punitiveness does not cover New Zealand, the second most punitive case, because it is not classed as having majoritarian voting; and, Pathway 2a to low punitiveness is agnostic on voting system in order to accommodate France, classed as a low punitiveness case with a majoritarian voting system. Case analysis can help us judge how far these anomalies reflect limits in the construction or calibration of our sets and/or point to omissions in theoretical debates.

There are good reasons to view voting systems in New Zealand, Korea and France as problematically classified. Lacey (2012) argues New Zealand’s 1996 transition to PR occurred in the context of a collapse of public confidence in politics, the introduction of referenda allowing single issues such as crime to shape political priorities, and the rise of ‘law and order’ style politics amongst newly empowered small parties, all creating an adversarial institutional profile quite distinct from that of the PR nations of continental Europe. This could point to a need to adapt our ‘majoritarian voting’ set to capture the extent to which institutions foster an adversarial political culture.

A similar question mark might be placed over our classification of Korea’s political institutions. While its parliament is elected via a semi-proportional multi-member system, it has a directly elected president chosen via first-past-the-post election. There are good reasons to focus on the presidential branch, Han (2021) describes Korea as having ‘Presidentialism with Parliamentary Characteristics’ and Dostal (2017: 483) labels it an ‘imperial presidency’, suggesting *‘[t]here is perhaps no other democratic country in the world in which the constitutional position of the President is as overwhelmingly strong’.* Contestation for the post has been adversarial, with strong political polarisation (Al-Fadhat and Choi, 2023). This may point to recalibrating the country’s score for this set and/or broadening the set’s focus. For the other cases in Pathway 1b – Portugal and Spain – the classification of their voting systems is much less contentious, suggesting there is a pathway to punitiveness for PR-based democracies. A possible qualification is that a longer-term view flags the more recent (1970s) transition from authoritarian to democratic polities in these two cases as an important contextual factor. For example, Makin (2013) has argued that initial moves away from authoritarian-era punitiveness in Spain were short-lived and that punitiveness soon returned as part of political contestation, with populist agendas becoming a key part of election-winning formulas for left and right. Korea also has a recent authoritarian legacy, transitioning to democracy in the 1980s, so all three cases in Pathway 1b share this characteristic. The potential interaction of electoral systems with historical political legacies merits further investigation, but we should note that one other country in our sample, Greece, also transitioned from authoritarian to democratic polity in the 1970s and is in our low punitiveness set, cautioning against simple conclusions here.

Finally, France’s characterisation as a majoritarian system with low punitiveness presents a challenge to key theories about the impact of political institutions on penal policy. However, its classification as majoritarian can be questioned because its second ballot system is not a first-past-the-post approach (Dolez and Laurent, 2010). We score it ‘more in than out’ of the majoritarian set (0.67), but a case might be made for placing it closer to the 0.5 cross-over of maximum ambiguity. Equally, it might be noted that France is something of a borderline case in our low punitiveness set, appearing just after our cross-over point. Indeed, some key theorists, notably Wacquant (2009), have cited France as an exemplar of a punitive turn and some of the test solutions computed for our robustness tests placed it in the high punitiveness set. When doing so, voting systems become more important in our solutions: low punitiveness pathways 2a and 2c collapse into a single pathway that combines a CME with strong social protection and a proportional voting system (comprising Austria, Belgium, Italy, Denmark, Finland, Norway, Sweden, Switzerland, Germany and Greece); while for high punitiveness a third pathway is added that combines majoritarian voting and low trust (comprising France, UK and USA). If it was judged that France is better classified as being just inside the high punitiveness set rather than just outside of it, this would weaken a different aspect of the political economy thesis, because weak economic co-ordination (being an LME) would no longer be a necessary condition for high punitiveness. That said, Hall and Soskice (2001) identified France as a potentially ambiguous CME case, suggesting it might be seen as hybrid case that is difficult to classify.

### Inequality

In line with theoretical expectations, all pathways to high punitiveness contain high inequality, and Pathway 2a to low punitiveness contains low inequality. However, questions are raised by the absence of inequality in Pathways 2b and 2c to low punitiveness.

Most cases in Pathway 2c display low inequality, but Germany and Greece challenge theoretical expectations. Kury (2019) argues that, despite the rise of right-wing populism, Germany has witnessed a decrease in public punitiveness during 2000s. Its resistance to a punitive turn has been attributed to a strong human rights-oriented approach to sentencing and the stabilising and moderating effect of its political coalitions under its PR voting system (Dünkel, 2017). Greece’s membership of the low punitiveness set might be questioned, as fluctuating incarceration rates over time place it within both ‘low’ and ‘high’ punitiveness ranges at different points. Whilst case literature presents mixed evidence about the impact of transitions from authoritarianism to democracy on Greek punitiveness, centrist or centre-left parties dominated in the decades following the authoritarian government, which some have associated with a period of penal leniency (Lambropoulou, 2005; Cheliotis and Xenakis, 2016). The rise of far-right parties from the early 2000s has been associated with increases in popular punitiveness (Alkiviadou, 2020), argued to have accelerated following the Global Financial Crisis (Cheliotis and Xenakis, 2016; Alkiviadou, 2020). As a recent World Prison Brief report summarises, *‘the unprecedented present levels of economic insecurity, the legitimacy crisis of the state and the systematic effort of the mass media to divert public anger away from the economic and political elite are contributing towards more punitive treatment of prisoners’* (Artinopoulou and Kamarakis, 2019: 40). It may be that the temporal frame of our analysis does not capture some of the nuances of this case, which may have more in common with Portugal and Spain than our sets suggest.

On the whole, our findings lend support to claims that punitiveness and inequality are related. However, the case of Germany is a reminder that inequality is likely to act in tandem with other conditions that may serve to ameliorate (or extend) its impact, including social protection.

### Social Protection

Our theoretical expectations were that punitiveness would be higher where social protection was weak and vice-versa. Pathway 1a, capturing the usual Anglophone nations, and Pathways 2a and 2c, capturing the usual Scandinavian and Western European nations, conformed to expectations. However, two pathways did not: Pathway 1b combined stronger social protection with higher punitiveness in Korea, Portugal and Spain, while Pathway 2b combined weaker social protection with low punitiveness in Ireland and Japan.

Korea’s placement outside the weak social protection set might be seen as surprising given its very modestly scaled welfare state and low social spending (Yang, 2020). Our analysis captures this: Korea has a very low net replacement rate but it escapes the weak social protection set on the basis of relatively strong employment protection. This could be taken as a reason to view it as incorrectly classified or point to the need for more nuanced indicators of social protection.

Classic arguments about the model of welfare in southern Europe (e.g. Ferrera, 1996), which highlight significant gaps in the social safety net and strong status differentials (e.g. between the payment levels of insurance benefits and means-tested social assistance), may also leave some surprised at the classification of social protection in Portugal and Spain. Both, particularly Portugal, have relatively high replacement rates in our income protection indicator, but alternative indicators of cash protection that exclude their relatively generous insurance-based payments – such as the OECD’s ‘adequacy of minimum income benefits’ indicator – would have placed them towards the bottom of the sample. However, even then, the picture would be similar to Korea because EPL scores are relatively high in these cases, again suggesting more nuanced indicators of social protection might unpack some of the complex interplay of institutions in these cases.

Turning to Pathway 2b, if arguments about the anomalous nature of New Zealand’s voting system are accepted then it might be tempting to conclude Pathway 1a identifies a clear Anglophone model based around high punitiveness, high inequality, weak social protection and weak economic co-ordination, with an adversarial winner-takes-all political system helping drive these features. But Ireland presents a significant challenge to this narrative and seems a potentially important case that receives less attention in comparative political economy debates than it should. Like the other Anglophone cases, it features high inequality, weak social protection and weak economic co-ordination but, crucially, it displays low punitiveness and has a proportional voting system. This might be taken as further evidence supporting arguments around the influence of political institutions on penal policy, though key commentators also point to societal values as being key. Japan, too, shares Ireland’s counterintuitive combination of conditions and commentary has emphasised societal values as key in explaining its low punitiveness.

Social Trust

Our expectation was that high trust would be found in low punitiveness countries and vice-versa. Of all the conditions included in our QCA, this showed the weakest results. Pathways 1a, 2a and 2c – capturing the vast majority of our cases – were agnostic on its influence. Pathway 1b (Korea, Portugal, Spain) included it in line with theoretical expectations. Pathway 2b (Ireland, Japan) included it but against theoretical expectations. Indeed, Lacey et al’s (2018) suggestion that countries with lower incarceration rates tend to have higher levels of social trust was not reflected in any of the low punitiveness pathways in our QCA.

Pathway 2b combines high inequality, weak social protection and weak economic co-ordination with low social trust and proportional voting. The inclusion of social trust in this pathway distinguishes the low punitiveness cases of Ireland and Japan from highly punitive New Zealand, where set membership conditions are otherwise the same; if we were to adjust our calibration of political institutions to account for New Zealand’s majoritarian history and adversarial style of politics, this anomaly would disappear. As such, we could reasonably discount low social trust as an important causal condition. Nonetheless, case studies of Ireland and Japan often point to cultural factors as key influences on their penal culture, which raises questions about the adequacy of our social trust measure in capturing these.

‘Irish exceptionalism’ has been a growing focus of recent discussion (Marder and Hamilton, 2023; Brangan, 2021; Brangan, 2020), building on observations that, despite sharing some important similarities with the UK (Rogan, 2011), Ireland has one of the lowest imprisonment rates in Europe (Hamilton, 2022). Whilst earlier commentary sought to explain this in terms of a weak and inexpert state bureaucracy (O'Donnell, 2011), or the pragmatic politics of non-ideological centrism (Rogan, 2011), recent attention has turned to cultural factors. For instance, Brangan (2021) talks of ‘pastoral penality’, in which agents of the state find ways to express empathy with those caught up in the criminal justice system rather than adopting a ‘correctional’ approach of punishment or reform, linking this to this historic influence of Catholicism on societal values.

Earlier work on Japan’s distinctively low crime rates often *‘invoke[d], in one way or another, the unique characteristics of Japanese culture and the resulting strong informal social control mechanisms’* (Roberts and Lafree, 2004: 179). Baradel (2021) notes that two classic models commonly cited in Western literature, ‘reintegrative shaming’ and ‘benevolent paternalism’, drew heavily on cultural explanations. However, we should be cautious of explanations that rely on simplistic conceptions of culture: these early perspectives on crime in Japan have been critiqued as lacking empirical grounding (Huang *et al.*, 2012) and an ethnocentrist reliance on ‘othering’ stereotypes of the ‘Far East’ (Bui and Farrington, 2019: 23). Moreover, we note that the Confucian values sometimes referenced in regards to Japan’s low punitiveness have also been offered to explain Korea’s high punitiveness (Lee, 2020), emphasising the complexities of interpreting cultural factors and the need for great care in unpacking societal values (Jo, 2011; Karstedt, 2012).

### Economic Co-ordination

Our assumption was LMEs would have high punitiveness and CMEs low punitiveness. This proved to be the case for the most part: all pathways to high punitiveness feature weak economic co-ordination (LME) and all countries classed as CMEs were in the low punitiveness set, with Pathways 2a and 2c featuring strong economic co-ordination as a condition. Pathway 2b was agnostic on economic co-ordination. However, both countries in this pathway (Ireland and Japan) are LMEs and an alternative, conservative, approach to truth table minimisation would add weak economic co-ordination to this pathway (see sections 4.2, 4.8 above).

Including Ireland and Japan’s status as LMEs in their low punitiveness pathway would present some challenges to our theoretical assumptions, but Japan’s classification as an LME might be viewed as problematic. Hall and Soskice’s (2001: 34) *Varieties of Capitalism* classed Japan and Korea as a distinctive variant of the CME, featuring group-based (or firm-based) co-ordination that contrasts with industry-based co-ordination common in Europe. However, the Witt Jackson index struggles to capture this distinctive model, scoring co-ordination in Japan and Korea at the same level as LMEs. However, we cannot ‘fix’ the theoretical conundrum of Japan’s low punitiveness by recoding the two cases as CMEs without creating a theoretical conundrum for Korea, which would then become a punitive CME. Irrespective of this debate, Ireland’s position would remain counter to theoretical expectations, underlining that at least one LME does possess lower levels of punitiveness. This points to the intriguing possibility that, whilst LMEs do tend towards punitiveness, other conditions may combine to counteract this trajectory.

### Punitiveness

Punitiveness features as the outcome of our QCA rather than in specific pathways, but case-based analysis requires us to reflect on this too. We note above that France could be classified as a high punitiveness case, raising questions about the thresholds in our set. The QCA robustness analysis addresses these issues, but a more challenging question is the suitability of incarceration rate as a proxy for punitiveness. Though it is widely acknowledged there are limitations in the measure, capturing only some aspects of punitiveness and imperfectly so, it is the measure most commonly utilised in comparative quantitative analyses of penality, reflecting certain advantages over the alternatives, not least the ready availability of commensurate data (Tubex, 2013).

Nonetheless, case analysis raises reasonable questions about the classification of some countries on the basis of elements of punitiveness missed by incarceration rates. Most notably, while we score Japan as fully out of the punitiveness set, it is one of only three cases (with Korea and USA) that retains the death penalty, which could be reason to classify it as highly punitive despite its very low incarceration rates. Such an approach would split the two cases in Pathway 2b (Japan, Ireland) into different outcomes, eliminating the pathway from our findings because it would no longer have a consistent outcome.

Newburn and Jones (2022) suggest a wider perspective on punitiveness would include better understanding of how punishment, penalty and policing interact in different countries; we concur but, as Roché and Flemming (2022: 256) suggest, ‘comparative policing is a new frontier’ in research, with a number of analytic barriers to be addressed before cross-national analysis can be ‘integrated into testable ‘middle-range theories.’’ Some recent small-n comparisons point to fruitful future agendas here – e.g. using data collected in France and Germany, Oberwittler and Roché (2022) identify variations in policing practice as experienced by adolescents in the two countries and link this to institutional differences that lead France to be more punitive – but the absence of systematic comparative data prevents us from adding such factors to our QCA.

It must also be acknowledged that national incarceration rates do not capture important variations *within* countries that often feature prominently in high-profile case studies of punitiveness. For example, as Lappi-Seppälä (2018: 246) notes ‘The role of race in US crime policy has been extensively analyzed and is sometimes posited as the primary factor in American punitive exceptionalism’. Accordingly, Lacey et al (2018: 209) examine the influence of legacies of racism on incarceration in the USA, UK and New Zealand in their discussion of the determinants of penal policy. They suggest a need to separate understanding of how marked racial disparities in punitiveness have developed *within nations* from understanding of why variations in punitiveness can be observed *between nations*, arguing ‘race alone is a poor candidate as an independent factor in explaining how penal policy is determined’ because of the distinctive histories and politics of race across different high-income democracies. A recent empirical study of prison disproportion by Anderson (2022) used a novel data set covering 18 democracies and draws similar conclusions, demonstrating that ‘conspicuous levels of ethnoracial disproportion are typical, and may even be ubiquitous, in contemporary democracies’ (Anderson, 2022: 3) but that levels of disproportion do not map against overall incarceration rates or the ‘usual suspects’. Indeed, Anderson’s data (2022: 13) shows higher levels of disproportionality in Finland, Norway and Ireland than in New Zealand, UK and USA. That said, configurational analysis may be able to trace the causal complexity at play in future work, but Anderson’s data set covers only 14 countries in our sample and the year 2016 only, so we cannot add it directly to our QCA.

## 7. Software Used

We utilised the QCA for R (Duşa, 2019) and SetMethods for R (Oana and Schneider, 2018) packages.

## 8. R Code for Replications

library(QCA)

library(SetMethods)

CAPEdata <- read.csv("CAPE data.csv", row.names=1)

# PR = high prison rate; IN = high inequaltiy; WS = weak social protection; TR = high level of trust; MV = majoritarian voting system; EC = high economic co-ordination; NP - negation of PR

# calibration

CAPEdata$PR <- calibrate(CAPEdata$PR, thresholds = "e=65, c=105, i=145")

CAPEdata$IN <-calibrate(CAPEdata$IN, thresholds = "e=0.4, c=0.45, i=0.5")

CAPEdata$RR12 <- calibrate(CAPEdata$RR12, thresholds = "i=20, c=55, e=80")

CAPEdata$EPL <- calibrate(CAPEdata$EPL, thresholds = "i=0.5, c=1.75, e=3")

CAPEdata$TR <- calibrate(CAPEdata$TR, thresholds = "e=0.2, c=0.4, i=0.7")

# combining some sets

CAPEdata$WS <- fuzzyand (CAPEdata$RR12, CAPEdata$EPL)

write.csv(CAPEdata,"FSCAPEdata.csv", row.names = TRUE)

FSCAPEdata <- read.csv("FSCAPEdata.csv", row.names=1)

# calibration diagnostics

skew.check(CAPEdata[,c("PR", "IN", "WS", "TR", "MV", "EC")], hist = TRUE)

ambig.cases(CAPEdata[,c("PR", "IN", "WS", "TR", "MV", "EC")])

# Tests of necessary conditions

QCAfit(x = CAPEdata[,c("IN", "WS", "TR", "MV", "EC")],

y = CAPEdata$PR)

QCAfit(x = CAPEdata[,c("IN", "WS", "TR", "MV", "EC")],

y = 1-CAPEdata$PR)

# test for SUIN conditions

SS\_Y <- superSubset(data = CAPEdata,

outcome = "PR",

conditions = c("IN", "WS", "TR", "MV", "EC"),

incl.cut = 0.9, cov.cut = 0.6, ron.cut = 0.6)

SS\_Y

pimplot(data = CAPEdata,

results = SS\_Y,

outcome = "PR",

necessity = TRUE,

jitter = TRUE,

all\_labels=TRUE)

SS\_N <- superSubset(data = CAPEdata,

outcome = "~PR",

conditions = c("IN", "WS", "TR", "MV", "EC"),

incl.cut = 0.9, cov.cut = 0.6, ron.cut = 0.6)

SS\_N

pimplot(data = CAPEdata,

results = SS\_N,

outcome = "~PR",

necessity = TRUE,

jitter = TRUE,

all\_labels=TRUE)

# write SUIN conditions into dataset

CAPEdata$NPSUIN <- fuzzyor(~CAPEdata$IN, CAPEdata$WS, CAPEdata$EC)

# check skew of SUIN to see if trivial

skew.check(CAPEdata$NPSUIN,

hist = TRUE,

main = "SUIN Condition")

# Sufficient conditions

# Truth tables with incl.cut at 0.8 #

ttPRISY <- truthTable(CAPEdata,

outcome = "PR",

conditions = "IN, WS, TR, MV, EC",

incl.cut = .8,

pri.cut = 0.51,

n.cut = 1,

show.cases = TRUE,

sort.by = "incl")

ttPRISY

ttPRISN <- truthTable(CAPEdata,

outcome = "~PR",

conditions = "IN, WS, TR, MV, EC",

incl.cut = .8,

pri.cut = 0.51,

n.cut = 1,

show.cases = TRUE,

sort.by = "incl")

ttPRISN

# minimisation of the truth tables, standard analysis

# standard analysis, conservative/complex solution PR

sol\_ypc <- minimize(ttPRISY,

details = TRUE)

sol\_ypc

# standard analysis, parsimonious solution PR

sol\_ypp <- minimize(ttPRISY,

details = TRUE,

include = "?",

row.dom = TRUE)

sol\_ypp

# standard analysis, intermediate solution PR

sol\_ypi <- minimize(ttPRISY,

details = TRUE,

include = "?",

dir.exp = "IN, WS, ~TR, MV, ~EC",

row.dom = TRUE)

sol\_ypi

# standard analysis, conservative/complex solution ~PR

sol\_npc <- minimize(ttPRISN,

details = TRUE)

sol\_npc

# standard analysis, parsimonious solution ~PR

sol\_npp <- minimize(ttPRISN,

details = TRUE,

include = "?",

row.dom = TRUE)

sol\_npp

# standard analysis, intermediate solution ~PR

sol\_npi <- minimize(ttPRISN,

details = TRUE,

include = "?",

dir.exp = "~IN, ~WS, TR, ~MV, EC",

row.dom = TRUE)

sol\_npi

#simplifying assumptions

sol\_ypp$SA

sol\_npp$SA

# Enhanced standard analysis, intermediate solution

# identify contradictory simplifying assumptions (CSA)

CSA <- LR.intersect(sol\_ypp, sol\_npp)

CSA

# ESA Truthtable PR

TT\_ypesa <-esa(ttPRISY,

contrad\_rows = c(CSA),

nec\_cond ="~EC")

TT\_ypesa

# ESA, conservative PR

sol\_ypcesa <- minimize(TT\_ypesa,

details = TRUE)

sol\_ypcesa

# ESA, parsimonious PR

sol\_yppesa <- minimize(TT\_ypesa,

details = TRUE,

include = "?")

sol\_yppesa

# ESA, intermediate PR

sol\_ypiesa <- minimize(TT\_ypesa,

details = TRUE,

include = "?",

dir.exp = "IN, WS, ~TR, MV, ~EC")

sol\_ypiesa

pimplot(data = CAPEdata,

outcome = "PR",

results = sol\_ypiesa,

all\_labels = TRUE,

jitter = TRUE,

fontsize = 2)

# ESA Truthtable ~PR

TT\_npesa <-esa(ttPRISN,

contrad\_rows = c(CSA))

# ESA, conservative ~PR

sol\_npcesa <- minimize(TT\_npesa,

details = TRUE)

sol\_npcesa

# ESA, parsimonious ~PR

sol\_nppesa <- minimize(TT\_npesa,

details = TRUE,

include = "?")

sol\_nppesa

# ESA, intermediate ~PR

sol\_npiesa <- minimize(TT\_npesa,

details = TRUE,

include = "?",

dir.exp = "~IN, ~WS, TR, ~MV, EC")

sol\_npiesa

pimplot(data = CAPEdata,

outcome = "~PR",

results = sol\_npiesa,

sol = 1,

all\_labels = TRUE,

jitter = TRUE,

fontsize = 2)

pimplot(data = CAPEdata,

outcome = "~PR",

results = sol\_npiesa,

sol = 2,

all\_labels = TRUE,

jitter = TRUE,

fontsize = 2)

### ROBUSTNESS TESTS FOR PR###

# load data

RCAPEdata <- read.csv("CAPE data.csv", row.names=1)

FSCAPEdata <- read.csv("FSCAPEdata.csv", row.names=1)

head(RCAPEdata)

View(RCAPEdata)

head(FSCAPEdata)

View(FSCAPEdata)

# Create an object storing the condition names:

conds <- c("IN", "WS", "TR", "MV", "EC")

#### Create initial solution ######

IS <- minimize(data = FSCAPEdata,

outcome = "PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

nec\_cond ="~EC",

dir.exp = "IN, WS, ~TR, MV, ~EC",

details = TRUE,

show.cases = TRUE)

#### 1.1. Sensitivity ranges, PR ####

rob.calibrange(

raw.data = RCAPEdata,

calib.data = FSCAPEdata,

test.cond.raw = "PR",

test.cond.calib = "PR",

test.thresholds = c(65,105,145),

step = 1,

max.runs = 40,

outcome = "PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

nec\_cond ="~EC",

dir.exp = "IN, WS, ~TR, MV, ~EC")

# for IN

rob.calibrange(

raw.data = RCAPEdata,

calib.data = FSCAPEdata,

test.cond.raw = "IN",

test.cond.calib = "IN",

test.thresholds = c(0.4,0.45,0.5),

step = 0.01,

max.runs = 40,

outcome = "PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

nec\_cond ="~EC",

dir.exp = "IN, WS, ~TR, MV, ~EC")

# for TR

rob.calibrange(

raw.data = RCAPEdata,

calib.data = FSCAPEdata,

test.cond.raw = "TR",

test.cond.calib = "TR",

test.thresholds = c(0.2,0.4,0.7),

step = 0.01,

max.runs = 40,

outcome = "PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

nec\_cond ="~EC",

dir.exp = "IN, WS, ~TR, MV, ~EC")

# for WS

rob.calibrange(

raw.data = FSCAPEdata,

calib.data = FSCAPEdata,

test.cond.raw = "WS",

test.cond.calib = "WS",

test.thresholds = c(0.0,0.5,1),

step = 0.01,

max.runs = 40,

outcome = "PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

nec\_cond ="~EC",

dir.exp = "IN, WS, ~TR, MV, ~EC")

# for EC

rob.calibrange(

raw.data = RCAPEdata,

calib.data = FSCAPEdata,

test.cond.raw = "EC",

test.cond.calib = "EC",

test.thresholds = c(0.0,0.5,1),

step = 0.01,

max.runs = 40,

outcome = "PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

nec\_cond ="~EC",

dir.exp = "IN, WS, ~TR, MV, ~EC")

# for MV

rob.calibrange(

raw.data = RCAPEdata,

calib.data = FSCAPEdata,

test.cond.raw = "MV",

test.cond.calib = "MV",

test.thresholds = c(0.0,0.5,1),

step = 0.1,

max.runs = 40,

outcome = "PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

nec\_cond ="~EC",

dir.exp = "IN, WS, ~TR, MV, ~EC")

# Determine sensitivity range for raw consistency threshold:

rob.inclrange(

data = FSCAPEdata,

step = 0.01,

max.runs = 20,

outcome = "PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

nec\_cond ="~EC",

dir.exp = "IN, WS, ~TR, MV, ~EC")

# Determine sensitivity range for frequency cut-off:

rob.ncutrange(

data = FSCAPEdata,

step = 1,

max.runs = 20,

outcome = "PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

nec\_cond ="~EC",

dir.exp = "IN, WS, ~TR, MV, ~EC")

#### Fit-oriented and case-oriented robustness ####

# Creating the test solutions:

# altering consistency to 0.85

TS1 <- minimize(data = FSCAPEdata,

outcome = "PR",

conditions = conds,

incl.cut = 0.85,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

nec\_cond ="~EC",

dir.exp = "IN, WS, ~TR, MV, ~EC",

details = TRUE,

show.cases = TRUE)

TS1

# 1st alteration of calibration of cross-over for PR, to 98

FSCAPEdata2 <- FSCAPEdata

FSCAPEdata2$PR <- calibrate(RCAPEdata$PR,

type="fuzzy",

thresholds = c(65,98,145),

logistic = TRUE,

idm = 0.95)

TS2 <- minimize(data = FSCAPEdata2,

outcome = "PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

nec\_cond ="~EC",

dir.exp = "IN, WS, ~TR, MV, ~EC",

details = TRUE,

show.cases = TRUE)

TS2

# 2nd alteration of calibration of cross-over for PR, to 110

FSCAPEdata3 <- FSCAPEdata

FSCAPEdata3$PR <- calibrate(RCAPEdata$PR,

type="fuzzy",

thresholds = c(65,110,145),

logistic = TRUE,

idm = 0.95)

TS3 <- minimize(data = FSCAPEdata3,

outcome = "PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

nec\_cond ="~EC",

dir.exp = "IN, WS, ~TR, MV, ~EC",

details = TRUE,

show.cases = TRUE)

TS3

# Create the test set in a list:

TS <- list(TS1, TS2, TS3)

# Calculate parameters for the robust core:

rob.corefit(test\_sol = TS, initial\_sol = IS, outcome = "PR")

# Calculate robustness parameters:

RF <- rob.fit(test\_sol = TS,

initial\_sol = IS,

outcome = "PR")

RF

# Plotting the initial solution against the test set:

rob.xyplot(test\_sol = TS,

initial\_sol = IS,

outcome = "PR",

fontsize = 2,

jitter=TRUE,

all\_labels = TRUE,

area\_lab=TRUE)

# Obtaining names of case types and robustness case parameters:

rob.cases(test\_sol = TS,

initial\_sol = IS,

outcome = "PR")

# Worse test solution:

rob.singletest(test\_sol = TS, initial\_sol = IS, outcome = "PR")

#### ~PR ######

# load data

RCAPEdata <- read.csv("CAPE data.csv", row.names=1)

FSCAPEdata <- read.csv("FSCAPEdata.csv", row.names=1)

head(RCAPEdata)

View(RCAPEdata)

head(FSCAPEdata)

View(FSCAPEdata)

# Create an object storing the condition names:

conds <- c("IN", "WS", "TR", "MV", "EC")

# Create the initial solution:

ISN <- minimize(data = FSCAPEdata,

outcome = "~PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

dir.exp = "~IN, ~WS, TR, ~MV, EC",

details = TRUE,

show.cases = TRUE)

ISN

# Determine sensitivity ranges for qualitative calibration anchors of condition ~PRIS:

rob.calibrange(

raw.data = RCAPEdata,

calib.data = FSCAPEdata,

test.cond.raw = "PR",

test.cond.calib = "PR",

test.thresholds = c(65,105,145),

step = 5,

max.runs = 40,

outcome = "~PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

dir.exp = "~IN, ~WS, TR, ~MV, EC")

# Determine sensitivity range for raw consistency threshold:

rob.inclrange(

data = FSCAPEdata,

step = 0.01,

max.runs = 20,

outcome = "~PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

dir.exp = "~IN, ~WS, TR, ~MV, EC")

# Determine sensitivity range for frequency cut-off:

rob.ncutrange(

data = FSCAPEdata,

step = 1,

max.runs = 20,

outcome = "~PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

dir.exp = "~IN, ~WS, TR, ~MV, EC")

#### 1.2. Fit-oriented and case-oriented robustness ####

# Creating the test solutions:

# altering consistency to 0.75

TSN1 <- minimize(data = FSCAPEdata,

outcome = "~PR",

conditions = conds,

incl.cut = 0.75,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

dir.exp = "~IN, ~WS, TR, ~MV, EC",

details = TRUE,

show.cases = TRUE)

TSN1

# altering consistency to 0.85

TSN2 <- minimize(data = FSCAPEdata,

outcome = "~PR",

conditions = conds,

incl.cut = 0.85,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

dir.exp = "~IN, ~WS, TR, ~MV, EC",

details = TRUE,

show.cases = TRUE)

TSN2

# altering calibration of PR crossover to 98

FSCAPEdata4 <- FSCAPEdata

FSCAPEdata4$PR <- calibrate(RCAPEdata$PR,

type="fuzzy",

thresholds = c(75,98,145),

logistic = TRUE,

idm = 0.95)

TSN3 <- minimize(data = FSCAPEdata4,

outcome = "~PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

dir.exp = "~IN, ~WS, TR, ~MV, EC",

details = TRUE,

show.cases = TRUE)

TSN3

# altering calibration of PR crossover to 115

FSCAPEdata5 <- FSCAPEdata

FSCAPEdata5$PR <- calibrate(RCAPEdata$PR,

type="fuzzy",

thresholds = c(75,115,145),

logistic = TRUE,

idm = 0.95)

TSN4 <- minimize(data = FSCAPEdata5,

outcome = "~PR",

conditions = conds,

incl.cut = 0.8,

n.cut = 1,

include = "?",

contrad\_rows = c(CSA),

dir.exp = "~IN, ~WS, TR, ~MV, EC",

details = TRUE,

show.cases = TRUE)

TSN4

# Create the test set in a list:

TSN <- list(TSN1, TSN2, TSN3, TSN4)

# Calculate parameters for the robust core:

rob.corefit(test\_sol = TSN, initial\_sol = ISN, outcome = "~PR")

# Calculate robustness parameters:

RF <- rob.fit(test\_sol = TSN,

initial\_sol = ISN,

outcome = "~PR")

RF

# Plotting the initial solution against the test set:

rob.xyplot(test\_sol = TSN,

initial\_sol = ISN,

outcome = "~PR",

fontsize = 3.5,

jitter=TRUE,

all\_labels = TRUE,

area\_lab=TRUE)

rob.xyplot(test\_sol = TSN,

initial\_sol = ISN,

outcome = "~PR",

fontsize = 3.5,

jitter=TRUE,

all\_labels = TRUE,

area\_lab=FALSE)

# Obtaining names of case types and robustness case parameters:

rob.cases(test\_sol = TSN,

initial\_sol = ISN,

outcome = "~PR")

# Worse test solution:

rob.singletest(test\_sol = TSN, initial\_sol = ISN, outcome = "~PR")

## 9. References

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