

# **NEW METHODS TO ASSESS RISK OF CONFLICT AND VIOLENCE**



**Predicting changes in the Global Peace Index**

**INSTITUTE FOR  
ECONOMICS  
& PEACE**

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## **Quantifying Peace and its Benefits**

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# EXECUTIVE SUMMARY

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This research brief, produced by the Institute for Economics & Peace (IEP), presents new and ground-breaking approaches to forecasting and conceptualising the risk of conflict.

The report is the first known attempt to forecast and predict changes in the IEP's Global Peace Index (GPI), based on IEP's unique Positive Peace framework that empirically measures the *attitudes, institutions and structures* that build a more peaceful society.

Due to the difficulty in forecasting the onset of large-scale violence, it is important to better understand and conceptualise new approaches to measuring the risk of it. As the GPI has recorded in the past ten years, the global trend in peace has been deteriorating due to the large conflicts in the Middle East, increased terrorism and historic displacement of people, which is having profound impacts on global peace and stability. While some risks can be foreseen and planned for, profoundly destabilising events such as civil unrest, conflict onset and the collapse of entire countries have, all too often, caught the world by surprise.

Our collective failure to predict the onset of large man-made events, like the Syrian civil war, has substantial impacts on human wellbeing, economic development and geopolitical stability. It is thus not surprising that a key question for policymakers, business and civil society today is, how can the likelihood of big risks such as conflict onset be better understood, and what can be done to mitigate the risk of these events occurring.

In order to address this challenge, IEP has developed two types of forward-looking risk models to predict future changes in the GPI. The GPI is used as the key variable to measure large deteriorations in peace as it captures a comprehensive and objective measure of violence, conflict and societal safety and security.

The two IEP risk models are called the *IEP Like-Country* model and the *IEP Positive Peace Deficit* model. The results from both models have been performance tested in a number of ways and compared against five other measures commonly used to forecast conflict and understand vulnerability to violence. The result of these various tests and comparisons show IEP has developed an approach that is able to consistently outperform

the other forecasting approaches and tools it has been compared to.

The majority of the results discussed in the paper are from the Positive Peace Deficit model, which successfully forecasted several notable deteriorations in country peacefulness since 2008. Looking at the ten most at-risk countries according to the model in 2008, five countries experienced significant declines in peace; these included Syria, Mozambique, Eritrea, Niger and Vietnam. The country that experienced the largest deterioration in peace was Syria, which ranked 99th out of 163 countries in the 2008 GPI, and fell to last in 2016. This was a noteworthy prediction. Many in the international community considered it a relatively stable country. Consequently, few other forecasts placed it significantly at risk of conflict.

Looking more broadly at the 20 countries that fell into conflict between 2008 and 2017, all were Positive Peace Deficit countries, meaning the model determined they had weak institutions and social measures and were vulnerable to deteriorations in peace. Five of these 20 were measured in the ten most at-risk of conflict according to the Positive Peace Deficit model.

The positive predictive value of the Positive Peace Deficit model for large deteriorations in peace from 2008 to 2016 is 55 per cent, which compares to the accuracy of the other models that averaged between 25 and 40 per cent accuracy, or positive predictive value. This means the IEP measure was accurate 55 per cent of the time in identifying whether or not a country was going to experience a large fall in peace. Importantly, this also includes true negatives or countries that were determined to maintain their level of peace.

If countries that are at risk of falling into conflict can be identified up to seven years in advance, then meaningful interventions can potentially be staged. Given the high costs of conflict compared to prevention, the potential of acting upon these models with this level of positive predictive accuracy has the potential to guide resource allocation and lead to better and more cost effective decision-making. Using the Positive Peace

Deficit model to look forward, the model shows as of 2017, five of the ten countries most at-risk according to the Positive Peace deficit model were also in there in 2008. These include **Bhutan, Equatorial Guinea, Sierra Leone, Laos, and Eritrea**. The five other countries were all sub-Saharan African - **Madagascar, Guinea, Angola, Malawi and Togo**. This indicates these countries lack the attitudes, institutions and structures to maintain their current levels of peacefulness and that they are particularly vulnerable to internal or external shocks.

Research by Department for International Development (DFID), IEP and United Nations Development Program (UNDP) all suggest conflict prevention and peacebuilding interventions can be highly cost-effective when successful. This is because the economic impact of conflict, instability and violence is large when compared to the size of the investments to prevent conflict. IEP's research on the cost of violence and conflict to the global economy finds that the economic losses from violence were 12.6 per cent of world GDP in 2016, or approximately \$2,000 for each person on the planet. IEP analysis shows the cost-savings ratio of peacebuilding or the actions that lead to conflict prevention is 1:16 on average.

Risk models do not need to be 100 per cent accurate to be useful to practitioners and policymakers. To take a simple

example, if a prediction model was only 25 per cent accurate and subsequent peacebuilding strategies interventions were effective, the cost-benefit ratio would be diminished by four times. However, when the cost-benefit ratio is 1:16, decreasing it by four times is still an economically attractive savings ratio of 1:4.

Applying IEP's global cost of violence model to the risk predictions underlines this point. The global cost of conflict in 2015 was US\$742 billion, a very large sum. In a utopian world, if all peacebuilding interventions were 100 per cent effective, and guided by a 100 per cent accurate risk model, then the cost savings would be the cost of the peacebuilding interventions themselves, subtracted from the US\$742 billion cost of conflict.

Finally, this report is the first attempt at developing risk and forecasting methods for conflict. The accuracy tests show that while IEP measures were successful in outperforming other measures, there is still room for improvement. IEP will continue to develop these models further, aiming to better predict future conflict and violence.

The report is divided into three sections. Section one contains the results of the IEP risk models and predictions, section two details the methodology behind the calculations and section three contains a discussion of some of the key challenges in prediction and risk assessment and management.

## SUMMARY OF REPORT FINDINGS

- IEP has developed two types of forward-looking risk measures to predict future changes in the GPI; these are called the IEP Like-Country model and the IEP Positive Peace Deficit model. The Global Peace Index (GPI) is used as the key variable to reflect societal peacefulness as it captures an objective multidimensional measure of violence and conflict.
- IEP compared its two risk measures against five other measures that are commonly used in conflict forecasting and found the IEP measures performed the strongest at predicting changes in the GPI. Of the ten countries most at-risk according to the 2008 forecast of IEP's Positive Peace Deficit model, five experienced notable deteriorations in peacefulness. These five countries were **Syria, Mozambique, Eritrea, Niger and Vietnam**.
- The country that experienced the largest deterioration in peace that was forecasted by the model was Syria, which was ranked 99th out of 163 countries in the 2008 GPI and last in 2016. Many models did not predict Syria as it was considered to be a relatively stable country compared to other fragile states.
- Of the 20 countries that fell into conflict between 2008 and 2017, all were Positive Peace Deficit countries, meaning the model determined they had weak institutions and social structures. Five of these 20 were measured as the ten most at-risk of conflict according to the Positive Peace Deficit model.
- When testing the accuracy of various measures in predicting major changes in the GPI seven years in advance, the IEP models performed the strongest. The positive predictive value of the Positive Peace Deficit model and the Like-Country models were 55 and 52 per cent respectively. This compares to the positive predictive value of the other models that averaged between 25 and 40 per cent.
- Five of the ten countries most at-risk according to the Positive Peace deficit model in 2017 were also present in 2008. These include **Bhutan, Equatorial Guinea, Sierra Leone, Laos, and Eritrea**. The five other countries in the ten most at risk were all sub-Saharan African - **Madagascar, Guinea, Angola, Malawi and Togo**.

- This indicates these countries lack the attitudes, institutions and structures to maintain their current levels of peacefulness and that they are particularly vulnerable to internal or external shocks.
- Research by DFID, IEP and UNDP all suggest conflict prevention and peacebuilding interventions are highly cost-effective when successful. This is because the economic impact of conflict is devastating on the economy. Research by IEP shows the cost-savings ratio of conflict prevention is 1:16 on average.
- Risk models do not need to be 100 per cent accurate to be useful. If a prediction model was only 25 per cent accurate and subsequent peacebuilding strategies interventions were effective then a return of 1:16 would still be 1:4.
- The global cost of conflict in 2015 was estimated to be US\$742 billion. If all peacebuilding interventions were 100 per cent effective and guided by a 100 per cent accurate risk model, then the cost savings would be US\$725 billion.

## BACKGROUND: THE NEED TO BETTER ANTICIPATE CONFLICT RISK

**The world is at a 40 year high in terms of the number of conflicts and conflict deaths, which are at a 25-year high. Other forms of violence using terrorist tactics are also near all-time highs. Aside from the incalculable human losses from this increase in conflict, there are also enormous economic and social costs.**

The global cost of violence and its containment reached an all-time high of \$14.8 trillion in 2015, which is equivalent to 13 per cent of world GDP. These economic losses reinforce the importance of better anticipation and prediction of conflicts, underlining how research may be critical to developing tangible efforts to prevent conflict and war.

This is partly why the United Nations is currently re-prioritising its efforts around conflict prevention through the Sustaining Peace agenda. The recently appointed UN Secretary-General Antonio Guterres, at the beginning of his mandate, highlighted conflict prevention as 'the' priority for the UN system today. Underlining the sustaining peace agenda is a call for a more proactive agenda that helps the international community better pre-empt conflict and move policymakers and governments away from reactive approaches to crises.

Because of the size of these costs, the investments to prevent conflict are likely to be highly economically cost-effective so long as the investments themselves do not cause harm. We also know that the size of investments in conflict prevention are very small compared to the after-the-fact consequential losses from

conflict. The yearly spend on peacekeeping is approximately US\$8 billion compared to the direct losses from conflict which were some US\$750 billion in 2015. Meanwhile, the yearly investment in peacebuilding, which can be considered the more holistic set of investments aimed at reducing conflict, is at about US\$6.8 billion. While not all of these expenditures can be consistently strictly preventative in nature, their relatively small magnitude underlines the potential cost savings from higher levels of preventative investment. By identifying the countries at-risk of conflict onset can only further improve this cost-equation.

Meanwhile, the significant increase in data availability and rise of computing power in recent years has enabled new quantitative methods and research to identify conflict drivers and develop prediction models of different types of violence. However, the results of much of this research to-date has been contradictory as results are often very dependent on definitions of conflict, on the time span, geographic location and data used in the studies.

**This is best summed-up by the Human Security Report 2011 (HSR) which highlighted a number of contradictions in the literature<sup>1</sup>:**

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- Ethnic diversity has no impact on the risk of armed conflict—and it does.
- Dependence on primary commodities makes war more likely—and it does not.
- Increases in levels of democracy reduce the risk of war—and have no impact.
- Inequality increases the risk of war—and has no effect.
- Grievances increase the risk of war—and they do not.
- Countries whose neighbours experience civil war face increased risks of war themselves—and they do not.
- Economic growth decreases the risk of war—and it has no significant effect.
- Mountainous terrain increases the risk of war—and it does not.

Despite this, the HSR notes that there have been few attempts to resolve such issues.<sup>2</sup> While it is common that research produces divergent results, the lack of consensus severely undermines many models and their ability to measure the risk of conflict.

One of the key aims of this paper is to assess a number of prominent risk measures on a standardised set of test data to enable easier identification of the strengths and weaknesses of different models. The object of this report is not to compare measures for the purposes of ranking them on success. It is for these reasons the statistical performance of each of these measures have been anonymised. Rather the aim is to understand the strengths and weaknesses of each. Understanding this allows the bigger question to be addressed: “how can quantitative models be used in conflict risk management?”

While the rhetoric of conflict prevention has a long tradition in the international community and within the UN system and the moral, political and economic logic of better conflict prevention has long been recognised, our toolset to anticipate and predict where flashes of conflict may occur have not advanced. The argument for conflict prevention is powerful. Because the costs of conflict, war and violence are so high in human, economic and political terms, the benefits of prevention are almost always high.

# SECTION ONE: RESULTS

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IEP has developed two models that aim to predict changes in the GPI. The results from both models are discussed in this section, and the forecasts of the most accurate IEP Positive Peace deficit model are presented for 2017. This presents a list of the countries the IEP model forecasts as most at-risk of falling into conflict in the next several years.

- IEP has developed two types of forward-looking risk measures to predict future changes in the GPI; these are called the *IEP Like-Country* model and the *IEP Positive Peace Deficit* model.
- IEP's two risk models are tested for their accuracy in three ways.
  1. The first way is to test the accuracy of the Positive Peace Deficit model between 2008 and 2015 via a simple approach to look at how many of the countries determined most-at risk indeed experienced deteriorations in peace over the ten-year period.
  2. The second involves testing the IEP risk models against other commonly used risk measures that are used to forecast the risk of conflict, looking at both the true positive and true negative rates between 2008 and 2015.
  3. The third method of testing is the most comprehensive, testing the accuracy of predictions over multiple thresholds, over different time periods and at different magnitudes of change in the GPI.
- Of the ten countries most at-risk according to the 2008 forecast of IEP's Positive Peace Deficit model, five experienced notable deteriorations in peacefulness. These five countries were Syria, Mozambique, Eritrea, Niger and Vietnam.
- The country that experienced the largest deterioration in peace that was forecasted by the model was Syria, which was ranked 99<sup>th</sup> out of 163 countries in the 2008 GPI, falling to last in 2016. Because of its performance on many development metrics, other risk models did not predict its fall.
- Of the 20 countries that fell into conflict between 2008 and 2017, all were Positive Peace deficit countries, meaning the model determined they had weak institutions and were vulnerable to deteriorations in peace. Five of these 20 were measured in the ten countries most at-risk of conflict according to the Positive Peace Deficit model.
- The risk measures were also tested using a more sophisticated approach, by determining the true positive and true negative rates in order to calculate the positive predictive value of the measures.
- IEP compared its two risk measures against five other risk measures commonly used in conflict forecasting, finding the IEP measures performed the strongest at predicting changes in the GPI.
- When testing the accuracy of various measures in predicting major changes in the GPI seven years in advance, the IEP models performed the strongest. The positive predictive value of the Positive Peace Deficit model and the Like-Country models were 55 and 52 per cent respectively. This compares to the accuracy of the other models that averaged between 25 and 40 per cent positive predictive value.



- When multiple experiments were conducted by varying the time frames of prediction, the size of the deteriorations and the number of countries, the positive predictive value of the IEP measures went up to a median accuracy of 65 per cent. This means when testing the IEP models over different time periods it is slightly more accurate on average compared to the forecasts made over the seven-year period. With the exception of only one, the other measures performed marginally better than a coin toss.
- Using the Positive Peace Deficit model to look forward, the model shows as of 2017, five of the ten countries most at-risk according to the Positive Peace Deficit model were also in the top ten in 2008. These include Bhutan, Equatorial Guinea, Sierra Leone, Laos, and Eritrea. The five other countries in the top ten were all sub-Saharan African - Madagascar, Guinea, Angola, Malawi and Togo.
- Of the five countries that featured in the 2008 and the 2017 models at most risk, Bhutan, Sierra Leone and Laos all had improving Positive Peace scores. This indicates that these countries are improving in their underlying institutions and social structures, which offsets to some extent the likelihood of significant drops in peace.

## TESTING THE ACCURACY OF THE POSITIVE PEACE DEFICIT MODEL: FROM 2008 TO 2017

The IEP Positive Peace Deficit model provides a ranked list of countries most at-risk of deteriorations in peacefulness.

A simple approach to assessing the accuracy of the Positive Peace Deficit model is to look at the ten countries most at-risk in 2008 according to the model and assess how many experienced significant deteriorations based their objective measure of peace according to the GPI.

According to this approach, five of the ten countries the model forecasted as 'at-risk' experienced what IEP defines as significant deteriorations in peacefulness. This threshold is determined as a 0.2 score change in the GPI which reflects major changes in political instability, domestic political violence, conflict deaths or interpersonal violence.

Of these, five had seen significant and notable deteriorations in peacefulness<sup>1</sup> by 2017, and two had fallen into conflict<sup>2</sup> by 2017. These countries are highlighted in the table 1.1.

The likelihood of substantial drops in peace can be better understood by accounting for other qualitative factors, such as the pace of improvements in the country's underlying institutions and social structures or the likelihood of external

shocks such as natural disasters. Measuring 'deteriorations in peacefulness' is, of course, a matter of degree. The countries listed in Table 1.1 are there based on a change in internal GPI score of 0.2 or more as a threshold, but this threshold could be set higher or lower as well.

“ Of the ten countries most at-risk according to IEP's Positive Peace Deficit model in 2008, five experienced significant deteriorations in peacefulness.

**TABLE 1.1** THE TEN COUNTRIES MOST 'AT RISK' IN 2008 ACCORDING TO THE POSITIVE PEACE DEFICIT MODEL

Of the ten countries most at-risk according to IEP's Positive Peace Deficit model, five experienced significant deteriorations in peacefulness.

COUNTRY
SIERRA LEONE
ERITREA
LAOS
EQUATORIAL GUINEA
BHUTAN
SYRIA*
NIGER*
VIETNAM
TIMOR-LESTE
MOZAMBIQUE*

A more open-ended approach would take *any* deterioration in internal GPI score as an indication of a deterioration in peacefulness, and using this definition, seven of the top ten countries highlighted in Table 1.1 deteriorated in their levels of peace over that time. A more targeted approach, on the other hand, would set the threshold higher – for example using an internal GPI score deterioration of 0.3 or more as the threshold for decreased peacefulness sees three countries of the ten countries most at-risk deteriorating by more than the threshold: Syria, Mozambique and Niger. These countries experienced much more notable changes in peace, with Syria experiencing the largest change in GPI due to its devastating civil war which leaves the country at the very bottom of the GPI.

Assessing the Positive Peace Deficit model on more conventional definitions of conflict as defined by the Uppsala Data Conflict Programme (UCDP) indicates the model's performance. Table 1.2 shows the list of 20 countries that had battle deaths after 2008, that is, countries which experienced more than 20 battle deaths in any given year which did not have battle deaths in 2008. Of these 20, all of these countries had high positive peace deficits in 2008, and as of 2017, 15 of these countries still have positive peace deficits. Two of these countries are in the ten countries most 'at risk' according to the Positive Peace Deficit model – Syria and Mozambique, and five are in the top 20 at risk countries – Syria, Mozambique, Angola, Cameroon, Yemen.

**TABLE 1.2** COUNTRIES THAT FELL INTO CONFLICT BETWEEN 2008 – 2017

Of the 20 countries that fell into conflict between 2008 and 2017, all were positive peace deficit countries, meaning the model determined they had weak institutions and were vulnerable to deteriorations in peace. Five of the 20 were measured in the top ten most at-risk of conflict according to model.

COUNTRY	POSITIVE PEACE DEFICIT MODEL FORECAST
ANGOLA	FORECASTED AT RISK
CAMBODIA	POSITIVE PEACE DEFICIT
CAMEROON	FORECASTED AT RISK
CENTRAL AFRICAN REPUBLIC	POSITIVE PEACE DEFICIT
EGYPT	POSITIVE PEACE DEFICIT
COTE D'IVOIRE	POSITIVE PEACE DEFICIT
KENYA	POSITIVE PEACE DEFICIT
LEBANON	POSITIVE PEACE DEFICIT
LIBYA	POSITIVE PEACE DEFICIT
MALAYSIA	POSITIVE PEACE DEFICIT
MAURITANIA	POSITIVE PEACE DEFICIT
MOZAMBIQUE	FORECASTED HIGH RISK
NIGERIA	POSITIVE PEACE DEFICIT
RWANDA	POSITIVE PEACE DEFICIT
SENEGAL	POSITIVE PEACE DEFICIT
SOUTH SUDAN	POSITIVE PEACE DEFICIT
SYRIA	FORECASTED HIGH RISK
TAJIKISTAN	POSITIVE PEACE DEFICIT
UKRAINE	POSITIVE PEACE DEFICIT
YEMEN	FORECASTED AT RISK

# TESTING THE ACCURACY OF SEVEN RISK MEASURES OVER A SEVEN YEAR PERIOD

A more rigorous approach to testing the accuracy of the IEP risk models is to compare them to other measures while also establishing some experimental parameters that take into account the forecasts made by the models that were not accurate.

This means testing what are called the true positive and true negative rates to arrive at a *positive predictive value*.

Table 1.3 shows the results of this approach by testing the change in GPI of 0.2 or greater with the predictive time span of seven years. A deterioration of 0.2 was selected for being a significant threshold based on historical deteriorations in the GPI since 2008. In this experiment, the top 20 countries that score the highest in each risk measure was taken as being “at risk”. Only the Like-Country and Positive Peace Deficit models achieved over 50 per cent positive predictive value. Given that the GPI data only goes back a decade and accounting for the

fact that interventions require a lead time to be effective it was decided that seven years would be an appropriate baseline period for prediction and illustrative discussion.

The positive predictive value of the five other anonymised risk measures averaged from a low of 25 per cent to 40 per cent underlining the fact prediction is difficult and often incorrect.

The other models used in the tests have not been identified to avoid criticism of these models and to maintain the focus of the findings on the Like-Country model and the Positive Peace Deficit model.

**TABLE 1.3** SECONDARY RESULTS OF THE RISK COMPARISONS, ACCURACY BASED ON 0.2 SCORE CHANGE OVER SEVEN YEARS

Testing the accuracy of the seven risk measures in predicting changes in peace seven years in advance shows the IEP risk measures performed best with a positive predictive value of 52 and 55 per cent.

## EXPERIMENTAL PARAMETERS: GPI DETERIORATION = 0.2, TIME FRAME = 7 YEARS

Risk measure	True positive	True negative	False positive	False negative	True positive rate	True negative rate	Positive predictive value	Overall accuracy
Risk measure A	7	56	13	24	23%	81%	35%	63%
Risk measure B	5	54	15	26	16%	78%	25%	59%
Risk measure C	7	50	19	24	23%	72%	27%	57%
Risk measure D	8	57	12	23	26%	83%	40%	65%
Risk Measure E	6	55	14	25	19%	80%	30%	61%
IEP - Like - Country	11	59	10	20	35%	86%	52%	70%
IEP - Positive Peace Deficit	11	60	9	20	35%	87%	55%	71%

# TESTING THE ACCURACY OF SEVEN RISK MEASURES THROUGH MULTIPLE TIME PERIODS

To explore the accuracy of the IEP models further, the same experiment was conducted varying the number of countries taken as being “at risk”.

Instead of arbitrarily taking the top 20, this number has been varied from one to the maximum number of countries in the measures and recalculating the performance statistics each time. This allows for a Response Operating Characteristic Curve (ROC) to be constructed as shown in figure 1.1. Once again, both IEP measures perform the best in this experiment, achieving an accuracy rate of 65 per cent.

The area under the curve of a ROC is an informative measure of performance. A 100 per cent accurate model would have an area under the ROC of 1. A model with an area of 0.5 means that any country identified by the model as being “at risk” has a 50-50 chance of being a true positive or a false positive.<sup>3</sup> Because of the 50-50 statistic, such a model is compared to a minimum baseline of accuracy. Figure 1.1 shows the area under the curve for each measure examined.

**To test the sensitivity of these results to the time frame selected and the threshold for a significant deterioration, further experiments have been run for all feasible combinations of:**

1. Prediction time frames between 1 and 7 years.
2. Deteriorations in the GPI of between 0.1 and 1 in 0.1 increments.
3. The number of countries selected as being at risk for each measure varying from 1 to the maximum number of countries possible for each measure.

This configuration gives an experimental set of 4,407. The area under the ROC was calculated for each experiment. Figure 1.1 shows the distribution of results for each risk measure tested. Once again, IEP’s models perform better than the other measures tested.

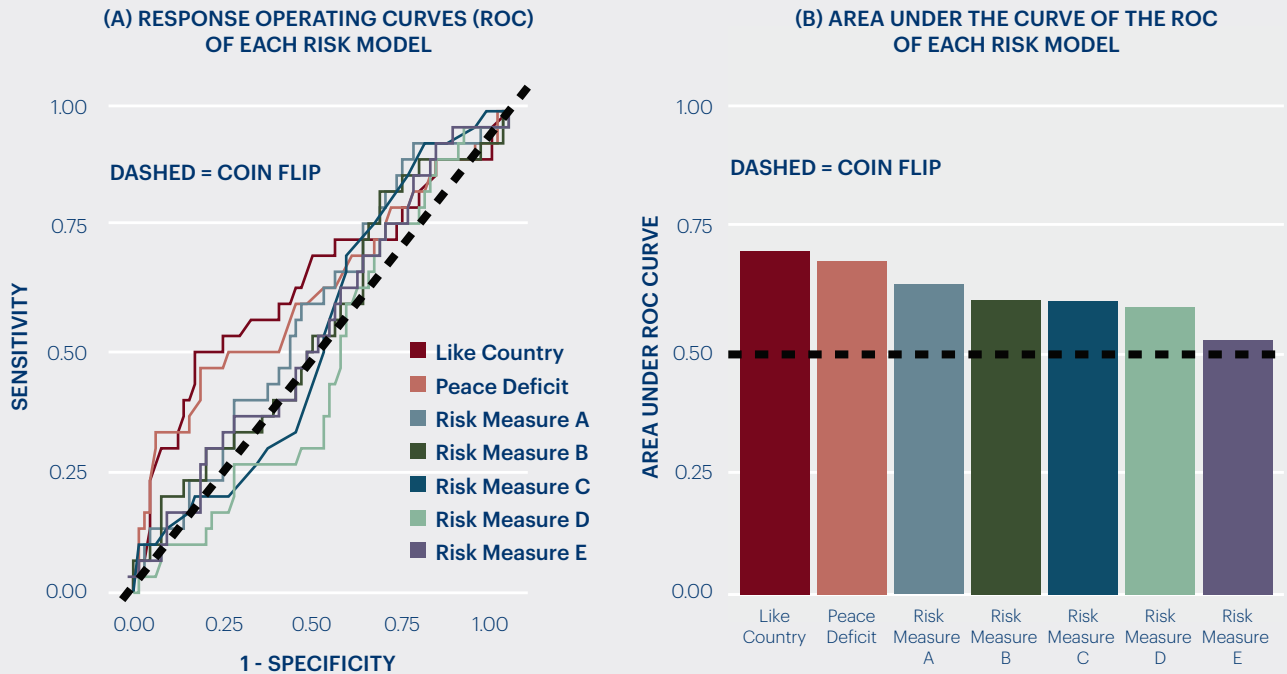
The Like-Country model and Positive Peace Deficit model performed equally well, with a 65 per cent probability of correctly identifying a deterioration of a country in the GPI compared to a non-deterioration. In practice, this means that if one were to use the IEP models to predict the ten most substantial deteriorations in the GPI over multiple time periods from one to seven years, the median accuracy of the models would be correct 65 per cent of the time. This places the IEP measures as 15 per cent more accurate on average than the minimum baseline of 50-50 accuracy, which is the base level of accuracy any model needs to exceed in order to be useful.

It is also important to note the anonymised risk measure A notably outperformed the other measures, reaching almost 58 per cent accuracy. The other measures B, C, D & E, performed only slightly better than a 50-50 chance meaning they are almost no better than randomly identifying countries at-risk.

Furthermore, while it is important to note that the level of accuracy achieved in this testing approach is higher when looking at multiple permutations than the method of testing over a fixed period, it is also potentially less useful. The magnitudes of change predicted here can be highly variant and policymakers require much more refined information on the nature of the changes that may occur. For this reason, the fixed approach in the second testing method set at a 0.2 change in the GPI is potentially more useful as it strictly limits predictions to very significant changes in the GPI score equivalent to the changes seen in countries like Tunisia, Nigeria and Greece after 2008.

**FIGURE 1.1** PERFORMANCES OF RISK MODELS COMPARED TO A COIN FLIP

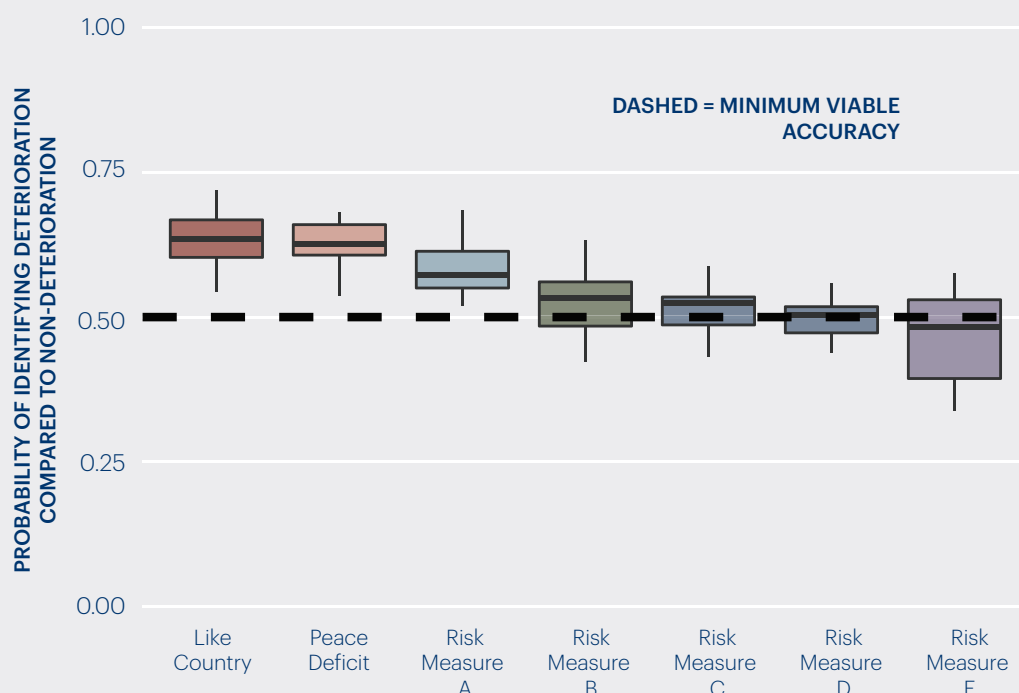
The response operating curve (ROC) shows the performance of each model for different thresholds of classification of countries into “at risk” and “not at risk”. The area under the curve of the ROC show that most models perform better than a coin flip.



Source: IEP

**FIGURE 1.2** PERFORMANCES OF RISK MODELS COMPARED TO A COIN FLIP

Across a variety of experiments, the “Like Country”, “Peace Deficit” and the “Anonymised Risk measure 1” consistently outperforms the other measures.



# RESULTS OF THE FUTURE FORECAST OF CONFLICT RISK

The 2017 Positive Peace Deficit model highlights the countries that are most-at risk of deteriorations in the GPI score.

As discussed, five of the ten highest Positive Peace deficit countries in 2008 experienced deteriorations in peace over the following seven years; these included Syria, Mozambique, Eritrea, Niger and Vietnam. Evidently, these deteriorations were not commensurate with each other - Syria experienced unprecedented collapse, versus Vietnam, which experienced a minor deterioration in its peace score due to an increase in violent demonstrations and further crackdowns on political freedoms.

For 2017, five of the ten countries most at-risk according to the Positive Peace Deficit model were also in the list in 2008. These include Bhutan, Equatorial Guinea, Sierra Leone, Laos, and Eritrea. The five 'new' countries were all sub-Saharan African - Madagascar, Guinea, Angola, Malawi and Togo. The fact countries like Syria are now no longer in the list reflects the fact that future risk in these countries have already been realised, i.e. we know that Syria is already at risk of violence and conflict - it is the very bottom of the GPI rankings. This is not to say conflict cannot further intensify or continue, rather the potential magnitude of collapse in peace cannot get much larger than is currently the case as it is already so lacking in peace.

The fact that five of the ten were also measured at risk in 2008 reflects an important point about the risk calculations and the nature of the Positive Peace Deficit model. These countries still, several years on, lack the resilience and capacity to deal with major internal or external shocks as well as the attitudes, institutions and structures to resolve existing and potential conflicts. In the period between 2008 and 2017, they have not made enough progress on Positive Peace to move them out of the risk category for recording higher levels of violence than currently. While Bhutan, Equatorial Guinea, Sierra Leone, Laos and Eritrea remain on the list when compared to the 2008 predictions, the magnitudes of the positive peace deficits have improved, and thus risk, in each of these countries has decreased since 2008 indicating increasing institutional capacity.

**TABLE 1.4** TOP COUNTRIES MOST AT-RISK OF NOTABLE CHANGES IN THE GPI AS OF 2017

Five of the top ten countries most at-risk according to the Positive Peace Deficit model were also in the top ten in 2008. These countries are marked with a (+).

COUNTRY
BHUTAN (+)
EQUATORIAL GUINEA (+)
SIERRA LEONE (+)
LAOS (+)
MADAGASCAR
GUINEA
ERITREA (+)
ANGOLA
MALAWI
TOGO

There are surprising countries in the list. For instance, Bhutan, which is often deemed the 'happiest country' in the world based on the Global Happiness Index measure, and which in 2017 ranked 13<sup>th</sup> out of 163 countries in terms of overall GPI score. Nonetheless, even though its Positive Peace scores are improving, some fundamental underlying institutional and structural factors leave the country with a large Positive Peace deficit.

Conversely, there are also countries that perhaps surprisingly did not have notable falls in peace when they were exposed to major shocks. For instance, Sierra Leone, a recent post-conflict country was exposed to large shocks which could have been trigger factors for instability and conflict. The large change in international iron ore prices, which had major impacts on the economy, was followed by the onset of Ebola. Over the prior decade Sierra Leone has had one of the largest improvements in Positive Peace.

Of the remaining five countries on the list for 2017, Guinea and Malawi saw the magnitude of their Positive Peace Deficits increase since 2008. Both countries had improvements on their levels of internal peacefulness but without a commensurate increase in the levels of Positive Peace, indicating that any changes to peacefulness may not be sustainable in the long run.

In Guinea, improvements in internal peacefulness were driven by an improvement in political stability and decreases in violent demonstrations, while in Malawi the improvement was driven by a decrease in the homicide rates as well as an improvement in the intensity of internal conflict. While these improvements in negative peace are beneficial, without improvements in Positive Peace these improvements will be difficult to sustain.

The Positive Peace Deficit model moves very slowly with eight out of the ten most 'at risk' countries on the 2017 list were amongst the 20 countries most 'at risk' in 2008, indicating that the signals for potential conflict may be apparent long before any outbreak of violent conflict itself. This underlines the fact that countries are slow to make progress in Positive Peace and that peacebuilding work needs to focus on long-term results. Importantly this does not mean peacebuilding and improvements in Positive Peace cannot occur over short periods, rather significant investment and focus is required to do so.

“ The Positive Peace Deficit model moves very slowly with eight out of the ten most 'at risk' countries on the 2017 list were amongst the 20 countries most 'at risk' in 2008, indicating that the signals for potential conflict may be apparent long before any outbreak of violent conflict itself.



# SECTION TWO

## METHODOLOGY: HOW IEP CALCULATES RISK

### IEP POSITIVE PEACE DEFICIT MODEL

**IEP's research defines peace in two key respects: Negative Peace and Positive Peace. Negative Peace is the absence of violence or fear of violence.**

IEP has quantified negative peace in the GPI. However, peace is more than the absence of violence. Positive Peace is defined as the *attitudes, institutions and structures* which create and sustain peaceful societies. These same factors also lead to many other positive outcomes which society feels are important. Therefore Positive Peace is described as creating the optimum environment for human potential to flourish.

Factors associated with Positive Peace have been empirically derived by IEP via statistical analysis of thousands of cross-country measures of economic and social progress to determine what factors are statistically significantly associated with negative peace. The Positive Peace Index (PPI), which consists of eight pillars, each containing three indicators, codifies this research.

The relationship between Positive and Negative peace can give strong insights into the levels of resilience, vulnerability and future peace. By quantifying Positive and Negative peace, it is possible to compare both measures to explore this relationship further. While there is no direct link to the raw scores of the PPI and the GPI, the ranks of a country in each index can be compared to highlight relative positions in both dimensions of peace. Given the inter-relationship of Positive and Negative peace, conceptually it would be expected that any country would rank approximately the same in both the GPI and the PPI. Differences in ranks would indicate that over time the disparity should disappear, therefore countries which are more peaceful than their Positive Peace are at more risk of deteriorating.

“ The relationship between Positive and Negative peace can give strong insights into the levels of resilience, vulnerability and future peace.

IEP has developed a methodology for assessing the risk of conflict using a heuristic measure: the Positive Peace Deficit model.<sup>1</sup> By comparing internal peace scores from the GPI with the Positive Peace Index (PPI), IEP calculates a country's peace gap to predict the potential for future deteriorations into violence and conflict. The model assumes that weak institutional and social capacity is a good indicator of the risk of conflict.

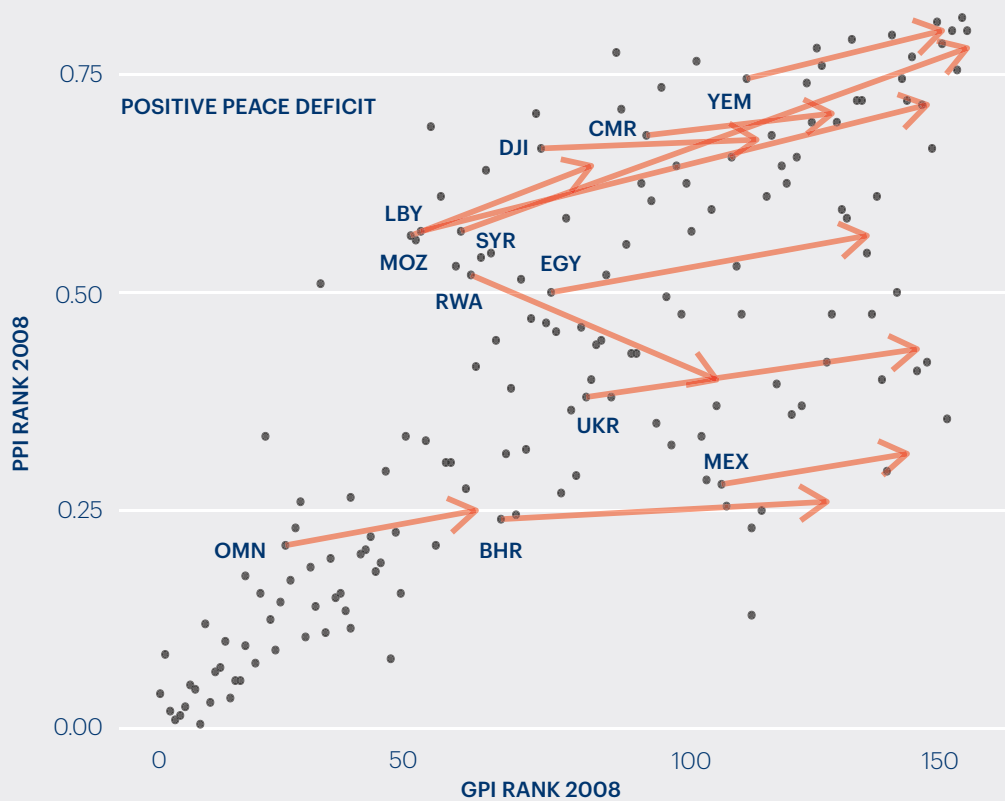
When Positive Peace is relatively weaker than Negative peace (as measured by the GPI internal score), a country is said to have a Positive Peace deficit, indicating that the current levels of Positive Peace are not likely to sustain the current low levels of violence. To illustrate, figure 2.1 plots the ranks of the PPI and GPI Internal Score in 2008.

In the period between 2008 and 2017, all of the 20 countries that deteriorated into conflict as defined by UCDP had high positive peace deficits.<sup>2</sup>



**FIGURE 2.1** GPI INTERNAL PEACE RANK VS PPI RANK, 2008

Countries with high levels of peace tend to have high levels of Positive Peace as well. However, there is much more variation within countries with mid and low levels of peace than countries with high peace.



Source: IEP

## IEP LIKE-COUNTRY MODEL

**Building on the Positive Peace Deficit model, IEP has also developed a Bayesian model for conflict prediction.**

Bayesian inference is a mathematical way of dealing with imperfect knowledge. For example, imagine a country that has always had a low level of peace. If only the country's history was taken into account, the prediction would be that the country will always have a low level of peace.

However, other countries with similar institutional capacity or economic compositions may have a different story and had found way out of conflict into higher levels of peace.

The “Like-Country” method uses Bayesian inference based on historic data to estimate the likelihood of a country either improving or deteriorating in peace. The process is as follows:

1. *Select a country for assessment (Country A).*
2. *Select indicators on which to identify “like countries”.*
3. *Select “like countries” as the countries with the similar values for the indicators as Country A.*
4. *Calculate the proportion of time that Country A was significantly less/more peaceful than it is currently (Probability 1).*
5. *Calculate the proportion of times that like countries were significantly less/more peaceful than Country A is currently (Probability 2).*
6. *Calculate which proportion of historical changes in peace that are significant (Probability 3).*
7. *Calculate using Bayesian inference the likelihood that Country A will be in the future significantly less or more peaceful.*

Combining these values gives a posterior possibility of how likely a country will fall in peace given other like countries.

The following formula gives the number required:

$$\frac{(\text{Probability 1} \times \text{Probability 2})}{(\text{Probability 1} \times \text{Probability 2} + \text{Probability 3} \times (1 - \text{Probability 1}))}$$

Using this process the following probabilities are calculated for each country:

- **P (Deterioration) = the likelihood that the country will deteriorate in peace in the next two years**
- **P (Improvement) = the likelihood that the country will improve in peace in the next two years**
- **The balance of probabilities = P (Deterioration) - P (Improvement).**

The balance of probabilities is used to identify those countries where levels of peace are much more likely to move in one direction or the other. If a country is far more likely to deteriorate in peace then the balance of probabilities will be positive. Conversely, if a country is much more likely to improve then the balance of probabilities will be negative. If a country is equally likely to improve or deteriorate, the balance of probabilities will be zero indicating that the data is insufficient to make an informed prediction.

#### EVALUATION METHODOLOGY

To assess the accuracy of different models to predict future conflict, the Global Peace Index is used as the key conflict measure as it captures the multidimensional measure of violence and conflict. The performance of IEP’s two models are compared to the performance of five other commonly used indicators. The measures have been tested via a number of experiments. Of the seven measures, four can be described as forward looking and the other three are what are described as ‘snapshot’ measures that measure levels of fragility and development as it is currently. The measures have been anonymised to ensure they are not unfairly judged as IEP has defined the criteria for accuracy.

# EVALUATING THE KEY INDICATORS FOR ASSESSMENT

The seven methods/models used in this analysis are:

- 1. IEP's Positive Peace Deficit model.<sup>3</sup>** Using country rankings in the Global Peace Index (GPI) and Positive Peace Index (PPI), IEP also calculates a country's peace gap to explore the potential deteriorations. Where Positive Peace is relatively lower than Negative Peace, a country is said to have a Positive Peace deficit, indicating a low level of institutional and social capacity to maintain peacefulness. The Positive Peace Deficit model highlights countries that are at risk of conflict due to weak institutional and societal capacity.
- 2. IEP's Like-Country model.<sup>4</sup>** Building on the Positive Peace Deficit model, IEP's Like-Country Model uses a Bayesian approach to assessing likelihood of deteriorations in a country's level of peacefulness in a two-year time frame. It does this by (1) calculating what percentage of time a country was less peaceful than it is today, (2) calculating what percentage of time similar countries, based on PPI scores, have been less peaceful than the country is today and (3) the probability of any country deteriorating by a certain amount. These three factors are used to compute a likelihood of country deteriorating using a standard Bayesian conditional probability equation.
- 3. Global Conflict Risk Index.<sup>5</sup>** This measure is an index of the statistical risk of violent conflict in the next 1-4 years and is exclusively based on quantitative indicators from open sources. With the assumption that structural conditions in a country are linked to the occurrence of violent conflict, the measure collects 25 variables in 5 dimensions (social, economic, security, political, geographical/environmental) and uses statistical regression models to calculate probability and intensity of violent conflict.
- 4. CPG Early Warning Project.<sup>6</sup>** The measure uses a wide range of data to identify countries at risk of new mass atrocities. The statistical component of this model focuses solely on cases of state-led violence, meaning a government acting against its own people. The country rankings are not designed to pinpoint threats from one country against another.
- 5. Systemic Peace State Fragility Index.<sup>7</sup>** This is an annual measure of state fragility where each country is assessed on effectiveness and legitimacy on four domains, (1) security, (2) political, (3) economic, and (4) social.
- 6. Fund for Peace Fragile States Index.<sup>8</sup>** This captures the pressures on states that push them to fragility on three domains (1) social, (2) economic and (3) political and military.
- 7. Human Development Index.<sup>9</sup>** This measure is a composite score of development, while not designed to be a risk measure per-se many analysts use development metrics as predictors of the likelihood of conflict.

Table 2.1 overleaf summarises these models in more detail. An interesting aspect of this analysis is the inclusion of both risk measures and snapshot measures. Risk measures are categorised as being "forward-looking". All of these either implicitly or explicitly describe themselves as being linked to an increased likelihood of deterioration in the future. Snapshot measures, on the other hand, are simply a description of a state of reality in a country in any given year. By including both, this analysis explores whether the risk models perform better than standard snapshot measures which are not designed to make predictions about the future.

To investigate this, table 2.2 presents a table of correlations for all five indicators. This shows that the two measures from IEP are not correlated to the other five indicators investigated.

**TABLE 2.1** RISK MODELS INVESTIGATED

Seven measures were investigated.

	RISK MODEL	FOCUS	MEASURES	METHODOLOGY	ASSUMPTIONS
RISK MEASURES	Global Conflict Risk Index	Inter-national, intra-national and sub-national conflicts	Likelihood x Impact	Logistic regression to estimate likelihood, multiple regression to estimate impact	It is possible to predict future events from past events
	IEP Positive Peace Deficit	Deteriorations in peace	Risk proxy	Compares ranks of a country in the GPI to the PPI to identify relatively peaceful countries that have weak institutional capacity	Weak institutional capacity is a good indicator of risk
	IEP Like-Country	Deteriorations in peace	Likelihood	Uses Bayesian calculations to measure the likelihood of deteriorations	That movements in the GPI follow certain and repeatable statistical distributions
	Early Warning Project	State-led mass killings	Likelihood	Uses the average of three models (1) logistic regressions (2) statistical inference (3) random forest machine learning	It is possible to predict future events from past events
SNAPSHOT MEASURES	State Fragility Index	A measurement of state fragility	Not applicable, is an annual snapshot in time	Rates effectiveness and legitimacy across (1) security, (2) political, (3) economic, and (4) social.	Not applicable
	Fragile States Index	Highlights pressures that are pushing a state towards the brink of failure.	Not applicable, is an annual snapshot in time	Weights three domains, (1) social, (2) economic and (3) political and military	Not applicable
	Human Development Index	Development outcomes	Not applicable, included as a benchmark	Calculates a composite score by weighting income, health and education of a country's citizens	Not applicable

**TABLE 2.2** CORRELATION BETWEEN RISK MODELS

There is a cluster of correlations, three of the five risk measures correlate with each other and not the other two, and vice versa.

	EARLY WARNING PROJECT	FAILED STATES INDEX	FRAGILE STATES INDEX	GLOBAL CONFLICT RISK INDEX	HDI	IEP - LIKE COUNTRY	IEP -PEACE DEFICIT
Early Warning Project	1.00	0.64	0.70	0.63	0.58	-0.04	0.23
Failed States Index	0.64	1.00	0.83	0.88	0.76	0.07	0.23
Fragile States Index	0.70	0.83	1.00	0.79	0.85	0.07	0.41
Global Conflict Risk Index	0.63	0.88	0.79	1.00	0.70	0.01	0.21
Human Development Index	0.58	0.76	0.85	0.70	1.00	0.13	0.42
IEP Like-Country	-0.04	0.07	0.07	0.01	0.13	1.00	0.69
IEP Peace Deficit	0.23	0.23	0.41	0.21	0.42	0.69	1.00

# MEASURING THE ACCURACY OF PREDICTIVE MODELS

When discussing risk, a prediction model will assess whether a country is at risk or not.

In prediction, standard measures are used to assess the levels of accuracy of such assessments. Central to these are the concepts of false positives and false negatives. If a country is assessed as being at risk of deterioration but does not deteriorate in the future observed timeframe this would be classed as a false positive. Conversely, if a country is assessed as not being at risk, and does, in fact, deteriorate within the future observed time frame, this would be classed as a false negative. For any prediction method, a ‘confusion matrix’ summarises the numbers of successful predictions and the number of false positives and negatives. Table 2.3 shows the standard format of a confusion matrix and the one that is used in this report.

By using Table 2.3 a number of standard measures can be calculated to compare predictive models for the purposes of conflict risk:

- **True Positive Rate** measures the proportion of countries identified as “at risk” that do deteriorate when compared to the full dataset within the time frame calculated by  $A/(A+C)$
- **True Negative Rate** measures the proportion of countries identified as “not at risk” that do not

deteriorate within the time frame is calculated by  $D/(B+D)$

- **Positive Predictive Value** is the proportion of countries that deteriorate that were identified as “at risk”. This is calculated by  $A/(A+B)$ .
- **Overall Accuracy** measures the total number of true positives and true negatives to the total number of predictions. This is a measure of how often the model correctly predicts a deterioration and is measured by  $(A+D)/(A+B+C+D)$ .

In the prediction literature, it is common for the overall accuracy to be used as a measure of the strength of the model. However, different models perform differently in each of the above measures of accuracy. To gain a full picture of a model’s strength and weaknesses each measure needs to be considered separately, but in practice this can be misleading. Given the impossibility of creating a 100 per cent accurate model, what is of most interest in practice is how many of the countries that any one model identifies as at risk actually fell into conflict historically. This proportion is termed the positive predictive value and the larger this number, the more likely the model will be useful in practice.

**TABLE 2.3** STANDARD CONFUSION MATRIX USED FOR RISK MODEL EVALUATION

The accuracy of a risk model is based on the number of true positives, true negatives, false positives and false negatives observed when comparing the projections of the models vs the true observed outcomes.

		IN YEAR Y + N THE COUNTRY HAS...	
		Deteriorated	Not deteriorated
A RISK MODEL PREDICTS IN THAT A COUNTRY YEAR Y IS...	At risk of deterioration	True positive (A)	False positive (B)
	Not at risk of deterioration	False negative (C)	True negative (D)

## SECTION THREE: DISCUSSION OF KEY CHALLENGES IN RISK

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### DO RISK MEASURES NEED TO BE ACCURATE TO BE USEFUL?

The results presented in the previous section highlight the complexity of building accurate models that are capable of predicting falls in peace in the future. The section raises a number of practical and conceptual considerations that are interesting to address individually.

In the literature, there is little consistency with how the performance of risk measures are reported. There are various statistical methods and technical justifications for different approaches to measuring forecasting accuracy, but this often clouds the larger question of *how accurate does a conflict risk model need to be in order to be useful?*

To answer this question in the context of conflict prevention, it is useful to imagine an ideal world where institutions were not bound by political constraints and were free to intervene into areas where the risk of violent conflict was assessed as high enough to act. In purely economic terms, if the cost of the intervention is more than the cost of responding then there would be an argument to simply wait until a conflict erupted. However, if the cost of the intervention was less than the cost of a response, it would make good economic sense to intervene providing the intervention was successful. In such cases a good risk model that predicted conflict and mobilised resources for prevention would be useful, providing that the cost-benefit ratio remained high. IEP estimates that the cost of armed conflict was more than 740 billion in 2015. Investments in peacekeeping is only one per cent of that amount, highlighting the potential benefits from more effective risk assessment combined with good economic analysis of the cost of interventions compared to the cost from conflict.

No risk model will be 100 per cent accurate all of the time and will invariably produce false positives that direct resources to

places where no conflict would have occurred anyway. So the cost of intervention must be weighed against the number of times a risk model provides a false positive, i.e. the number of times there was an intervention when it was not necessary. If it were possible to identify that a conflict was avoided, then it is possible to put a value on the cost-benefit trade-off for the inaccurate or unnecessary interventions that occurred.

To do this, say a risk model has a positive predictive value of 0.6. This means that 60 per cent of countries that are identified as being at risk eventually erupt into violence. Further, it also means that 60 cents out of every dollar invested in prevention goes to countries that would have otherwise descended into conflict. Forty cents in every dollar would go to countries that were not in reality at risk.

Agencies involved in conflict interventions have two strategies, one reactive, the other preventative. In the reactive case, agencies do not allocate any resources to prevention and only respond after conflict onset. Costs associated with a reactive approach include material loss due to the conflict and the cost of the response. An alternative approach would be a mixed strategy whereby some resources are invested into conflict prevention *and* into conflicts that do occur. This second mixed approach incurs costs associated with prevention, response and costs of conflict. Assume the mixed strategy allocates its prevention funding using a risk model.



If  $C_p$  is the cost of prevention and  $C_c$  is the total cost of conflict (including response), then the total cost of a mixed approach will be  $C_{Mixed} = C_p * (\text{True Positives} + \text{False Positives}) + C_c * \text{False Negatives}$ . The cost of the response only approach will be  $C_{Response Only} = C_c (\text{True Positives} + \text{False Negatives})$ . The break-even point occurs when the cost of the mixed approach equals the cost of the response only approach. Algebraically the relationship between  $C_{Mixed}$  and  $C_{Response Only}$  is presented in the equation below.

$$C_p = \frac{(\text{True Positives})}{(\text{True Positives} + \text{False Positives})} C_c = \text{Positive Predictive Value} \times C_c$$

So what risk model sensitivity would be a break-even point for intervention? Reports by UK Department for International Development (DFID), IEP and UNDP suggest that the ratio of cost of prevention to cost of conflict range between 1:4 to 1:16.<sup>12</sup>

For illustrative purposes, assuming a cost benefit ratio of 1:10 any model with greater than 10 per cent accuracy would result in savings of 100 per cent of the interventions. In other words, only one in ten of countries identified as “at risk” had to be genuinely at risk in order for the model to break even. A positive predictive value of greater than 10 per cent would mean that the mixed approach would be *less expensive* than the do nothing approach. If the cost difference was higher, say 1:16 as suggested by a recent IEP study, then the break-even sensitivity of the model would be much better, meaning that only 6 per cent would need to be effective, i.e. a model could be less accurate and still be useful.

Given these economics, the question that needs to be addressed and for which solutions need to be found, relate to the actual effectiveness of conflict prevention interventions as well as broader peacebuilding strategy.

## CAN CONFLICT RISK ASSESSMENT BE INTEGRATED INTO INTERNATIONAL RISK MANAGEMENT PROCESSES?

**Even if a perfect risk measure was found, how could it be used? At the nation-state level, knowing the magnitude of the risk of conflict is beneficial for the international community.**

However, being able to prevent conflict is difficult for the international community for a variety of reasons. International prevention of internal conflicts has been advocated since the end of the Cold War.<sup>3</sup> In the 1990s there was a view that international intervention in internal conflict could at least contain violence. However, the campaigns in Mogadishu and Monrovia in 1999 demonstrated that preventing or containing is not a straightforward case of the International community “stepping in”.<sup>4</sup>

Firstly, there can be unintended consequences. For example, in 1991 amid the height of tensions over secession, the US publicly stated that it “preferred a unified Yugoslavia” as a call against conflict escalation. However, many believe this was interpreted by Belgrade as a justification for Yugoslavia to use force against its people.<sup>5</sup> Secondly, even if the warning does come early enough, the International community may lack the resources or political will to intervene. In the case of the Rwandan genocide, the Belgian Ambassador warned his government in 1992 that the Hutus were planning extermination of the Tutsis.<sup>6</sup> By 1993 the UN Special

Rapporteur submitted a report stating that the actions that the Hutus had already perpetrated constituted genocide.

However, despite such direct warnings, no operation aimed at prevention was mobilised and the Rwandan genocide officially began on April 7, 1994, leading to the mass killings of an estimated 500,000 to 1,000,000 Rwandans.<sup>7</sup>

The norms and treaties of International Law restrict powers of any country to interfere with the sovereignty of another, making conflict prevention difficult to justify if it involves the use of military force.

Another challenge to risk measures in a practical sense is the potential that they result in “self-fulfilling prophecies”.<sup>8</sup>

If an accurate risk measure could be formulated, what would the effect be on the countries at risk? With additional attention directed their way, there is the potential for investors and aid donors to withdraw support for a region due to the higher level of perceived risk. The pro-cyclical nature of such funding wax and wane in unison with the levels of conflict.

If the risk measure suggests conflict is imminent, funds could disappear from the country further exacerbating root causes.<sup>9</sup>

Finally, there is also a philosophical problem for conflict prevention; if multi-laterals can justify the legality of an intervention and proceed, how can they measure success? Often called “the dog that didn’t bark” problem, prevention agencies have an issue in trying to prove that conflict would have occurred if they hadn’t intervened. Pricing the counterfactual is a challenge for the prevention community making the task of vying for funding in a world where the costs of humanitarian crisis response are continually on the rise also increasingly difficult.

To illustrate, in a recent report, due to an increase of natural disasters, conflict and rising costs, UNOCHA’s funding requirements has risen from US\$5.5 billion to US\$18 billion from 2003 to 2014, an increase of around 220 per cent.<sup>10</sup> This humanitarian reality and the associated cost constrains the international community’s ability to direct short-term resources into prevention.

## MEASURING RISK FROM EMPIRICAL EVIDENCE: IS IT EVEN POSSIBLE?

The ability to predict risk from empirical evidence is a topic of great debate. Such debates are epistemological and cover two main points (1) whether the empirical evidence of today does reflect ground truths and (2) whether the use of historical data can legitimately be used to assess future risks.

Looking at the Arab Spring, many have asked the question *why didn’t the world see it coming?* This has raised the question as to the applicability of data to accurately quantify risk. Taking the World Governance Indicators of Government Effectiveness and Rule of Law for Syria as the example shown in figure 3.1, the ten years prior to the Arab Spring uprisings show little variance in these indicators.<sup>11</sup> In fact, they show a slight improvement occurring from 2005-2006 until 2011. It is only with the onset of the Syrian civil war that these indicators change significantly.

Prior to the civil war, these gave no strong indication of the devastation that was to follow. They do, however, consistently suggest that these measures were low throughout the period when compared to the rest of the world.

The World Government Indicators are compiled from surveys and expert assessments across households, business, INGO and Governments. However, some analysts question the ability to truly trust the results from such surveys. “Preference falsification” has long been recognised as confounding results

when using surveys to glean the likelihood of an uprising.

In this aspect of human nature, people can respond *falsely* in response to questions about political views and this behaviour is especially prevalent in countries with oppressive Governments.<sup>12</sup> Revolutions require a critical mass and a mobilisation of the people. Without accurate knowledge of how widely a revolution is supported, it is not possible to ascertain if or when a critical mass could be reached.

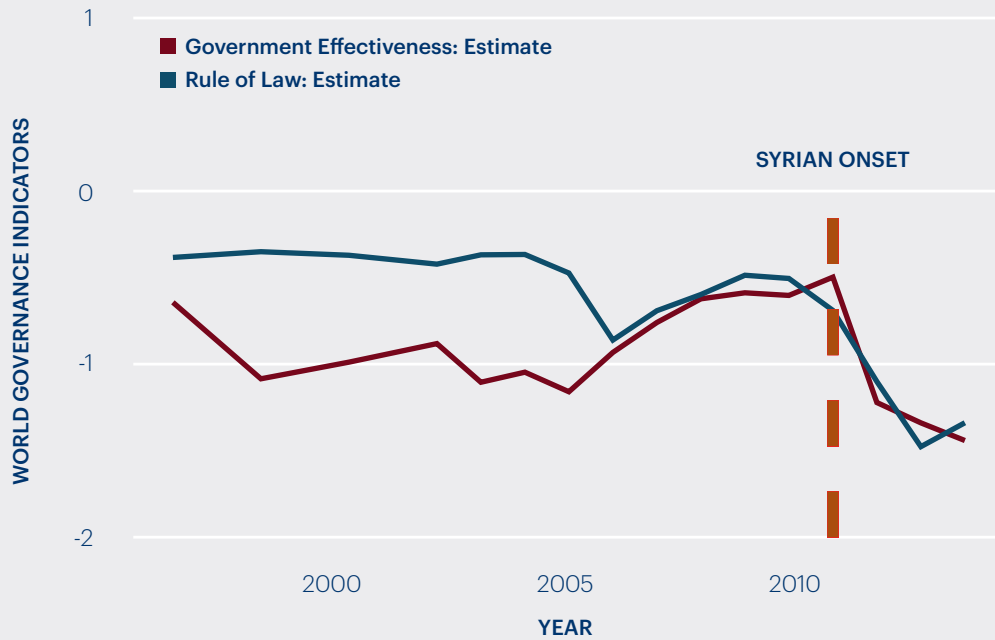
In a non-linear world with ever-increasing connectivity, it is difficult to know the impact of something. No one predicted or arguably could have predicted the impact of the self-immolation of Mohamed Bouazizi was to give rise to the Arab Spring. The notion that one small act can result in systematic failure is best described as the Swiss Cheese Model of risk as described in box 3.1.

Finally, there is the epistemological challenge that comes from using historical data to project risks in the future and some argue that the approach is methodologically flawed. This problem is summarised by the “Turkey” story in box 3.2.



**FIGURE 3.1** WORLD GOVERNANCE INDICATORS IN SYRIA

According to the World Bank, Government Effectiveness and Rule of Law were improving prior to the onset of the Syrian civil war.

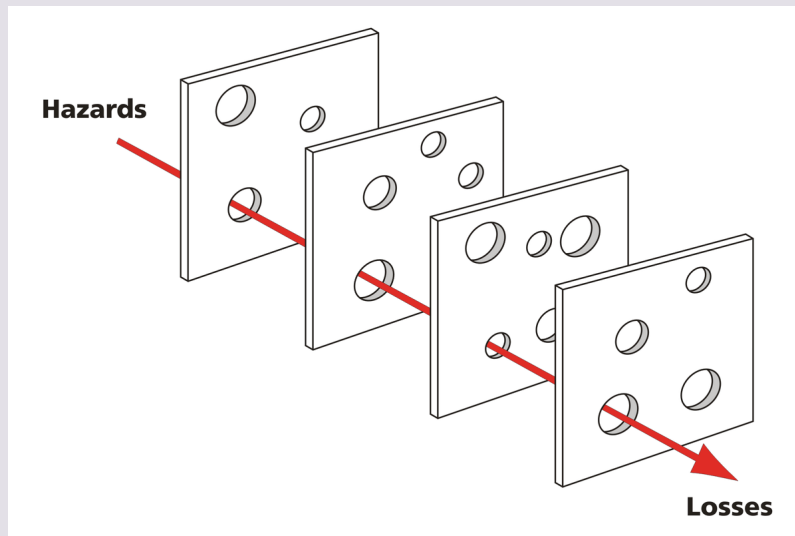


Source: World Bank

“ In a non-linear world with ever-increasing connectivity, it is difficult to know the impact of a given event.

### BOX 3.1 THE SWISS CHEESE MODEL OF RISK

Risk theorists in aviation, engineering and healthcare are well aware of the dangers of multiple risks occurring at the same time. This is illustrated by the “Swiss Cheese Model of Risk”.<sup>13</sup>



Imagine a series of slices of Swiss cheese rotating in a line. The slices represent defences against an event occurring and the holes represent weaknesses in these defences. While one defence can fail, a disaster can still be averted by the other defences. However, if at some point in time a path opens up through all defences the disaster can occur. The chain of events that led to the Global Financial Crisis may be described as an example of this. The combination of assumptions that house prices always rise coupled with poor risk assessment by credit rating agencies and a lack of understanding how a housing crash could trigger a financial crisis all occurred with catastrophic effects.

Had one of these defences been stronger the risk may have been better managed. Applying the model to country risk, an external shock such as a primary commodity price drop may not affect a country with a diversified economy. However if the economy is highly dependent on primary commodities, farmers will be heavily affected. This in of itself may not lead to conflict. However, according to the literature if these farmers are primarily young unmarried males then the likelihood of conflict is higher. If institutions are also weak then the ability to suppress conflict when it erupts may be limited.

### BOX 3.2 TURKEYS AND PREDICTION

The likelihood of world events is a constant unknown and it is impossible to quantify the likelihood of any one event happening. This makes prediction a practical impossibility. In many cases the only information available to use for prediction is historical data. However, this in itself is problematic as highlighted by the story of the turkey and the farmer. A farmer begins to feed a certain turkey every day at a certain time. Based on this the turkey became very good at predicting when she would get fed and this prediction was accurate for a long while.

This accuracy built the turkey's confidence that her predictions were accurate. As time went on the farmer began giving the turkey more and more food every day. This allowed the turkey to predict not only the time but the increasing amount of food that would be offered. Based on these predictions the turkey believed she had a very good relationship with the farmer. On Thanksgiving the turkey realised the peril of projecting the past into the future.<sup>14</sup>

# RESULTS OF CONFLICT RISK ANALYSIS CAN BE COUNTERINTUITIVE

This challenge can best be highlighted by exploring two simple questions:

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- 1. Is Syria risky?** – The answer to this is definitely yes, it is risky for tourists, investors and neighbouring countries.
- 2. Is Syria at risk of an escalation in conflict?** This yields a different answer. The likelihood of Syria getting much worse diminishes with each escalation. Similarly, the impact arguably diminishes too. There is a theoretical and finite upper limit to how bad a civil war can get. As the conflict in Syria continues and expands, the risk of it continuing to expand domestically may actually decrease.

This is a problem when talking about measuring risk. It implies that a risk measurement using the likelihood and impact approach of an escalation of violent conflict, Syria would potentially rank low.

To bridge this issue, in 2014 IEP delineated risk into two concepts: realised and potential risk. Realised risk is what is happening in a country today. Using Syria as an analogy, realised risk is the uncertainty that faces tourists, investors and INGOs due to the ongoing conflict. Potential risk is what could happen tomorrow.

Measuring realised risk is a relatively straightforward matter. For violence and conflict the Global Peace Index (GPI) can be thought of as measuring the realised risks in a country. If violence increases the GPI score increases and vice-versa. These measures are extremely useful in allowing cross-country comparison of a “ground-truth” in a given year. They are also useful in visualising the trajectories of countries over time to see if a country is becoming less or more peaceful. Syria is currently the least peaceful country in the world.

Measuring potential risks are more difficult. They also behave differently to more common measures. If you had a measure of potential risk of increased violent conflict, Syria for reasons explained above might not score as high as other countries: *as realised risk increases, potential risk may decrease, and vice-versa*. At its basest interpretation, it means that to know where conflict will be in the future, look at the peaceful countries today

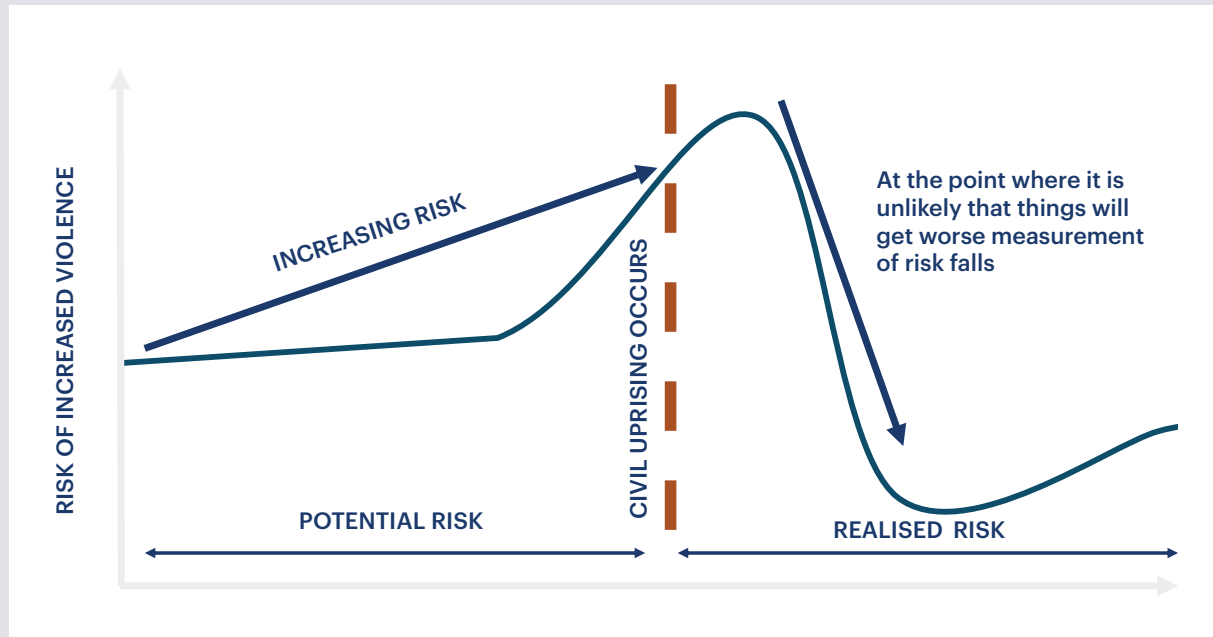
The counterintuitive nature of risk may also be due to the fact that the human brain is poor at assessing risk. For example, behavioural economics studies have found people tend to associate risk with an assessment of “likelihood” rather than the more broad concept of likelihood x impact. Such studies show that when given a choice between two situations where the mathematical expected outcome are the same, human preference is given to the option that seems less uncertain. The fear of loss, commonly called loss aversion, also factors into the decision-making process of humans creating a bias towards lower loss even in two situations where the risk calculated as likelihood x impact are the same. A good risk management process is a systematic approach aimed at avoiding such biases.

“ The counterintuitive nature of risk may also be due to the fact that the human brain is poor at assessing risk.

### BOX 3.3 HOW A RISK MEASURE OUGHT TO BEHAVE

To demonstrate this, imagine a nation that has been suffering from an increase of political instability in recent months. As things progress, the situation worsens and experts suggest that the risk of a civil uprising and subsequent violence is increasing. At a certain point in time, expert prediction is proved correct and the civil uprising occurs.

The violence continues to get worse but then gets to a point where it will probably not get worse. At this point, the risk of violence increasing drops. At the same point, measures of realised risk such as the GPI would increase reflecting the ground truth of the situation.



# RISK ASSESSMENT AND MANAGEMENT ARE DIFFERENT IN DIFFERENT CONTEXTS

In natural disaster risk management, as there is little that can be done about the likelihood of a natural disaster to occur, the aim is to *reduce the risk by reducing the impact*.

Such mitigation strategies could include strengthening existing infrastructure, building stronger dams or moving population away from areas that are at risk of being hit. This is shown in figure 3.2.

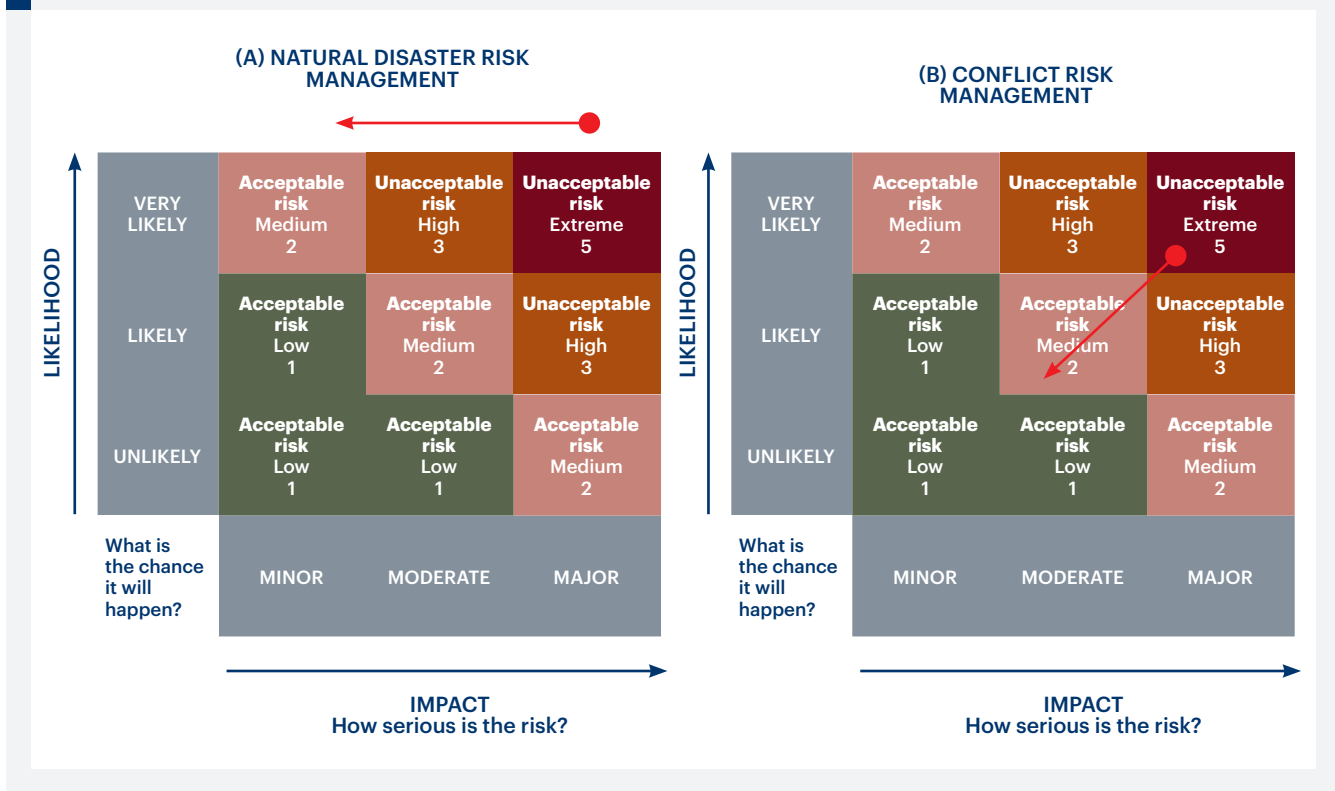
In contrast, as conflict is a man-made phenomenon, the dynamics of a risk management process can conceivably have two goals. Reducing both the likelihood and impact can be done for example by increased security to contain violence and prevent it from spreading. The fact that conflict risk management can reduce risk by reducing both factors of likelihood and impact is ultimately a good thing, but it has

confounding implications to quantitative approaches to measuring risk-based on the fragility and/or resilience of a country.

As risk, resilience and fragility are inherently linked in regards to conflict risk management, measures that include both are difficult to interpret. The reason for this is that by including both measures it's implied that a country can be fragile and have high risk, when in actuality countries have high risk because they are fragile. Furthermore, measures that include both natural disasters and conflict risks may suffer from conceptual clarity given the difference in nature of mitigation strategies.

**FIGURE 3.2** NATURAL DISASTER RISK MANAGEMENT VS CONFLICT RISK MANAGEMENT

Natural disaster risk management aims to reduce risk by reducing impact. Through capacity building conflict risk management has the ability to reduce risk by reducing both likelihood and impact.



# ADDITIONAL CHALLENGES IN RISK AND PREDICTION

Further to the points discussed above, there are a number of technical and empirical complexities to developing and using risk measures as well as implementing them. Such challenges include:

- 1. Some events are essentially unpredictable.** These can be described under the taxonomy of known-knowns, known-unknowns and unknown-unknowns. Often there are not enough observations of a particular phenomenon to measure its likelihood or the contextual information to observe their probability. In the case of unpredictable events, this describes a situation where the risk is completely unknown and where there were no observed comparable events prior to the event. These 'Black Swan' events are essentially unpredictable as they have no observable distribution and thus creating responses to them are very difficult.<sup>15</sup>
- 2. Difficulty identifying impact and likelihood.** Risk is classically about assessing the impact and likelihood of an event. However, due to lack of data the practical selection of likelihood and impact categories is often limited and done arbitrarily.
- 3. Resource intensity and the need to monitor risks.** Qualitative risk tools take a lot of resources to update and monitor and require constant updating depending on the phenomenon being measured. As a consequence, qualitative risk tools are not updated often.
- 4. The counterintuitive behaviour of some risk models.** Sometimes the realisation of a risk can in fact mean that the risk 'goes away'. For instance, the risk of civil war in Syria today is zero because it has already happened. Because risk management is supposed to be forward-looking this is an important factor and point of confusion for people doing risk analysis.
- 5. The epistemological issues of using historical data to assess risk.** Most research is based on negative drivers, but there is little data and evidence on positive drivers or 'positive interrupters' or 'resilience'. This means that the informational bias toward negative factors results in our risk models missing the positive or opportunity component of the assessment. This is what IEP's Positive Peace research agenda aims to address, please refer to the Positive Peace report.
- 6. Unclear time horizons of risk assessments.** Time horizon of risks are often poorly understood and communicated – *is it risky now, in two years' time or seven years' time?* Many risk assessment methodologies face this problem.
- 7. Narrow unit of analysis** – Contextual risk tools or early warning tools tend to have the nation state as the primary unit of analysis but sub-national risks will vary. Depending on the risk that is being monitored, the unit of analysis can be so narrow that the risk assessment does not generate any meaningful information. For instance, a risk assessment of the onset of violent demonstrations in India represented by a risk category of 'high risk' or say, 'moderate risk' would not be particularly helpful for an individual doing highly specific programmatic risk assessment in say, Mumbai.
- 8. Difficulties in providing actionable information** – Currently there are no risk tools that inform resource mobilisation, this underlines the difficulties in providing actionable information.
- 9. Behavioural economic issues,** these issues are various and are detailed in box 3.4. They generally refer to the inherent biases in human decision making which are very difficult and sometimes impossible to control for and particularly affect the ability of individuals to properly assess risk.

### BOX 3.4 WHY DO HUMANS ASSESS RISKS POORLY?

The field of behavioural economics has provided applied findings that are important for all risk managers to understand and appreciate when conducting risk management. It is well established in the behavioural economic literature how humans struggle to understand the likelihood of risk correctly. There are at least three concepts which are useful to draw attention to what undermines humans' ability to properly assess risk. These are important to understand because they underline why risk management systems exist – to help mitigate biases inherent in decision making.

Practically speaking these issues may mean we focus too much on the downside or negative risks, i.e. we remain too focused on the threats rather than the opportunities – risk is about upside potential as well. One consequence of remaining over-focused on risk aversion in risk assessment is that it closes our eyes to opportunities: our behaviour becomes more risk averse, and we can become obsessed with mitigating risks. Similarly, it may mean we overestimate unlikely events and underestimate likely events.<sup>16</sup>

Three concepts that are useful to understand are; **Hindsight bias, loss aversion and ambiguity aversion.**

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1. **Hindsight bias** – focusing on likelihood of events that have just happened.
2. **Loss aversion** is where humans typically respond differently when making decisions that may result in losing something we have, as opposed to gaining something we do not have.
3. **Ambiguity aversion** - is a preference for known risks over unknown risks.

# FUTURE RESEARCH

This report has measured the predictive capability of seven indicators and risk models for their ability to predict conflict. There are several ways the IEP measures which were the most accurate of the seven presented can be improved and better compared to other risk indicators.

The following is a list of ways in which the risk assessment presented here can be improved, it is not an exhaustive list and is provided only as a discussion for further research.

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- **Unit of analysis:** The risk models evaluated in this report all use the unit of analysis of the country-year. As such they are comparing the most peaceful and least peaceful countries together. This raises the question: is this a sensible comparison? Perhaps experimental design of the analysis to build regional risk models might in some ways make more sense. The challenge for this is that by splitting global data into subsets one immediately reduces the amount of data that can't be used for training any risk model, but it still another point of analysis.
- **Sub-national data:** Provides a better conceptual understanding of what is happening within a country. For example, national levels of inequality are useful for comparing countries with other countries but do not explain where the inequality areas are most concentrated. National surveys in part assist with putting context into the data. While they may not be the best tool for assessing the likelihood of a civil movement, they can shed light onto the structural factors and forces at play within locations within a country.
- **Systems modelling:** Attempting to model social systems as whole rather than individual indicators, and investigating clustering approaches to identify broader patterns of indicators that lead to heightened risk of conflict.
- **Using new data sources:** IEP is currently investigating using new indicators to inform its own risk models and testing more risk indicators that have not been included in this particular paper.
- **Alternatives to regression:** Regression is the primary means for assessing risk used in the literature. As the big data revolution continues, new data may emerge that allows for different types of analyses to be conducted in conflict risk. For example, coding media articles from around the globe on a daily basis. It would be interesting to decompose this data into core components and analyse the relationships between allies and enemies throughout the globe.
- **Linking risk measures to aid priorities:** If a risk/fragility model is developed, it should also come with a mapping of how to build resilience and consequently reduce risk. A full framework would result in a more easily applied tool than a simple table of scores. There is opportunity to link these findings to IEP's Positive Peace and economic research and develop models that can help policymakers and business allocate resources.



# APPENDIX A: EXPERIMENTAL DESIGN OF THE RISK MODEL COMPARISON

There are standard experimental design principles that are used when testing predictive model accuracy. Figure A.1 shows the general process for designing a prediction experiment.

The best experimental designs of a prediction model requires two sets of data, the training and the test set.<sup>1</sup> Models are built and performance optimised on the training set but the accuracy of the model should be calculated on the test set. The performance of the models on both sets are called the in-sample accuracy on the training set and the out-of-sample accuracy for the test set. Because the model is optimised on the training set, the in-sample accuracy will be better than the out-of-sample accuracy.

The purpose of this paper is to estimate the out-of-sample accuracy of existing risk models. This is done by assessing the predictions made by each model and compare the predictions to deteriorations in the Global Peace Index Internal Score. This measures the levels of domestic peacefulness within a

country. A number of decisions need to be made to define a test set. This will have implications for the size and applicability of the data used. For example, in the case of the GPI, deteriorations needs to be defined and over what time period. A second decision needs to be made as to how many countries to classify as being “at risk” from each model tested. The specific parameters used to create the test set are summarised in table A.1.

Finally, any country that was recognised as being in violent conflict at in the year of the risk assessment are removed.<sup>2</sup> This is because this paper is interested in the ability of measures to assess the predictive capacity of the future conflicts, not conflicts that were ongoing at the time of measurement.

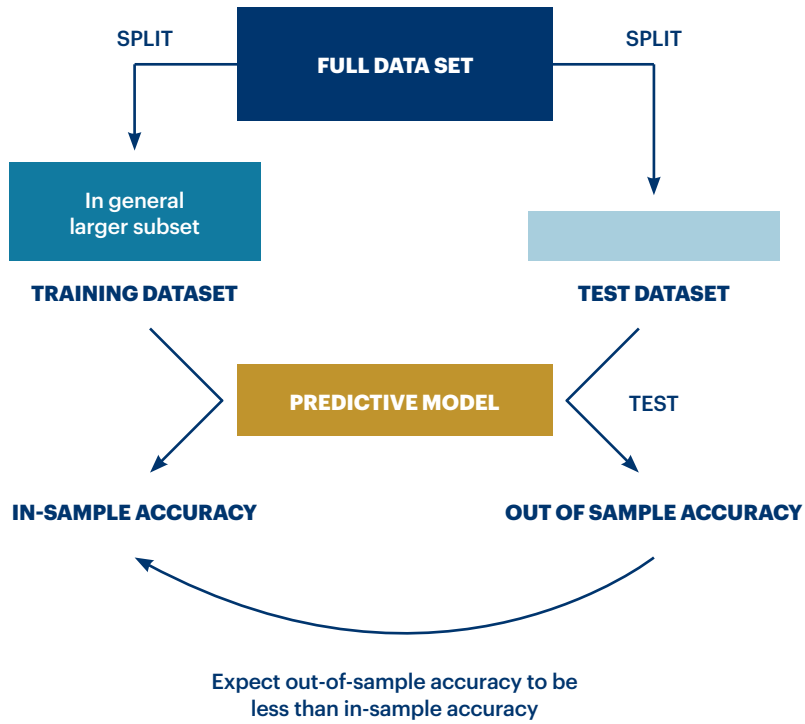
**TABLE A.1** DECISION PARAMETERS OF THE GPI TEST SET

The following parameters have been used to define the GPI Internal Score test set.

PARAMETER	THRESHOLD
Deterioration threshold	0.2
Over what time period	7 years
Number of countries to take as “at risk” in each risk model	The top twenty countries scoring the highest on each measure

**FIGURE A.1** EXPERIMENTAL DESIGN OF PREDICTIVE MODELS

Experimental design for prediction involves splitting all data into two groups. The first group can be used for building the model and is called the training set. The second set is called the test set. Accuracy can be improved by creating a model that best describes the training set but accuracy of the model should be calculated on the test set.



## APPENDIX B: GLOSSARY

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- **Capacity:** The combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals.<sup>1</sup>
- **Coping capacity:** The ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters.<sup>2</sup>
- **Disaster:** A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.<sup>3</sup>
- **Exposure:** People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses.<sup>4</sup>
- **Fragility:** The combination of exposure to risk and insufficient coping capacity of the state, system and/or communities to manage, absorb or mitigate those risks. Fragility can lead to negative outcomes including violence, the breakdown of institutions, displacement, humanitarian crises or other emergencies.<sup>5</sup>
- **Hazard:** A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental. <sup>6</sup>
- **Impact:** The effect of a shock. Immediate effects of a shock are called direct. Each direct impact can trigger further shocks within the system, resulting in indirect impacts.<sup>7</sup>
- **Resilience:** The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.<sup>8</sup>
- **Risk assessment:** A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend.<sup>9</sup>
- **Risk management:** The systematic approach and practice of managing uncertainty to minimise potential harm and loss.<sup>10</sup>
- **Risk:** The combination of the probability of an event and its negative consequences.<sup>11</sup>
- **Shock:** A risk is the combination of the probability of a negative event and its negative consequences. A shock occurs when this risk becomes a reality. For example, a country may be at risk of earthquakes because it lies on a fault line. When an earthquake actually hits, this is called a shock.<sup>12</sup>
- **Stressor:** Long-term trends, weakening the potential of a system and deepening the vulnerability of its actors, like increased pollution, deforestation, exchange rate fluctuations and electoral cycles.<sup>13</sup>
- **Vulnerability:** The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.<sup>14</sup>

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## END NOTES

### EXECUTIVE SUMMARY

1. Mack, 2010
2. Mack, 2010

### SECTION ONE - RESULTS

1. Deteriorations in peacefulness is defined as a deterioration in internal GPI score of 0.2 or more between 2008 and 2017.
2. Falling into conflict is defined as having more than 20 battle-deaths in any given year after 2008, where in 2008 there had been no battle-deaths.
3. Accenture, 2014

### SECTION 2 - METHODOLOGY – HOW IEP CALCULATES RISK

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3. Institute for Economics & Peace, 2016a
4. Institute for Economics and Peace, 2016b
5. Joint Research Center of the European Commission, 2015
6. Early Warning Project, 2015
7. Marshall & Cole, 2014
8. The Fund for Peace, 2015
9. UNDP, 2015

### SECTION 3 - DISCUSSION OF KEY CHALLENGES IN RISK

1. Chalmers, 2004
2. Institute for Economics & Peace, 2017
3. Tanner, 2000
4. Stedman, 1995
5. Stedman, 1995
6. Stanton, 2005
7. Stanton, 2005
8. Collier, 2007
9. The World Bank, 2013

10. UNOCHA, 2014
11. The World Bank, 2015
12. Goodwin, 2011
13. Smith, 2013
14. Taleb, 2011
15. Taleb, 2011

### APPENDIX A

1. Leek, 2014
2. Countries selected from the UCDP battle-related deaths database (UCDP, 2015)

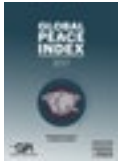
### APPENDIX B

1. UNISDR, 2009
2. UNISDR, 2009
3. UNISDR, 2009
4. UNISDR, 2009
5. OECD, 2016
6. UNISDR, 2009
7. Smith, 2013
8. UNISDR, 2009
9. UNISDR, 2009
10. UNISDR, 2009
11. UNISDR, 2009
12. OECD, 2014
13. OECD, 2014
14. UNISDR, 2009

**NOTES**

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An analysis on the trends in peace, its economic value, and how to develop peaceful societies.



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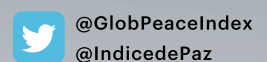
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