

# Statistics: a front line weapon in the fight against alternative facts

**David Spiegelhalter**

*Chairman of the Winton Centre for Risk & Evidence Communication,  
University of Cambridge*

*President, Royal Statistical Society*

@d\_spiegel

*Statistics Flanders 2018*

Information Science and Statistics

Robert G. Cowell · A. Philip Dawid  
Steffen L. Lauritzen · David J. Spiegelhalter

# Probabilistic Networks and Expert Systems

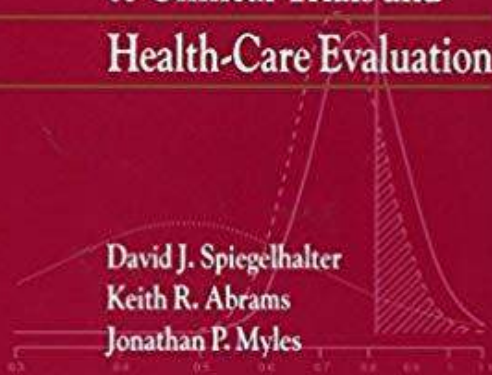
Exact Computational Methods  
for Bayesian Networks

 Springer

WILEY

# Bayesian Approaches to Clinical Trials and Health-Care Evaluation

David J. Spiegelhalter  
Keith R. Abrams  
Jonathan P. Myles



STATISTICS  
IN PRACTICE

Texts in Statistical Science

# The BUGS Book

A Practical Introduction to  
Bayesian Analysis



David Lunn  
Christopher Jackson  
Nicky Best  
Andrew Thomas  
David Spiegelhalter

 CRC Press  
Taylor & Francis Group  
A CHAPMAN & HALL BOOK



# FOUR Climate Change by Numbers

Home Clips



This programme is not currently available on BBC iPlayer

At the heart of the climate change debate is a paradox - we've never had more information about our changing climate, yet surveys show that the public are, if anything, getting less sure they understand what's... 🕒 1 hour, 15 minutes

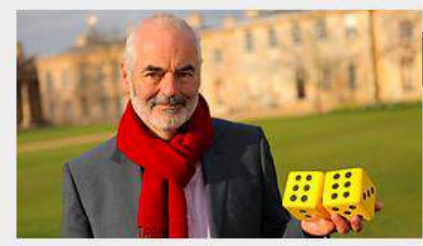
**Last on**  
BBC FOUR Thu 5 Mar 2015  
22:00  
BBC FOUR

# FOUR Tails You Win: The Science of Chance

Home Clips

**DURATION: 1 HOUR**  
Smart and witty, jam-packed with augmented-reality graphics and fascinating history, this film, presented by Professor David Spiegelhalter, tries to pin down what chance is and how it works in the real world. For...  
[> SHOW MORE](#)

78 [Share](#) [f](#) [t](#) [v](#)



**Next on**

BBC FOUR **Next Thursday**  
21:00  
BBC Four

[See all upcoming broadcasts of Tails You Win: The Science of Chance \(3\)](#)









# Summary

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- Statistics are not always used reliably
- Problems with mainstream media reporting of statistics
- Making stats communication more trustworthy
- Countering misinformation

# Statistics and contested science

---

## Anti-vaccine movement spreading ‘fake news’ online and putting children at risk, England’s top doctor warns

Vaccination uptake had reach 95 per cent in 2016 but is stuck at 91 per cent so far this year despite a Europe-wide measles outbreak

**Alex Matthews-King** Health Correspondent |

Thursday 1 November 2018 11:19 | 39 comments | [190 shares](#)



Like

Click to follow  
The Independent

### *Measles in Europe*

2016            4,240

2017            21,315

2018            64,946

Numbers are often used to persuade rather than inform

---



Making numbers look large or small





Making numbers look large or small

# 'Fake news' is not a helpful term

---



**Donald J. Trump**   
@realDonaldTrump



Congratulations to [@FoxNews](#) for being number one in inauguration ratings. They were many times higher than **FAKE NEWS @CNN** - public is smart!

2:16 AM - 25 Jan 2017



32,105



162,691





# Trust in numbers...

---

Onora O'Neill: trust should be based on...

- Competence



# 2012 PRESIDENTIAL RUN

GOP CANDIDATES



**FOX**

47'

SOURCE: OPINIONS

DYNAMIC



# Trust in numbers...

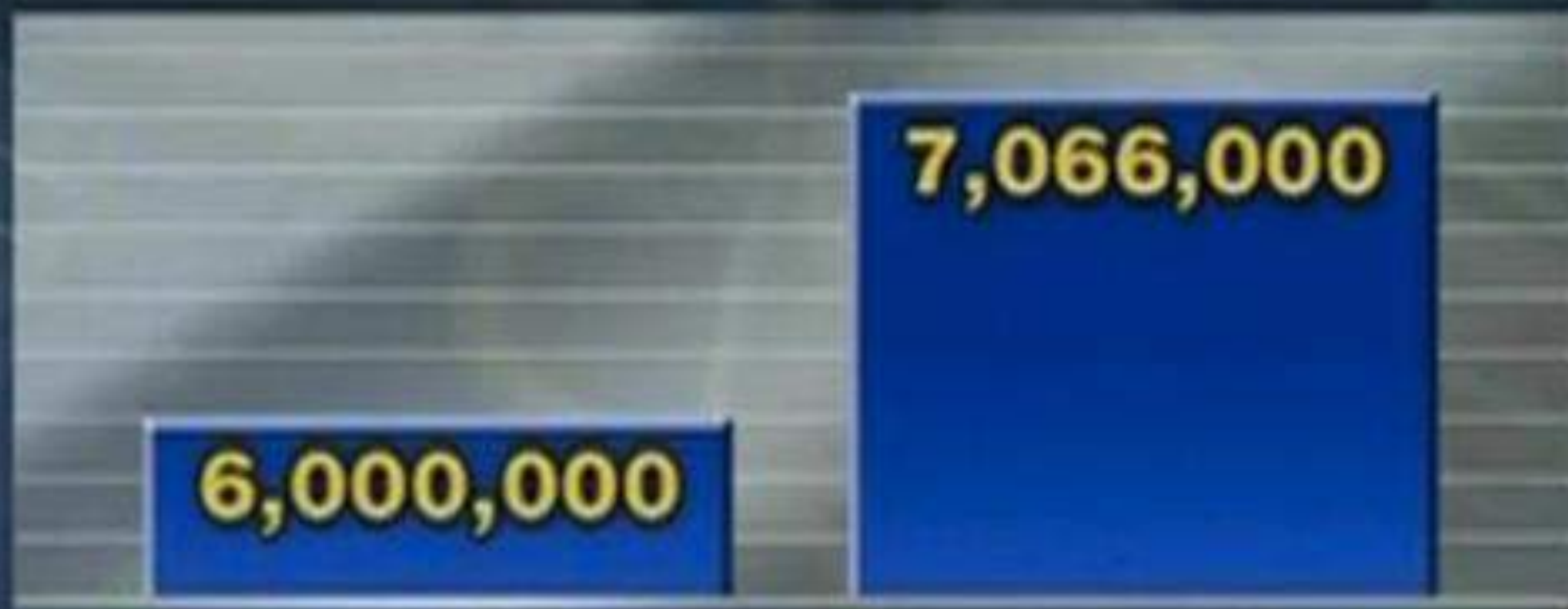
---

Onora O'Neill: trust should be based on...

- Competence
- Honesty



# OBAMACARE ENROLLMENT



AS OF  
MARCH 27

MARCH 31  
GOAL



Fox news

# OBAMACARE ENROLLMENT



SOURCE: CBO



# Trust in numbers...

---

Onora O'Neill: trust should be based on...

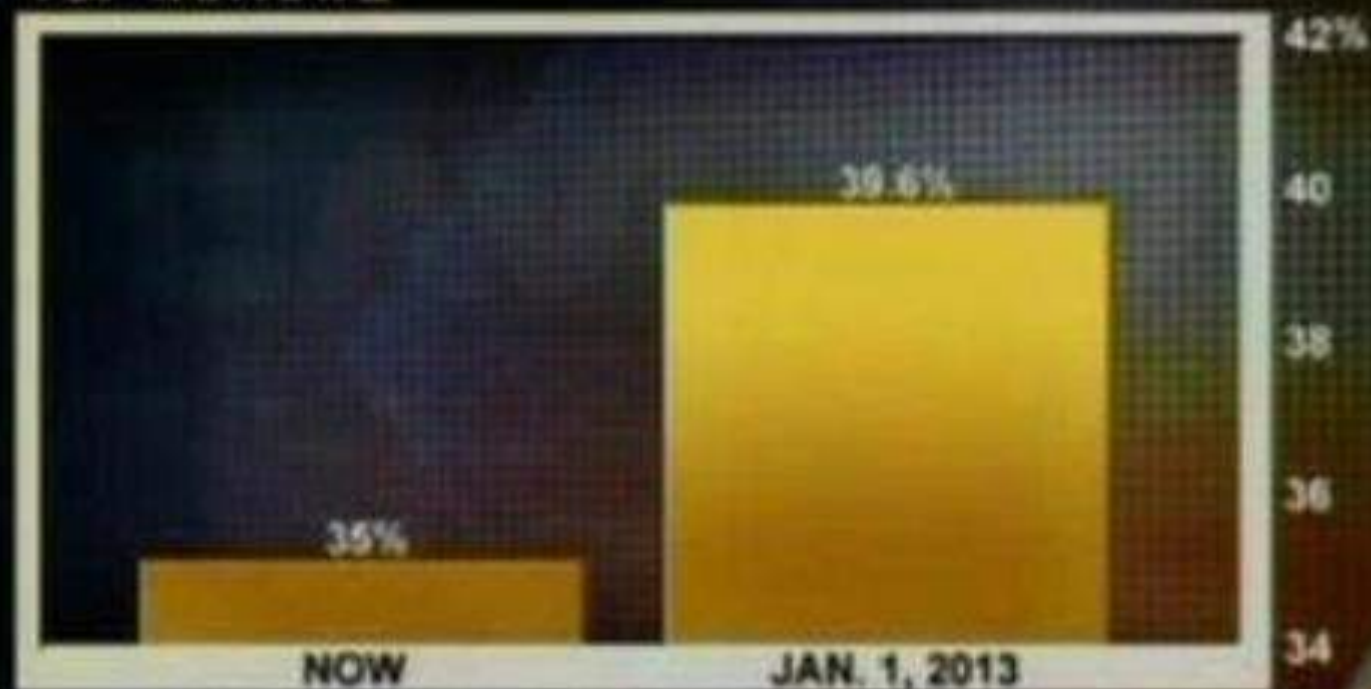
- Competence
- Honesty
- Reliability





# IF BUSH TAX CUTS EXPIRE

## TOP TAX RATE



8:01 p ET

**FOX**  
BUSINESS

TOP STORIES

TECHNOLOGY

CONSUMER

WITH THE JUSTICE DEPARTMENT AND ACQUIRES FULL T

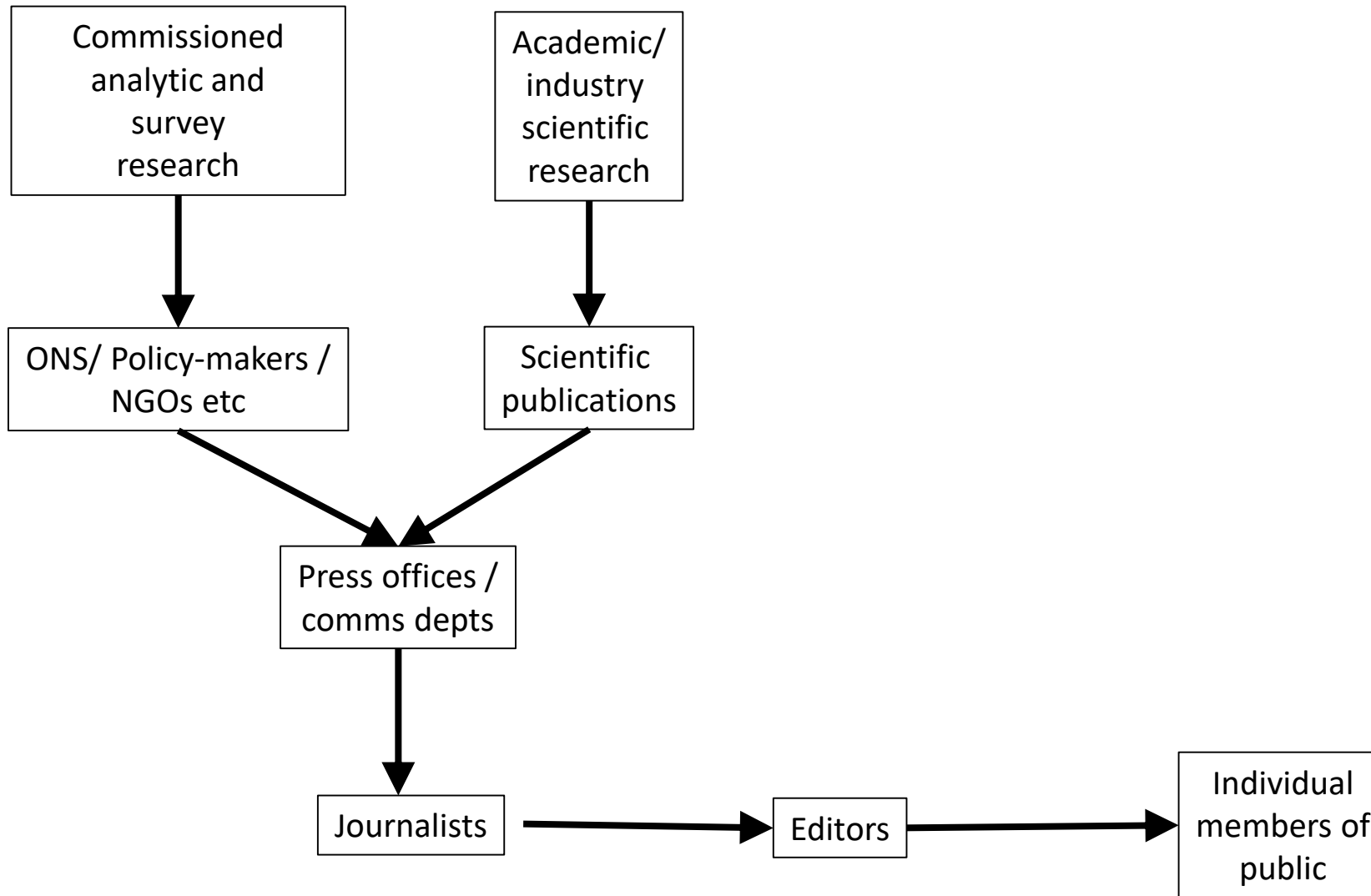
DOW 13008.68 ▼ 64.33

S&P 1379.32 ▼ 5.98

NASDAQ 2939.52 ▼ 6.32

# The pipeline of statistical evidence

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thanks to Liz Gerard



# The usual grumbles

---

- Not enough acknowledgment of the **stage** of the scientific process
- Too much notice is taken of
  - **single studies**
  - **change** from a previous period of a single statistic such as unemployment or crime
- Medical treatments have harms and benefits, and are rarely either **wonderful** or **awful**
- **Uncertainty** is ignored
- Exaggerated and **misleading headlines**

# The perils of the press release ...

---

# Socioeconomic position and the risk of brain tumour: a Swedish national population-based cohort study

Amal R Khanolkar,<sup>1,2</sup> Rickard Ljung,<sup>2</sup> Mats Talbäck,<sup>2</sup> Hannah L Brooke,<sup>2</sup> Sofia Carlsson,<sup>2</sup> Tiit Mathiesen,<sup>3</sup> Maria Feychting<sup>2</sup>

- abstract:
  - *We observed consistent associations between higher socio-economic position and higher risk of glioma*
- press release
  - *High levels of education linked to heightened brain tumour risk*
- Daily Mirror...





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Technology Money Travel Fashion

M · Science · tumour

# Why going to university increases risk of getting a brain tumour

23:30, 20 JUN 2016 BY ANDREW GREGORY

Highly educated people are more likely to suffer from brain tumours than those who do not progress as far in their education



13  
SHARES



1  
COMMENT

## Are Your Savings Enough to Retire

If you have a £250,000 portfolio, download the "15-Minute Retirement

But sometimes helpful ...

---

Bloomberg Markets: European Open

# No Amount of Alcohol Use Is Safe

Digital Originals

August 24th, 2018, 1:00 PM GMT+0100

euronews.

Europe

World

More ▾

Programmes ▾

**BREAKING  
NEWS**

Six dead in shooting in Bakersfield, California

Home > News > World > No amount of alcohol is safe for your health, study finds

WORLD

## No amount of alcohol is safe for your health, study finds

By [Alice Tidey](#) • last updated: 24/08/2018

**FREE METRO**

Just one drink a day 'can increase risk of premature death'

# Just one drink a day 'can increase risk of premature death'

BBC

David Spiegel...



News

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# NEWS

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Health

## No alcohol safe to drink, global study confirms

By [Laurel Ives](#)  
BBC Health

🕒 24 August 2018



Share



GETTY IMAGES

Just one drink a day leads to health risks



# Is there no safe level of drinking?

---

**Alcohol use and burden for 195 countries and territories, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016**

GBD 2016 Alcohol Collaborators\*

Lancet, August 2018

*“Our results show that the safest level of drinking is none.”*

# So what did they find for light drinking?

---

## ***Lancet Press release***

- *...drinking one alcoholic drink a day increases the annual risk of developing one of the 23 alcohol-related health problems by 0.5%, compared with not drinking at all*
- *... from 914 people in 100,000 non-drinkers to 918 in 100,000 for people who consume one alcoholic drink a day”*
- These **expected frequencies** are not in the paper
- The Lancet Press office had to get them from the authors
- Lancet Guidelines: *“For risk changes or effect sizes, give absolute values rather than relative changes”*

# Putting things in perspective - 1

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- This means 25,000 people, having one drink a day for a year, gives rise to one extra serious health event
- New unit? *Number Needed to Drink (NND)*



# Putting things in perspective - 2

---

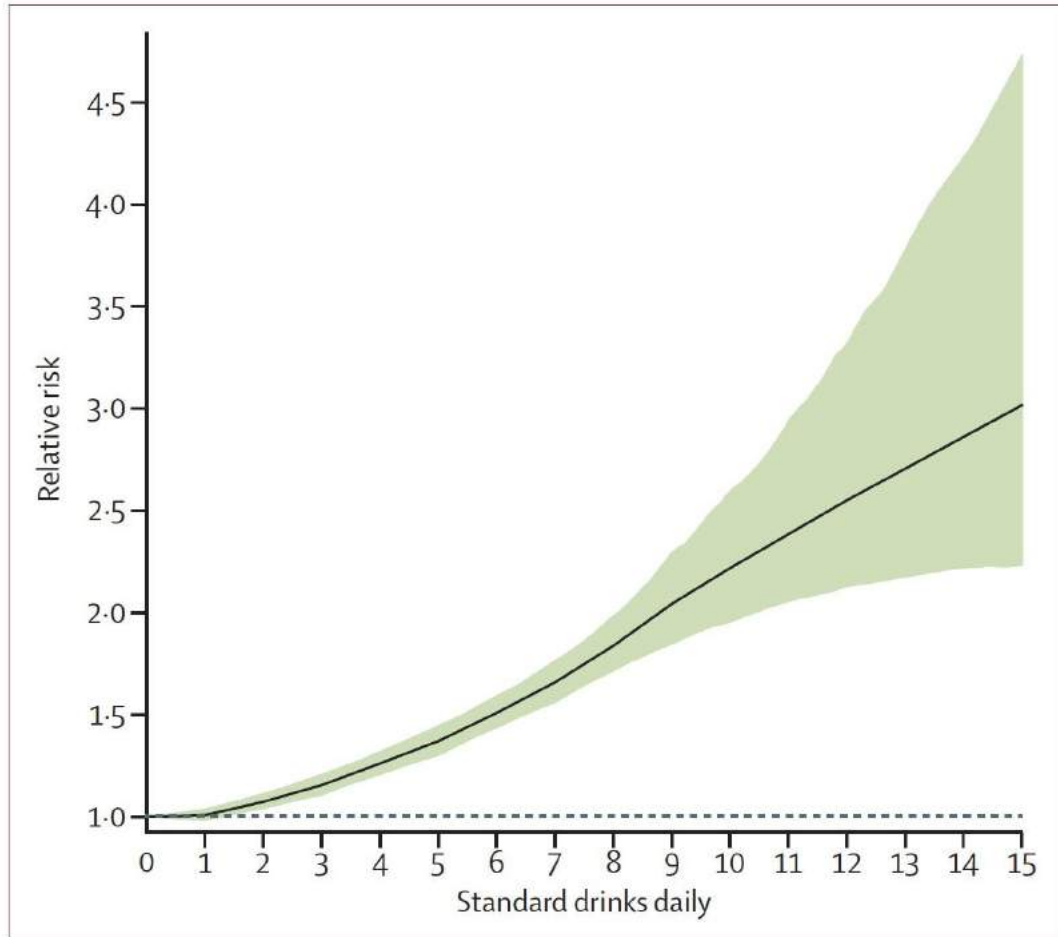
- One 10g drink a day is 3.65 kg of alcohol a year
- Equivalent to 16 x 70cl 40% ABV bottles of gin a year



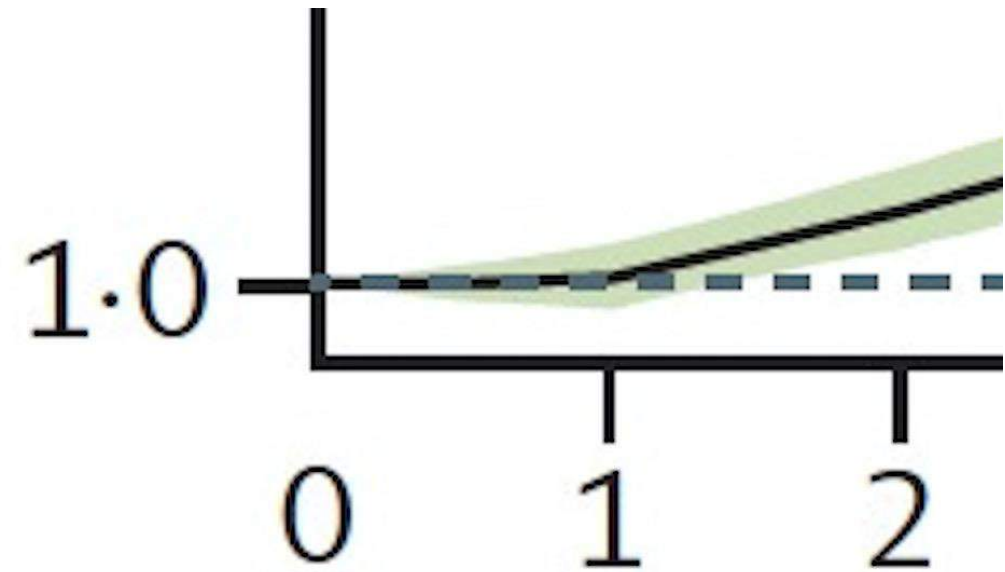
- For 25,000 people, this is *400,000 bottles of gin* to get one serious health event

# What about uncertainty?

---



**Figure 5: Weighted relative risk of alcohol for all attributable causes, by standard drinks consumed per day**  
Age-standardised weights determined by the DALY rate in 2016, for both sexes. The dotted line is a reference line for a relative risk of 1. DALY=disability-adjusted life-year.



- Not even confident there is harm at one drink
- Claim of harm is neither practically nor statistically significant

‘Expected frequencies’ are now in UK GCSE Maths syllabus:



Categories

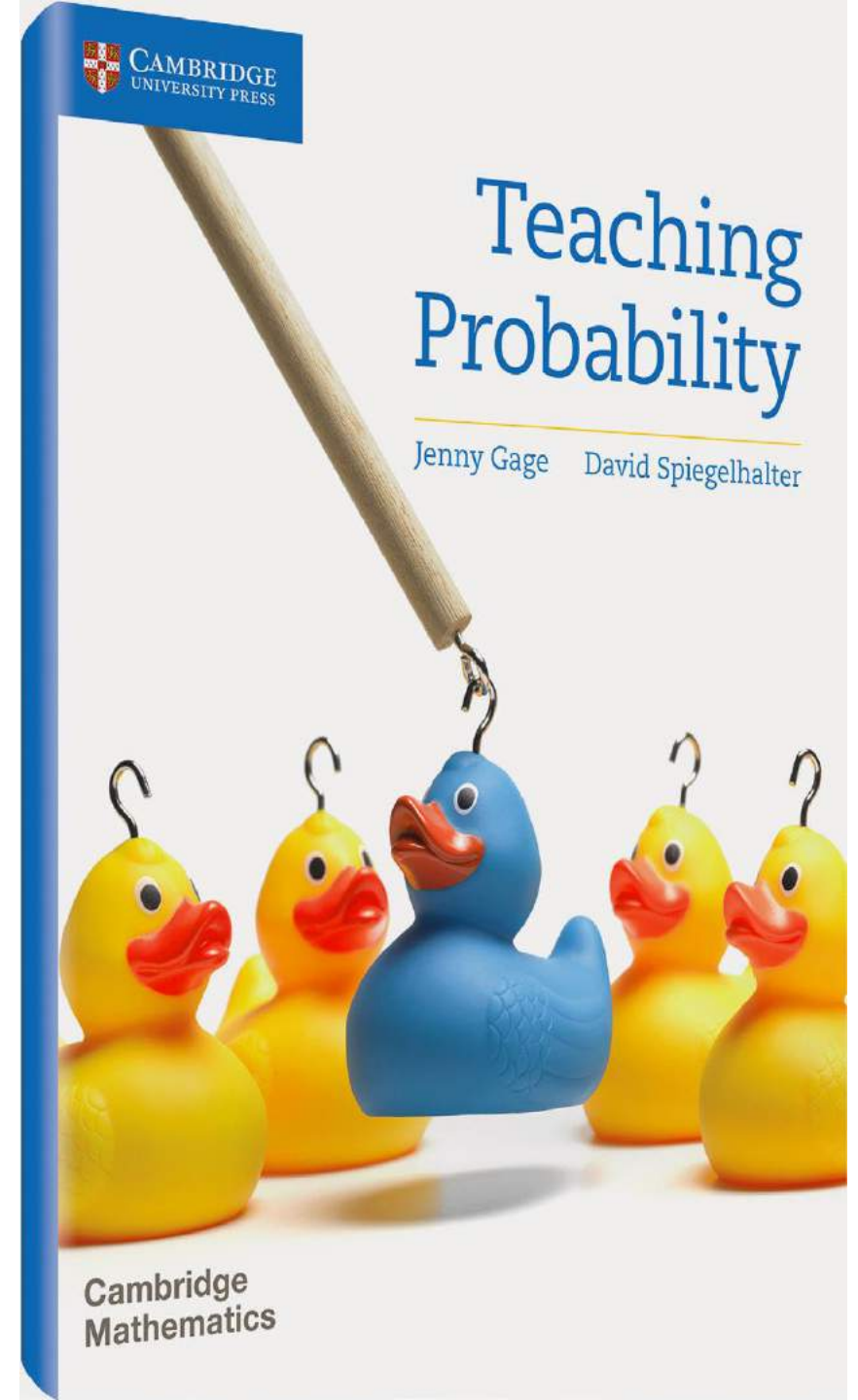
Courses

Programs

ONLINE COURSE

## Teaching Probability

Learn how to create effective lessons on probability to help equip 11 - 16 year olds with skills for life.





23<sup>rd</sup> January  
2017

# News

UK

World

Politics

General Election 2017

Science

Education

Health

Business

News

## Browned toast and crispy roast potatoes 'a potential cancer risk'



95 Comments



Acrylamide  
(again)

22<sup>nd</sup> January  
2017

# Winton Centre for Risk and Evidence Communication

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Winton Centre for Risk and Evidence  
Communication

## How dangerous is burnt toast?

News

Submitted by David Spiegelhalter on Sun, 22/01/2017 - 13:04

Events



- *“adults with the highest consumption of acrylamide could consume 160 times as much and still only be at a level that toxicologists think unlikely to cause tumours in mice”*
- that’s at least 160 slices of burnt toast a day







23<sup>rd</sup> January  
2017  
11.15

**Mail**Online

---

# **DON'T fear potatoes (or burnt toast!) Food Standards Agency back-tracks over cancer link to spuds**

- Food officials say crunchy roast potatoes and burnt toast are both 'danger foods'
- This is because they have higher levels of acrylamide - a highly toxic compound
- But a statistician said someone would need to eat 320 slices of toast to be at risk
- And the FSA's chief scientific adviser now claims there is no reason to worry

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By [STEPHEN MATTHEWS FOR MAILONLINE](#)

**PUBLISHED:** 11:15, 23 January 2017 | **UPDATED:** 15:30, 23 January 2017

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# A word about risks

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- Just because a lot of something is harmful, does not mean that a little bit is worth worrying about



- Hans Rosling: we must distinguish what is **frightening** from what is **dangerous**.



# 'Manipulative' communication

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- Often **not** the fault of journalists
- So who can we trust?

# Onora-O'Neill again..

---

- Organisations should not be aiming to 'increase trust'
- Rather, aim to demonstrate *trustworthiness*
- Need *intelligent openness* about information
  - *accessible*
  - *intelligible*
  - *useable*
  - *assessable*



# Code of Practice for Statistics

Ensuring official statistics serve the public



Edition 2.0  
February 2018

## The pillars and principles of the Code of Practice for Statistics

---

### Trustworthiness

*Confidence in the people and organisations that produce statistics and data*

#### T1 Honesty and integrity

People in organisations that release statistics should be truthful, impartial and independent, and meet consistent standards of behaviour that reflect the wider public good.

#### T2 Independent decision making and leadership

Organisations should assign a Chief Statistician/Head of Profession for Statistics who upholds and advocates the standards of the Code, strives to improve statistics and data for the public good, and challenges their inappropriate use.

#### T3 Orderly release

Organisations should commit to releasing their statistics in an open and transparent manner that promotes confidence.

#### T4 Transparent processes and management

Organisations should have effective business processes and appropriate resources to support their statistical functions and be open about their plans, priorities and progress.

#### T5 Professional capability

People producing statistics should be appropriately skilled, trained and supported in their roles and professional development.

#### T6 Data governance

Organisations should look after people's information securely and manage data in ways that are consistent with relevant legislation and serve the public good.



# Part of demonstrating trustworthiness..

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- is admitting uncertainty
- But can we communicate uncertainty about facts, numbers and science, without losing trust and credibility?

# Uncertainty about statistics

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[Business](#) [Your Money](#) [Market Data](#) [Markets](#) [Companies](#) [Economy](#)

## UK unemployment falls to 1.44 million

© 24 January 2018 | 1350

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**UK unemployment fell by 3,000 to 1.44 million in the three months to November, official figures show.**

The number of those in work increased sharply and wages rose at their fastest rate in almost a year, the Office for National Statistics said.

# Uncertainty about statistics

Home UK World Business Politics Tech Science Health Family & Education

Business Your Money Market Data Markets Companies Economy

## UK unemployment falls to 1.44 million

© 24 January 2018 1350

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UK unemployment fell by 3,000 to 1.44 million in the three months to November, official figures show.

The number of people in work increased sharply in almost a year, and wages rose at their fastest rate since 2012, the Office for National Statistics said.



# Uncertainty about statistics

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**Business** Your Money Market Data Markets Companies Economy

Office for National Statistics

Release calendar Meth

Home Business, industry and trade Economy Employment and labour market People, population and communities

Search for a keyword(s) or time series ID

Home > Employment and labour market > People in work > Employment and employee types > UK labour market

Statistical bulletin:  
**UK labour market: January 2018**  
Estimates of employment, unemployment, economic inactivity and other employment-related statistics for the UK.

UK unemployment falls to 1.44 million

© 24 January 2018 | 1350



UK unemployment fell by 3,000 to 1.44 million in the three months to November. Official figures show.

The number of people in work increased sharply in almost a year. Wages rose at their fastest rate in almost a year, said.

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## UK unemployment falls 1

© 24 January 2018 | 1350



UK unemployment fell by 3,000 to 1.44 million in November, official figures show.

The number of people in work increased sharply in November, and wages rose at their fastest rate in almost a year, the Office for National Statistics said.

## Table of contents

1. Main points for September to November 2017
2. Summary of latest labour market statistics
3. Things you need to know about this release
4. Employment
5. Public and private sector employment (first published on 13 December 2017)
6. Actual hours worked
7. Workforce jobs (first published on 13 December 2017)
8. Average weekly earnings
9. Labour disputes (not seasonally adjusted)
10. Unemployment
11. Economic inactivity
12. Young people in the labour market
13. Redundancies
14. Vacancies
15. Future publication dates
16. Links to related statistics
17. Quality and methodology

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## UK unemployment falls to 1.44 million

© 24 January 2018 | 1350



UK unemployment fell by 3,000 to 1.44 million in November, official figures show.

The number of people in work increased sharply in almost a year, and wages rose at their fastest rate since 2012, the government said.

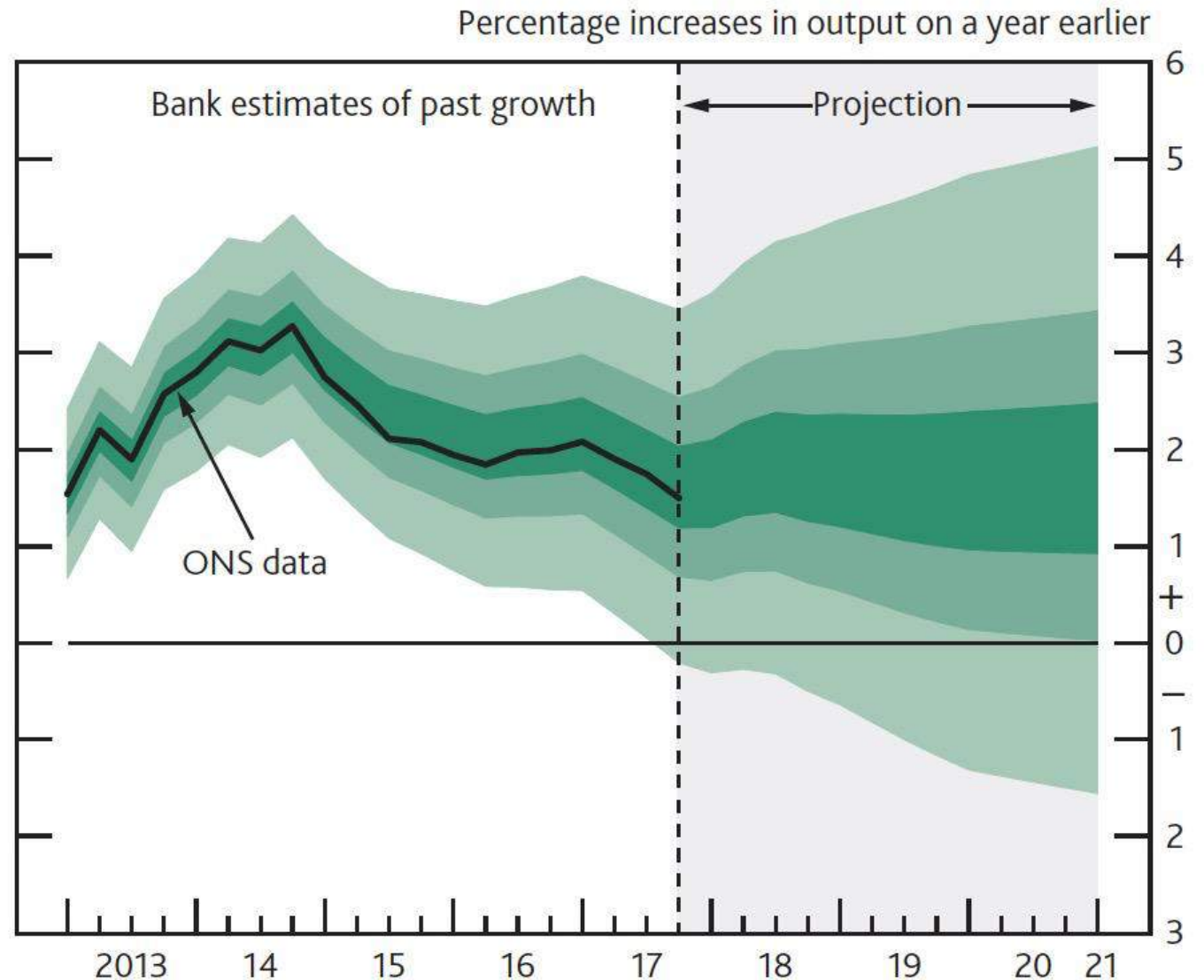
As well as calculating precision measures around the numbers and rates obtained from the survey, we can also calculate them for changes in the numbers. For example, for September to November 2017, the estimated change in the number of unemployed people since June to August 2017 was a small fall of 3,000, with a 95% confidence interval of plus or minus 77,000. This means that we are 95% confident the actual change in unemployment was somewhere between an increase of 74,000 and a fall of 80,000, with the best estimate being a small fall of 3,000. As the estimated fall in unemployment of 3,000 is smaller than 77,000, the estimated fall in unemployment is said to be “not statistically significant”.



# February 2018 Inflation report

- ONS do not provide 'error' on GDP

## GDP projection (wide bands)(a)(b)

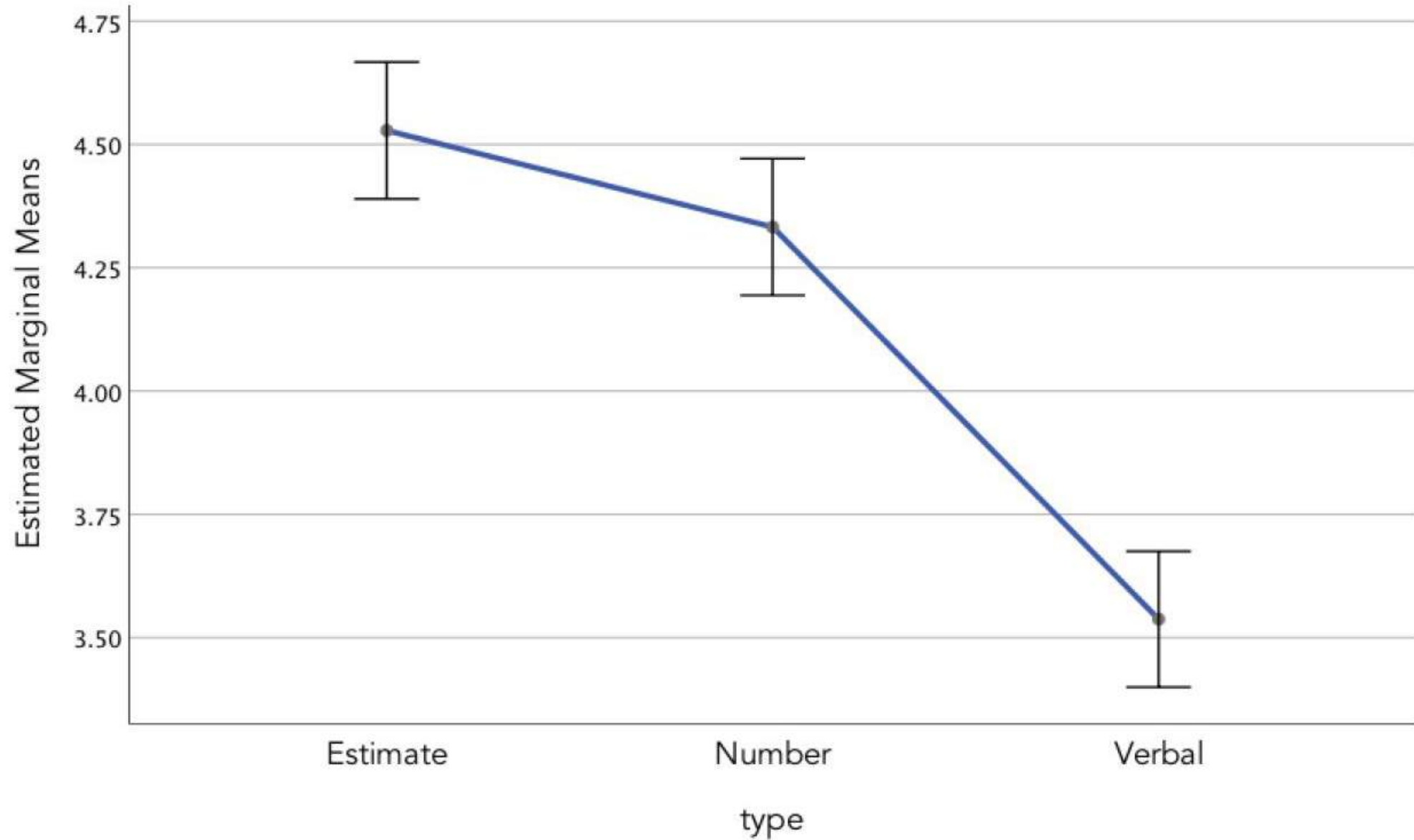


# Randomised trial of communicating uncertainty about numbers

---

- **Topics:**
  - Number unemployed,
  - Tigers in India,
  - Global temperature change
- **Format:**
  - Estimate
  - Range
  - Verbal qualifier,
- **Trust/credibility:** in number and source
- **Design:** Online panel, between-person, 1126 participants

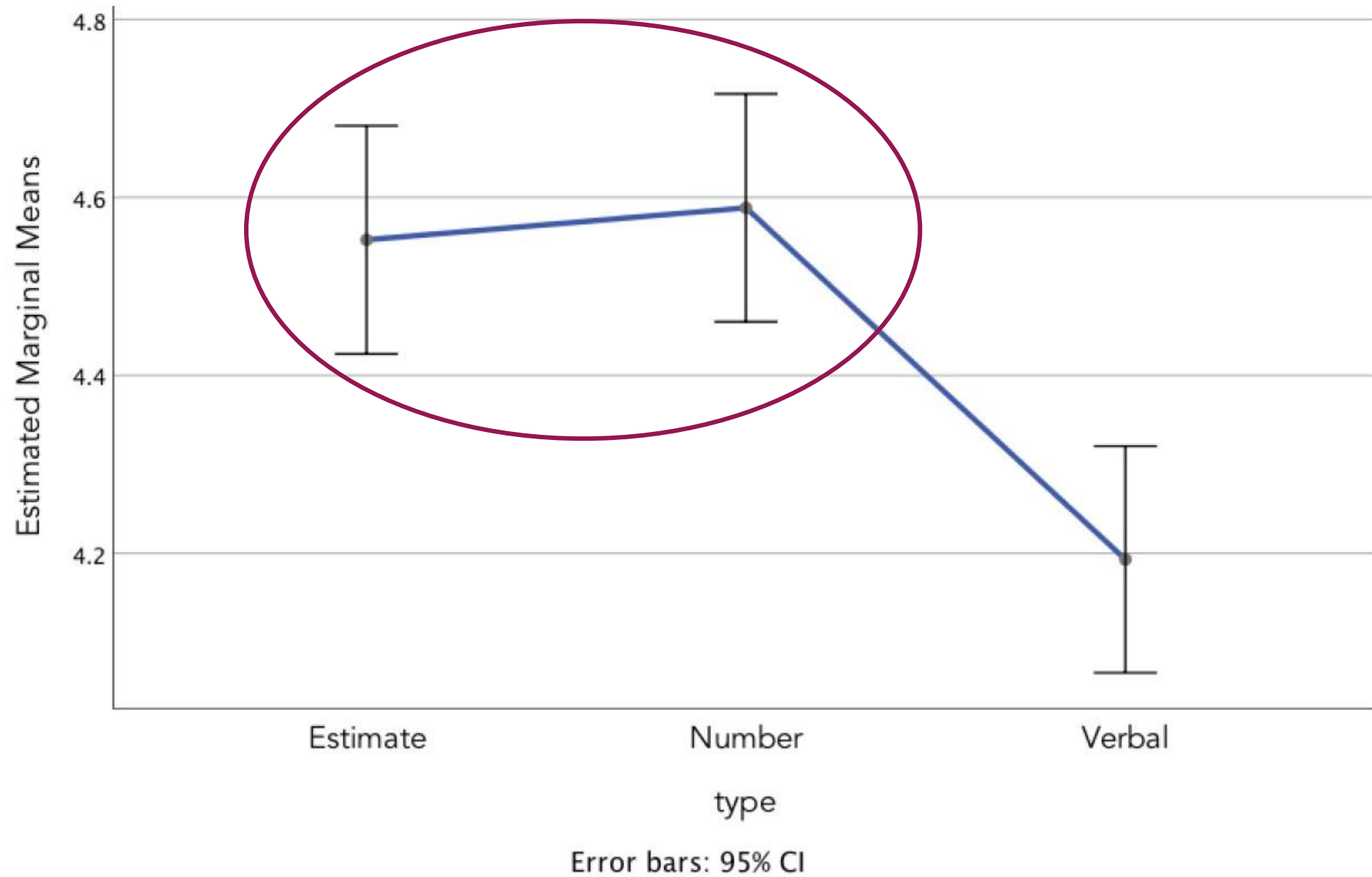
To what extent do you think this number is trustworthy?



Error bars: 95% CI



To what extent do you think the writers of the report are trustworthy?



# Migration statistics are highly political, but uncertain

---

Statistical bulletin:

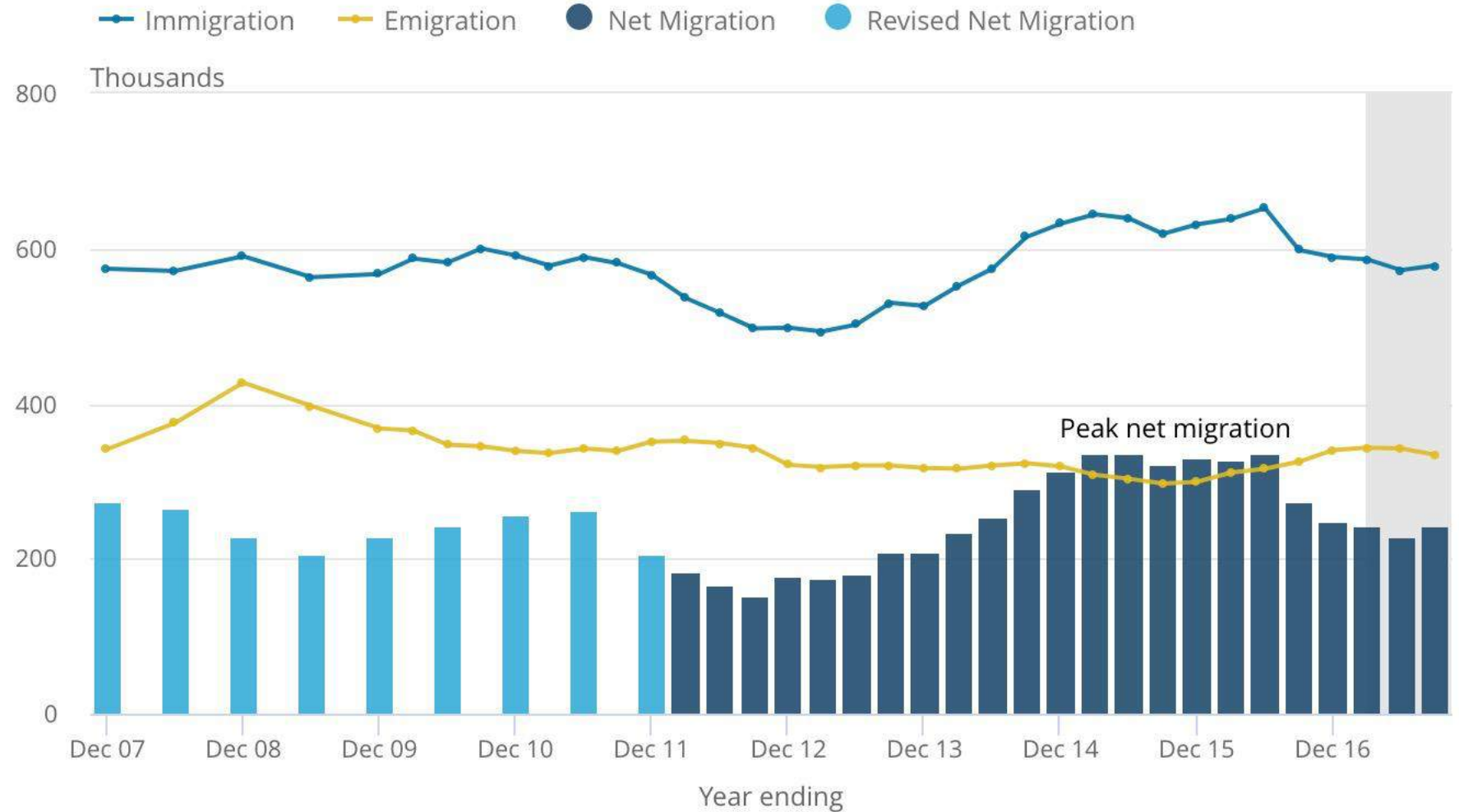
Migration Statistics Quarterly Report: July 2018  
(rescheduled from May 2018)

*Our best assessment shows around 280,000 more people coming to the UK than leaving in 2017*

# February 2018 report

## Figure 1: Long-Term International Migration

UK, 2007 to 2017 (year ending September 2017)

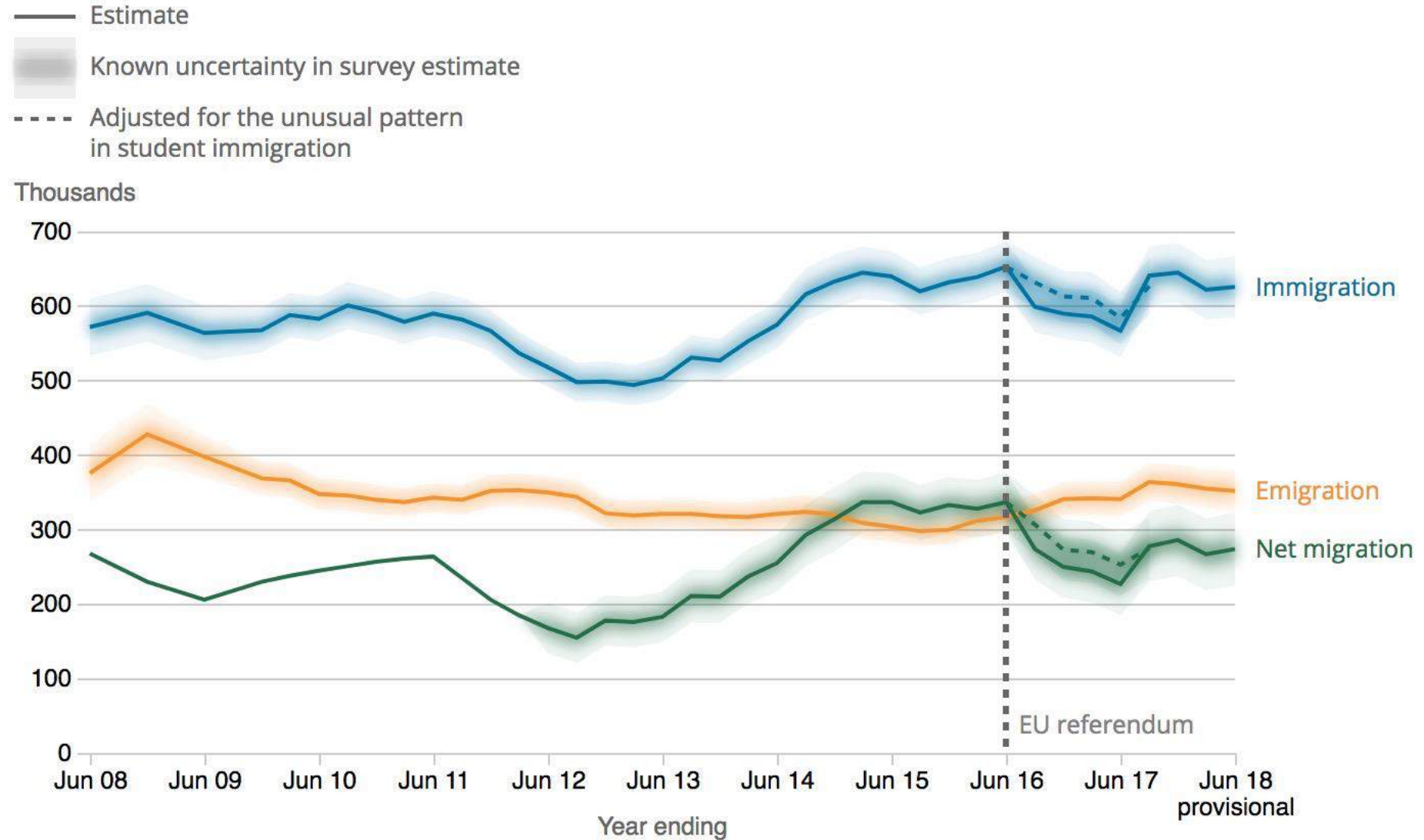


Source: Long-Term International Migration, Office for National Statistics



UK migration report  
November 2018

Figure 1: Long-Term International Migration, UK, year ending June 2008 to year ending June 2018



Source: Long-Term International Migration, Office for National Statistics

Only visualises  
sampling error

Quality issues as  
verbal caveats

# Communicating quality, uncertainty and change

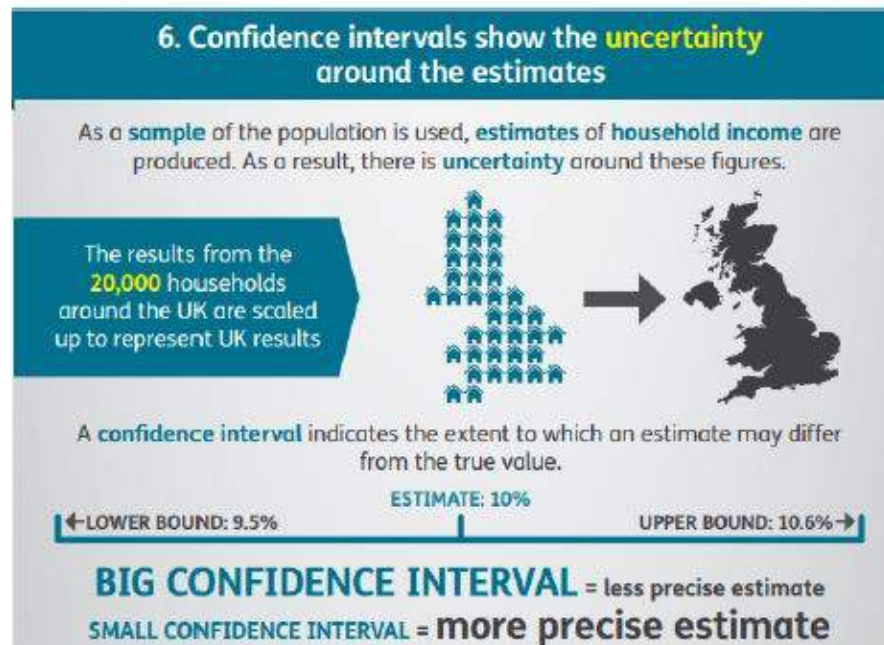
Guidance for producers of official statistics

Second Edition  
Version 2.0  
December 2018



# Data visualisation

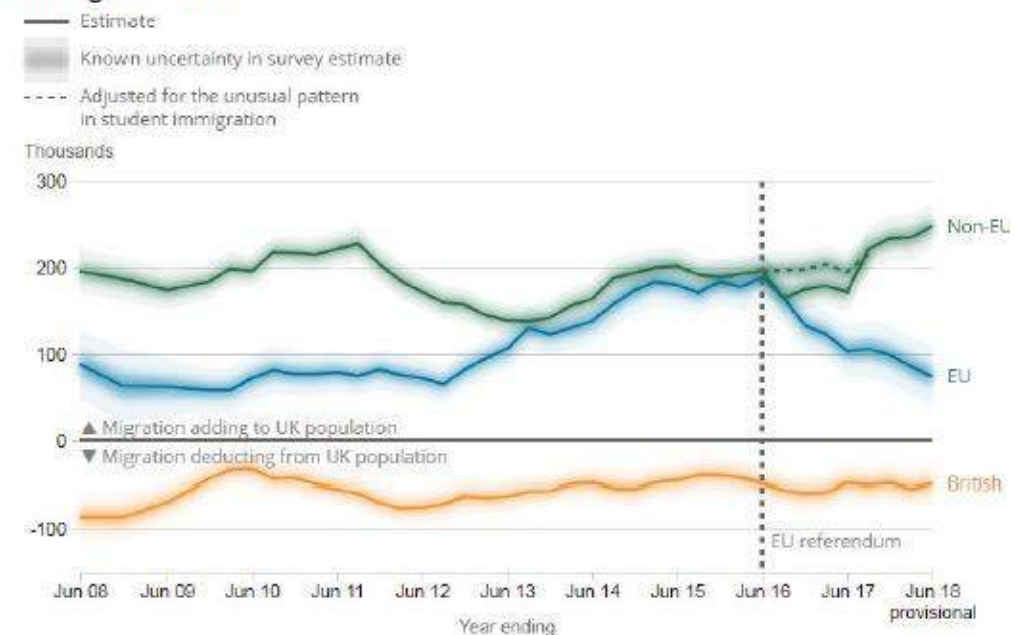
The example below from the Department of Work and Pensions is a section from an infographic explaining how confidence intervals help to show uncertainty. Non technical users (“Inquiring Citizens”) find visualisations like this useful to help them better understand technical concepts such as confidence intervals.



Department for Work and Pensions Infographic: How low income is measured in households below average income, June 2015 [24]

The second example below is a graph of changes in net migration by citizenship in the UK which also illustrates the uncertainty in the survey estimates. Notice also how annotations are used within the graph to help with the interpretation of the data series e.g. flagging when migration is and is not adding to the UK population.

**Figure 2: Net migration by citizenship, UK, year ending June 2008 to year ending June 2018**



Source: Long-Term International Migration, Office for National Statistics

Office for National Statistics: Migration Statistics Quarterly Report: November 2018 [25]



# Trustworthy communication of statistics

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- **Intelligent openness:** *accessible, intelligible, useable, assessable*
- **Be confident about uncertainty**
- **Listen to audiences,** and test all outputs
- **Vigorously pre-empt misunderstandings**
- **'Star-ratings'** for underlying quality of evidence?
- **Work closely** with communication professionals and journalists

# Countering misinformation / anti-science

---

- Not a simple or new problem
- Not just a matter of ‘putting people right’  
(although backfire effect has been exaggerated)
- Some will be unreachable
- Pre-emptive ‘innoculation’
- ‘Experts’ need to demonstrate trustworthiness
- Educate to ‘call out’

# Training people to question claims

---

# THE LANCET

Published: 21 May 2017

## Effects of the Informed Health Choices primary school intervention on the ability of children in Uganda to assess the reliability of claims about treatment effects: a cluster-randomised controlled trial

*Allen Nsangi, Daniel Semakula, Andrew D Oxman, Astrid Austvoll-Dahlgren, Matt Oxman, Sarah Rosenbaum, Angela Morelli, Claire Glenton, Simon Lewin, Margaret Kaseje, Iain Chalmers, Atle Fretheim, Yunpeng Ding, Nelson K Sewankambo*



# This researcher may have discovered the antidote to health bullshit

A big, new experiment shows it's possible to train kids to detect dubious health claims.

Updated by Julia Belluz and Alvin Chang | May 22, 2017, 8:23am EDT



TWEET



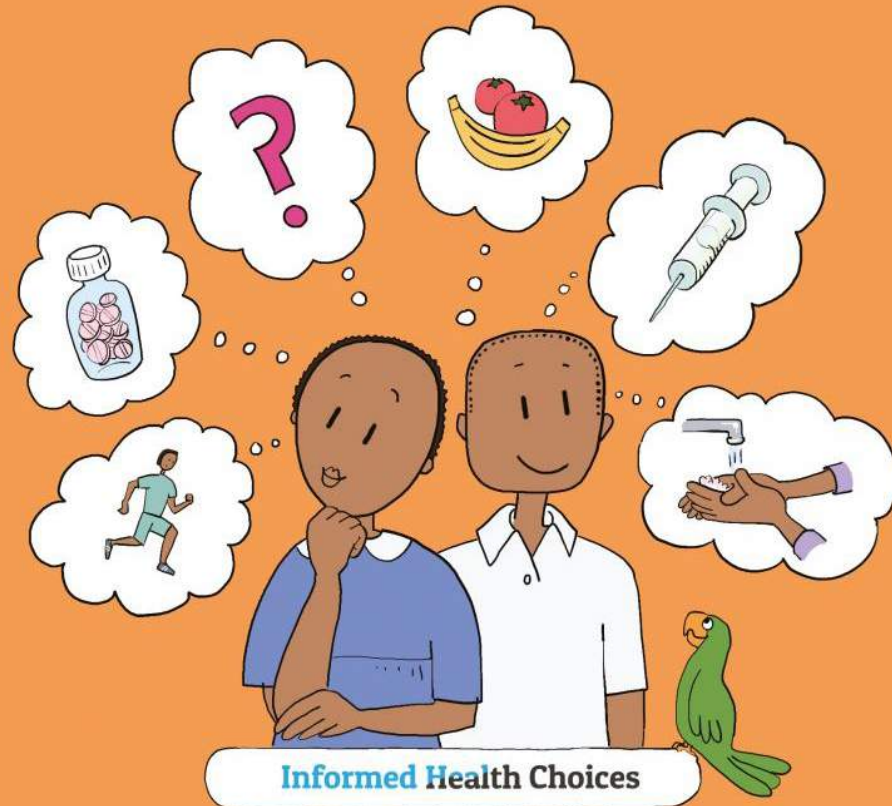
SHARE



A health science book for primary school children

# The Health Choices Book:

Learning to think carefully  
about treatments



**Informed Health Choices**





## You Can Handle The Truth

Students in Uganda are the guinea pigs for a new scientific discipline – researchers are teaching them to be the first firewall against alternative facts.

Available now

🕒 53 minutes

Academics from Uganda and Norway worked with 10,000...

# Statisticians going from **introvert** to **extravert**

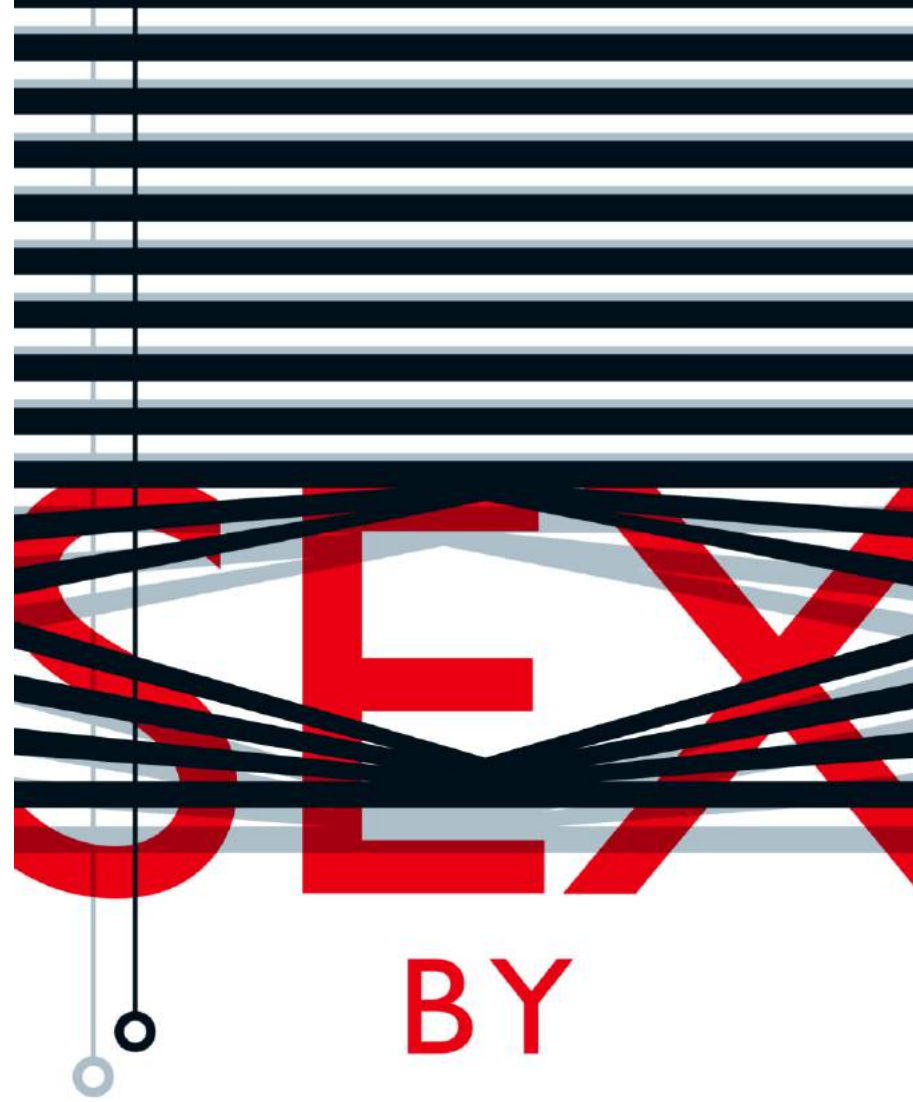
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- Need more 'outgoing' statisticians taking an active role in public life and media
- Some statistics agencies trying to make this transition
- ONS Digital, named '*Statistician's comment*'
- Royal Statistical Society now has 30 'statistical ambassadors'



# When communication goes wrong..

---



BY

NUMBERS

The Statistics of Sexual Behaviour

DAVID SPIEGELHALTER



David Spiegelhalter

# sex

by numbers



# How often do (opposite sex) couples report having sex?

---

**Median (middle) number of occasions of sex in the past 4 weeks (people aged 16-44)**

Natsal-1

2

5

9

Natsal-2

2

4

9

Natsal-3

1

3

7

The bars represent the interquartile range: 50% of the population were in this range, 25% were below the lower value, and 25% were above the higher value.

1990

2000

2010



# Britons having sex less often

National Survey of Sexual Attitudes and Lifestyles finds frequency of sex has fallen by 20% since last survey in 2000



When I said all this in a talk....

---

🏠 > Science

# Britons are having less sex, and Game of Thrones could be to blame, warns Cambridge professor

David Spiegelhalter, the Winton Professor of the Public Understanding of Risk, said the trend in declining sex rates over the last 30 years was 'very worrying.'

In 1990 couples had sex around five times a month, but now it is just three times, a 40 per cent decrease in just 20 years. If current trends continue couples would not be having sex at all by 2030.





ADVERTISEMENT

CULTURE

# IS 'GAME OF THRONES' RUINING OUR SEX LIVES?

BY TUFAYEL AHMED ON 6/6/16 AT 1:42 PM





FOOD & DRINK

Dublin food and drink scene >

# DublinLive



BUCKET LIST

The Dublin Bucket List >

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Traffic & Travel

Property

Fun Stuff

Lifestyle

TRENDING

CRIME

LUAS

THINGS TO DO DUBLIN

Soccer

GAA

Music and Nightlife

Things to Do

D » News » Dublin News » Television

## Couples 'will stop having sex by 2030' due to the large rise in TV ratings

11:55, 6 JUN 2016

BY JOHN PATRICK-KIERANS





Get Results.

Get Women's Health



Women's Health

SEX & LOVE

SLIM SEXY YOGA

IN THE MAG

SHOP

SUBSC

# Sex Will Be Obsolete by 2030 Because of Netflix, According to One Lone Scientist

Apparently, the future holds no chill.

BY KORIN MILLER, June 7, 2016





**EXKLUSIV:**  
**Privatpatienten zahlen die Zeche**  
Wer noch privat versichert ist, sollte prüfen, ob... **mehr**

Von wegen heiß

02. Juni 2016 15:59 Uhr

## Warum wir wegen "Game of Thrones" alle weniger Sex haben

Wo man auch hinschaut, findet man heute Sex, nur in den Schlafzimmern wird er immer weniger. Ein Statistikprofessor gibt daran nun ausgerechnet der heißen Serie "Game of Thrones" die Schuld.



Drucken





Benessere

## Il sesso sparirà, nel 2030 tutti in bianco

Lo dice la scienza e la colpa è tutta della tecnologia, lo studio arriva da Cambridge



Dai mitici [anni settanta](#) tutti sesso, droga e rock and roll a un futuro senza sesso, una generazione triste quella futura. E le dinamiche di coppia e i giochi di potere e il toy boy e il vecchio con la Lolita? Sarà un mondo allo sfascio quello futuro, senza punti di riferimento, senza trasgressioni, senza tradimenti e fughe d'amore, perché [il sesso aiuta a vivere](#).

L'allarme arriva dall'Univeristà Cambridge dove un esperto di statistica il professor **David Spiegelhalter**, ha realizzato che gli inglesi fanno sesso il 40% in meno rispetto a quanto ne facevano 20 anni fa. Secondo



CFA Institute

A Difference That M

JUN 6, 2016 @ 11:50 PM

4,516 VIEWS

# Is 'Game Of Thrones' Killing Your Sex Life?



**JV Chamary**, CONTRIBUTOR

*I cover the science of life.* [FULL BIO](#) ▾

Number of times the average person had sex in the past 4 weeks

