Technological Disruption in Markets with Friction

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Road map

1. Preliminaries
2. Frictions
3. Technology
4. Robots, AI and their industrial penetration
5. Job destruction in the age of robots and AI
6. Job creation in the age of robots and AI
7. Worker transitions and government policies

1. Preliminaries

Markets in economics

- Traditional economic theory of markets derives prices and quantities by equating supply and demand – each derived from maximizing behaviour of agents (producers, consumers, workers, sellers and so on)
- But several things don’t add up when you take this framework literally

Markets with frictions

- Take the labour market
  - Why do people change jobs so frequently?
  - Why do firms grow, shrink, move in and out so frequently and at such differential rates from each other
  - Why is there unemployment?
- To explain these and many other facts we need to break the conventional Supply = Demand equality by introducing “frictions” – obstacles, or barriers, to the clearing of markets.

Technological disruption

- Technological disruption is defined as the case when a new technology taken on by someone in the market (usually a new entrant, like Apple, Google, or in the old days Ford and thousands others) “disrupts” established production processes and existing players have to adapt or perish
- Look at Apple and Nokia for example. Nokia was a market leader in 2007. It has now gone

Why disruption?

- Technology does not disrupt the conventional market of textbook economics
- It shifts the supply curve and that's it
- But if there is friction, e.g., imperfect information, response lags etc., new technology disrupts – could bankrupt an incumbent leader

2. Frictions

What are frictions in labour markets?

- Initially economists emphasized imperfect information about the location of jobs, so they focused on spatial job search
- But information about location is probably not important – the internet has not made much difference to the outcomes of frictions (e.g., coexistence of vacancies and unemployment)

Matching frictions

- More important are **matching** frictions – is the worker good for the job, is the job good for the worker, can the match improve, are there better matches elsewhere?
- Matching frictions are linked to information – where are the best jobs located? But they are more broad: I might know that there is a good job at UCL but would they take me? Maybe they want a micro-econometrician?
- The internet might provide the location information. Training might be required to overcome the matching frictions. There may be niche tailor-made jobs elsewhere?

A short digression: Modelling breakthrough

- How do you put these ideas into an equilibrium model of the economy?
- Borrow ideas from production theory! Firms spend time and resources to find good workers, workers spend time and resources to find a good job. Eventually good matches take place

Formalisation: the matching function

- Think of a short period of time, e.g., a week. Let *u* be the resources spend by workers during the week looking for a good match, *v* the resources spent by firms and *m* the productive matches agreed during the week (all in the economy as a whole)

- There is a well behaved function, with properties like a production function, that satisfies

$$m = m(u,v)$$

Called the **aggregate matching function**. It increases in both *u* and *v.* It has constant returns to scale.

The Beveridge curve

- The matching function underlies the famous Beveridge curve.
- Approximate *u* with unemployment and *v* with vacancies
- Each week many jobs close down (are destroyed) because new technology makes them obsolete and for other reasons
- Let *s* be the fraction of jobs that break up each week (about 15% a quarter)

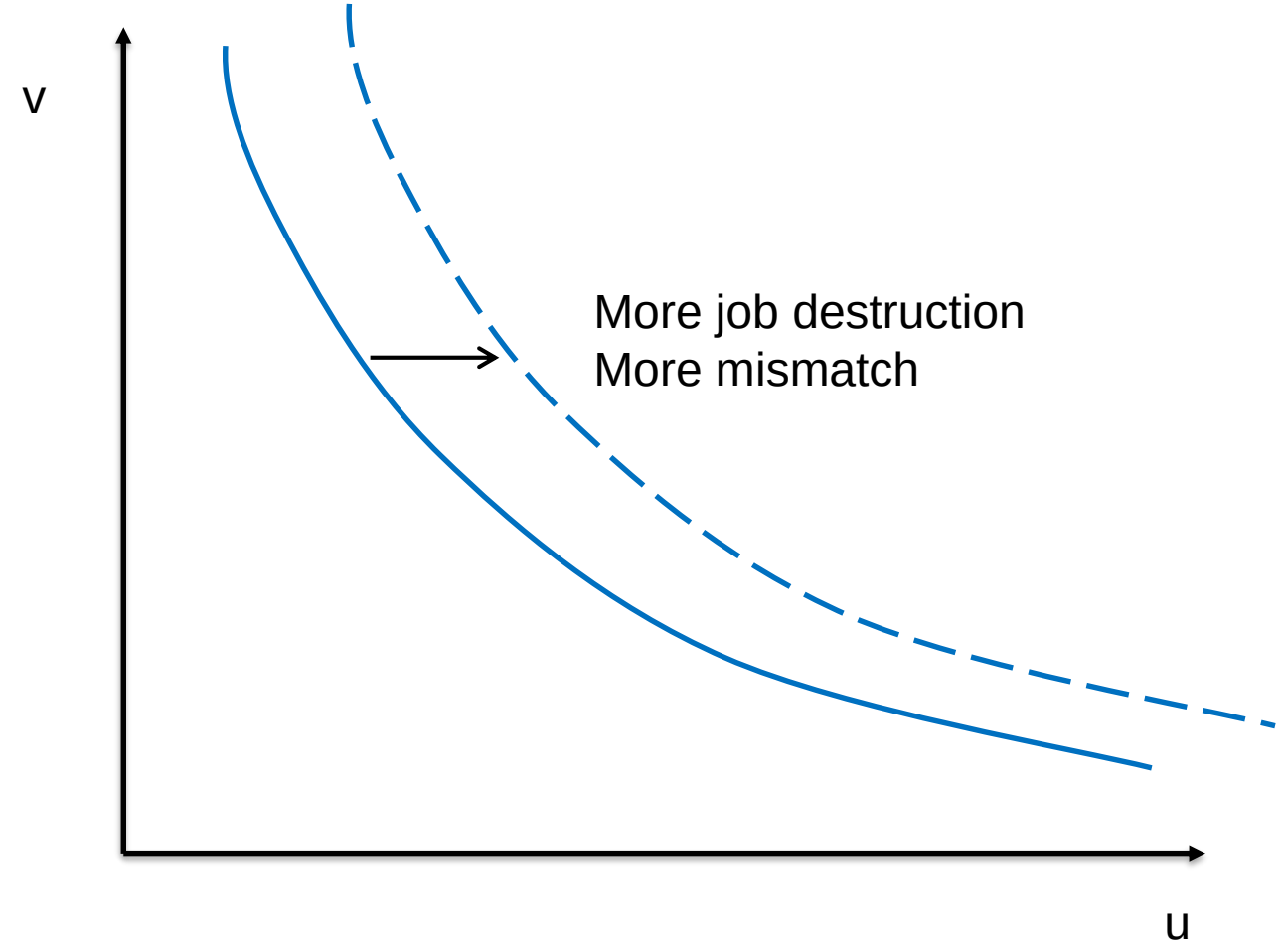
Equilibrium in the labour market

- The Beveridge curve gives the dynamic equilibrium in the labour market where the number of jobs created is equal to the number of jobs destroyed

$$m(u,v) = s(1-u)$$

1-*u* is the rate of employment

- Less well matched new jobs and workers shift *m* down; more technological shocks raise *s.*



The Beveridge Curve

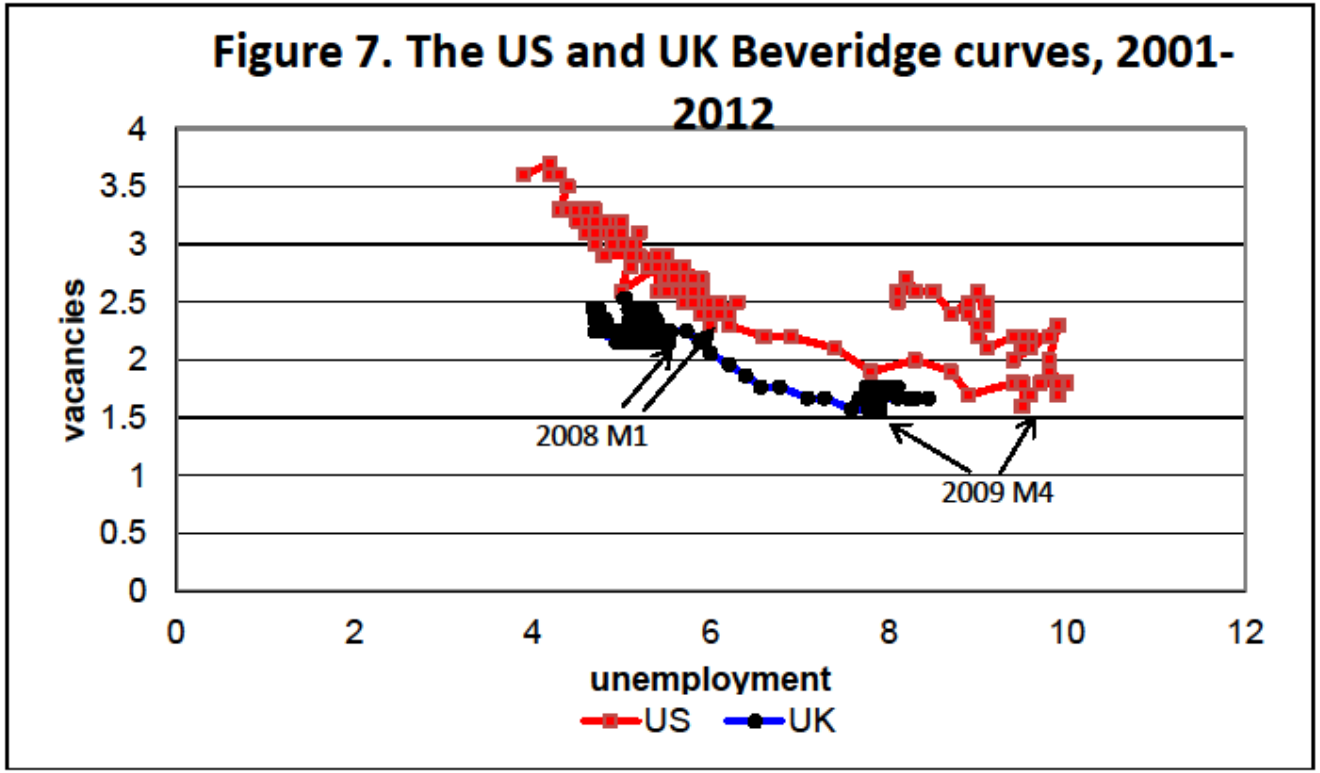


Figure 7. The US and UK Beveridge curves, 2001-2012
vacancies
4
3.5
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
10
12
unemployment
2008 M1
2009 M4
US
UK

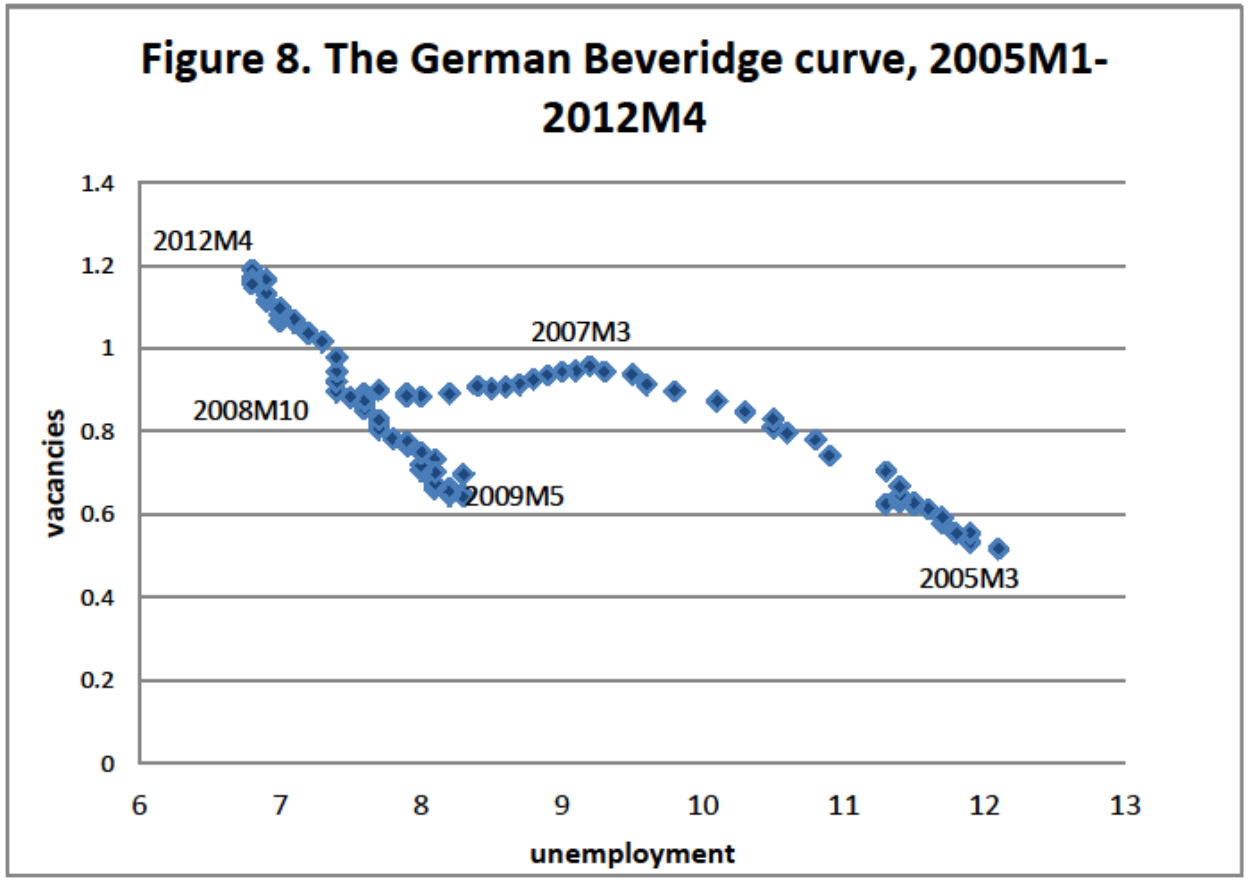


Figure 8. The German Beveridge curve, 2005M1-2012M4
1.4
1.2
1
0.8
0.6
0.4
0.2
0
vacancies
2012M4
2007M3
2008M10
2009M5
2005M3
6
7
8
9
10
11
12
13
unemployment

3. Technology

Technological disruption

- New technology destroys jobs that become obsolete, in the sense that new more productive techniques make them unprofitable
- But new jobs are created either directly by firms adopting the new technologies or elsewhere in the economy
- Challenge faced is the transition of workers from the old to the new

Job restructuring

- So new technology requires **job restructuring**
- Joseph Schumpeter famously claimed that obsolete jobs should be allowed (even encouraged) to die because this accelerates productive job creation elsewhere
- He called it **creative destruction**

Electricity as an example

- Electricity brought massive job restructuring for the benefit of society
- It led to large-scale production of industrial goods – domestic appliances, light bulbs, heating and air conditioning, electrical machinery and many more
- It led to the assembly line and to large-scale factories
- Many more jobs were destroyed by these discoveries than threatened by robots! But many more created too

Motor car

- Internal combustion engine might be nearing its end but it also brought massive job restructuring
- Horse breeders lost their jobs
- Thousands of new jobs for road builders opened up
- Motels flourished

Technological disruption: Outside the Bank of England just before the introduction of the motor car

And just after c 1910

4. Robots, AI and their industrial penetration

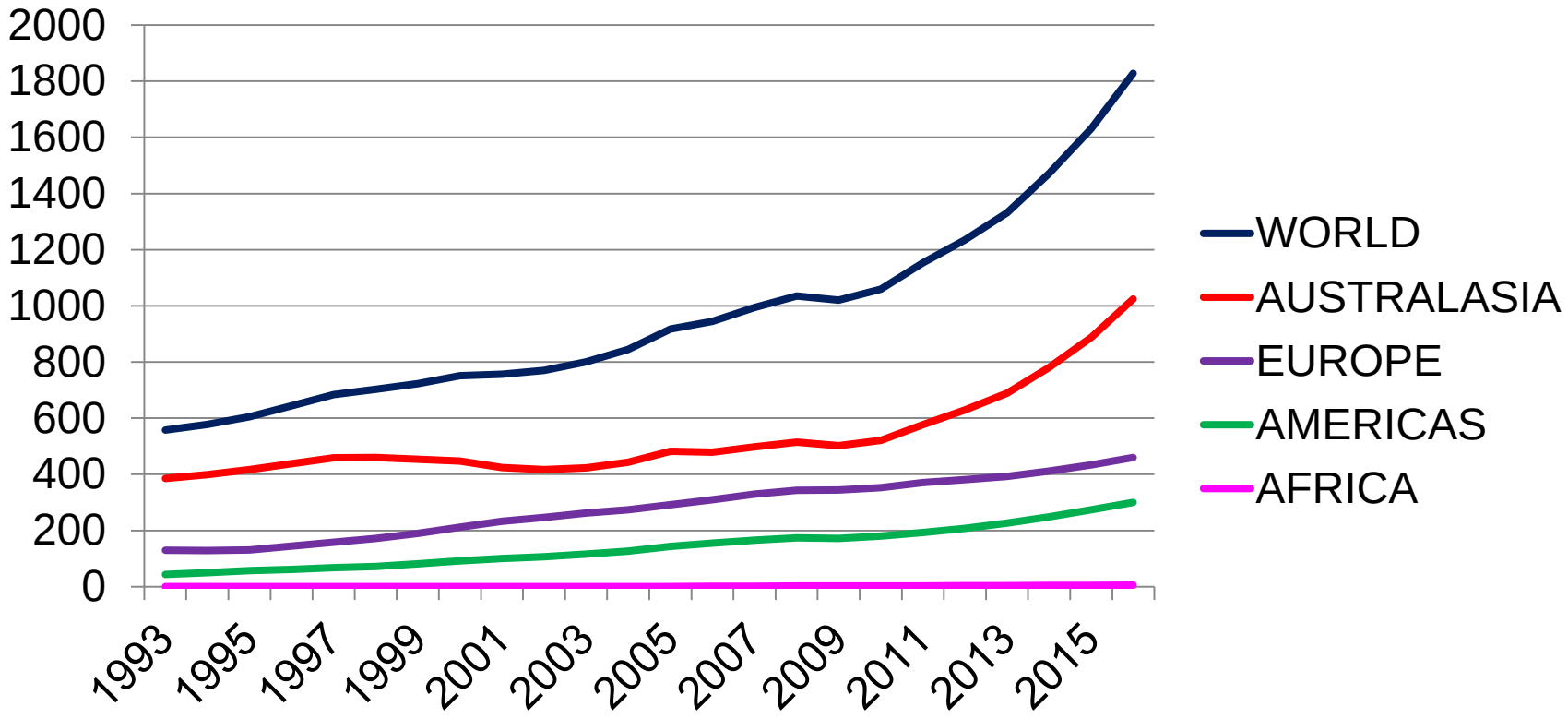
Robots and AI

- Robots and AI are the new technologies to “disrupt” labour markets – new ways to organise labour markets are needed
- Examples: Automation in industry, self-driving cars, electronic passport gates, voices answering questions put to electronic devices
- Robots took off when they became self-controlled mobile devices
- Research in AI started a long time ago – 1950s – but commercial applications are very recent. AI needs “big data”

Industrial penetration

- Rapid growth of robot use in recent years but most growth still to come
- Most growth in Asia (China and South East) although in terms of usage only Japan and South Korea have large penetration

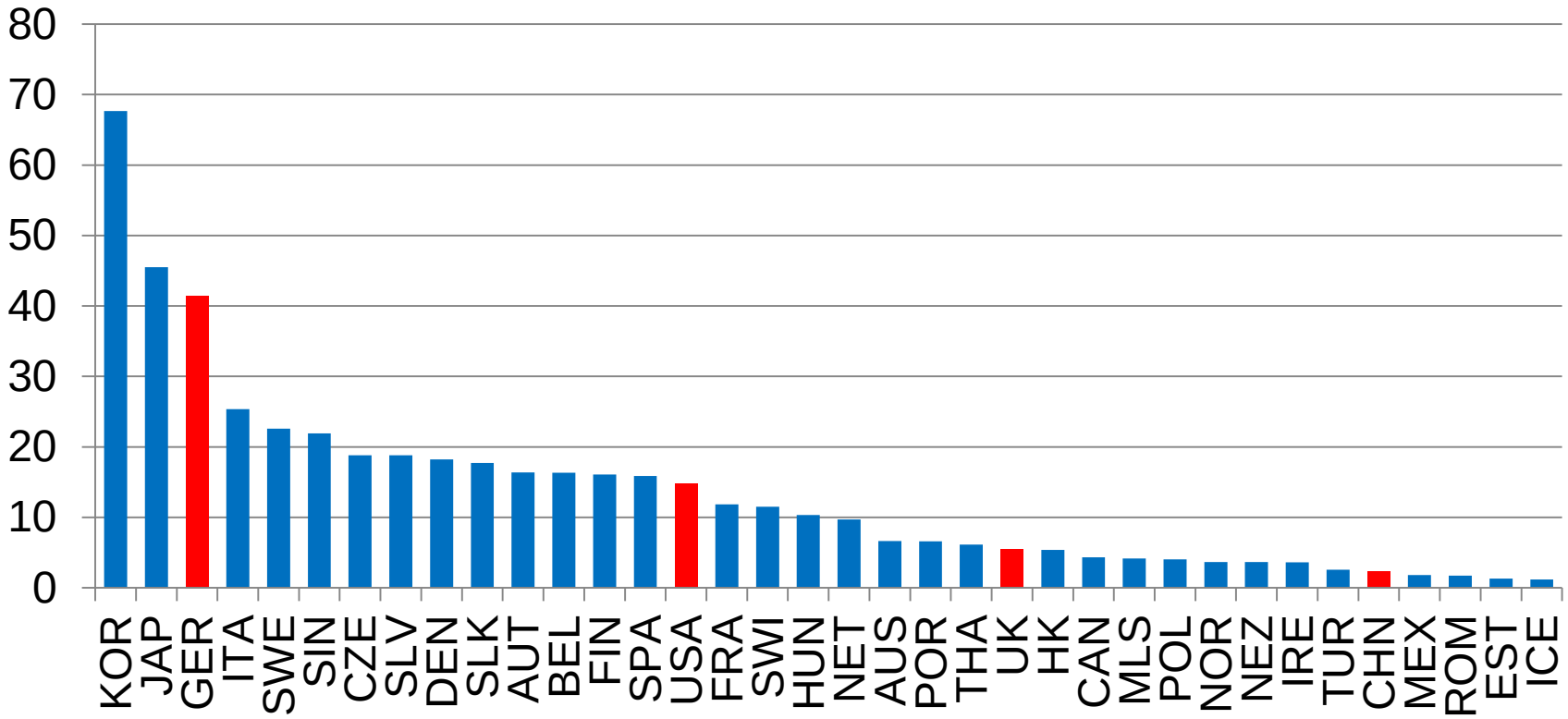
Total number of industrial robots (thousands)



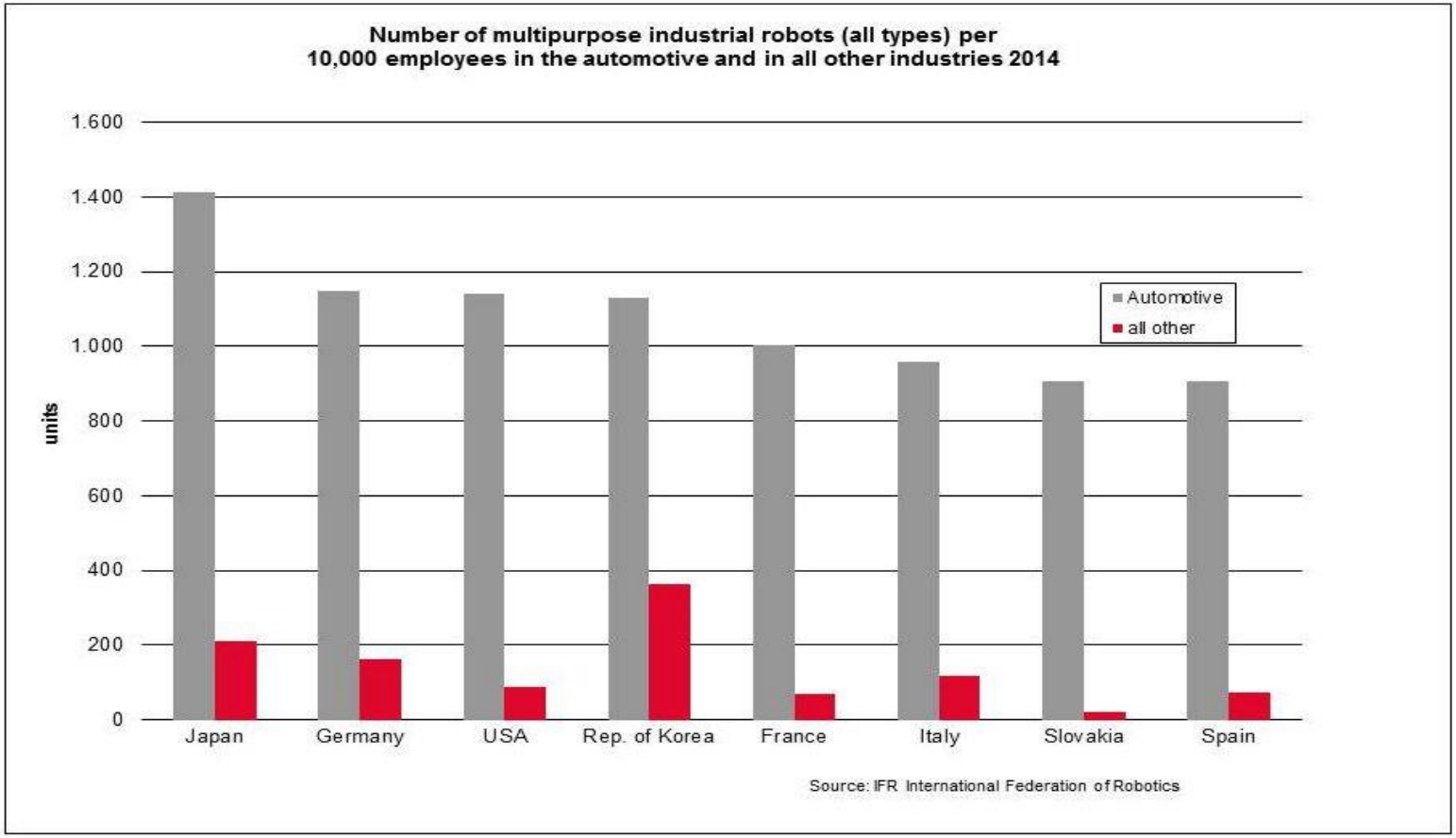
Country data

- Big differences between countries
- Republic of Korea, Japan, Germany leaders
- Automotive industry dominant user
- Poor correlation with R&D except for the three leading countries

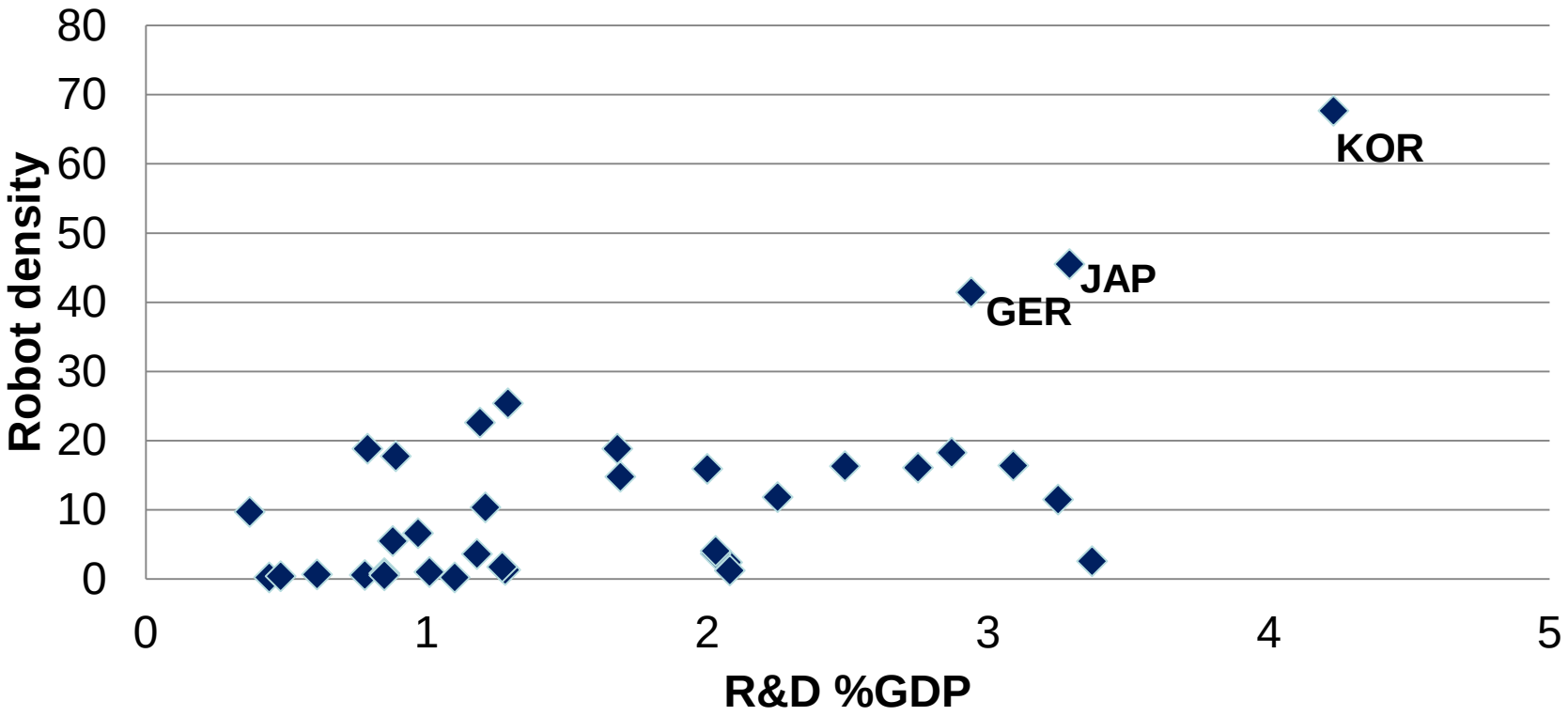
Robots per 10,000 employees (2014, below 1.00 omitted)



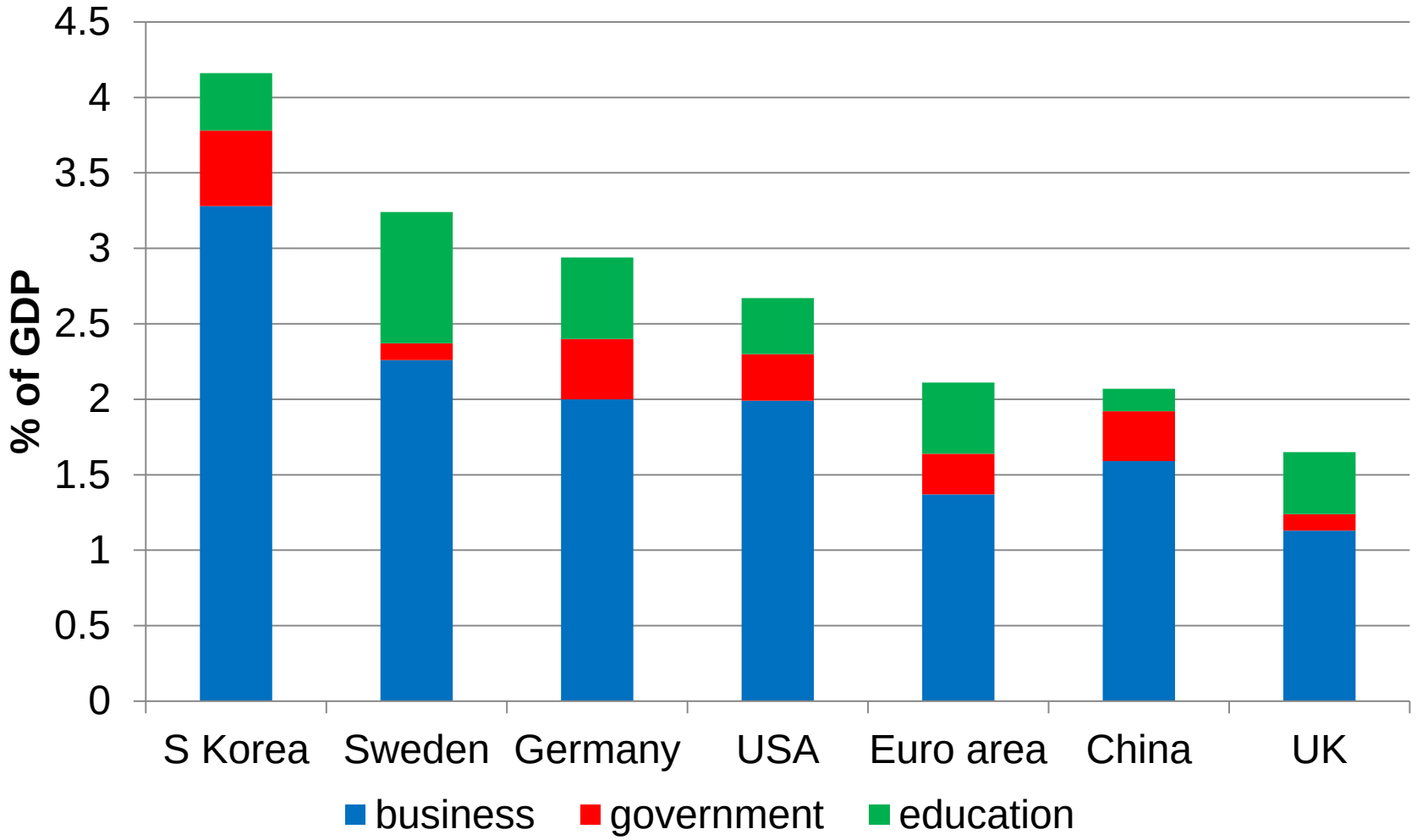
Automotive industries main users



Robot density on R&D



Sectors of R&D



Computerization and the internet

- Compared with earlier technological breakthroughs computers destroy jobs done by more skilled people.
- Its key ingredient is big data: machines with AI process enormous amounts of data to perform tasks that are **predictable**, given the data input
- Jobs at risk are those that rely on data processing

5. Job destruction in the age of robots and AI

Implications of computerization for jobs

- Large literate exists documenting that jobs that rely on data processing and could be computerized are heavily concentrated in the middle of the skills distribution (polarization – Autor and Dorn; Goos, Manning and Salomons)
- Estimates of job destruction are based on replacement of tasks (activities) by computers.

Range of estimates

- Fairly easy to obtain estimates of tasks at risk from the new technology
- Key is that tasks at threat operate in predictable environments
- But the mapping from tasks to jobs is difficult because task composition of jobs is flexible and easy to change
- Frey and Osborne estimated probabilities of tasks at risk. Recent (2018) OECD study confirms the tasks at risk

Jobs at risk

Worst affected		Least affected	
Telemarketer	99%	Mental health social worker	0.30%
Loan officer	98%	Occupational therapist	0.35%
Cashier	97%	Dietician nutritionist	0.39%
Legal assistant	94%	Doctor and surgeon	0.42%
Taxi driver	89%	Clergy	0.81%
Fast food cook	81%		

Some estimates

- General consensus emerging that up to half of tasks are at risk over the next 20 years
- This translates to 10-20% of jobs (OECD about 10-15%, McKinsey 14% in the USA)
- Could prove wrong: lots of anecdotal evidence of jobs redefining themselves, changing task composition; e.g. bank tellers, university professors

Technical capabilities vs. economics

- So far most studies focused on technical capabilities of robotics
- But implementation and diffusion depends on the economics
- Robots and AI are replacing human labour or other machines
- Their speed of adoption depends on the cost of the alternative factors
- High-wage countries are more likely to adopt them than low-wage ones

6. Job creation in the age of robots and AI

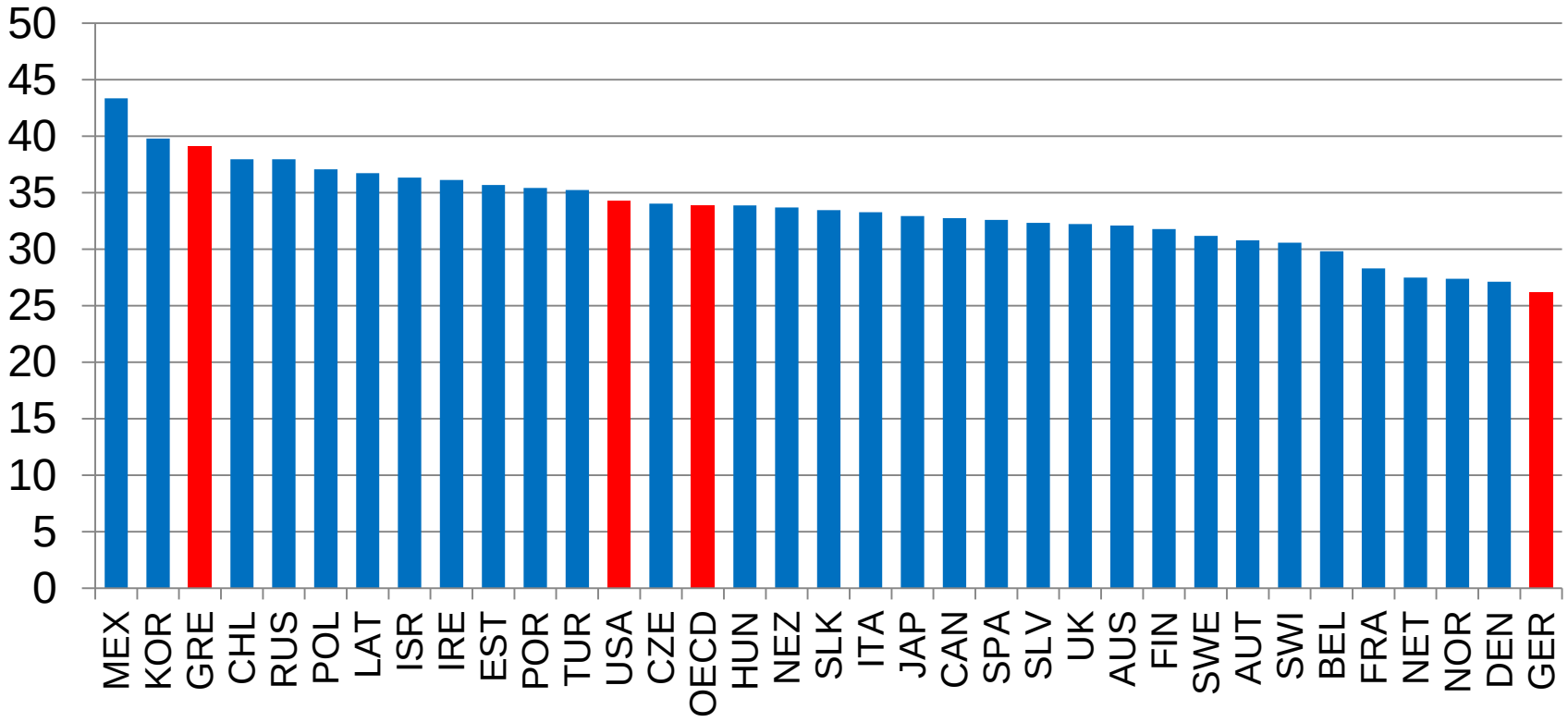
Total hours

- On average countries with higher productivity work shorter hours
- John Maynard Keynes writing in 1933 famously predicted that in the longer term the working week will be cut to 15 hours if full employment is to be maintained
- But his prediction was based on availability of work, not voluntary increases of leisure time

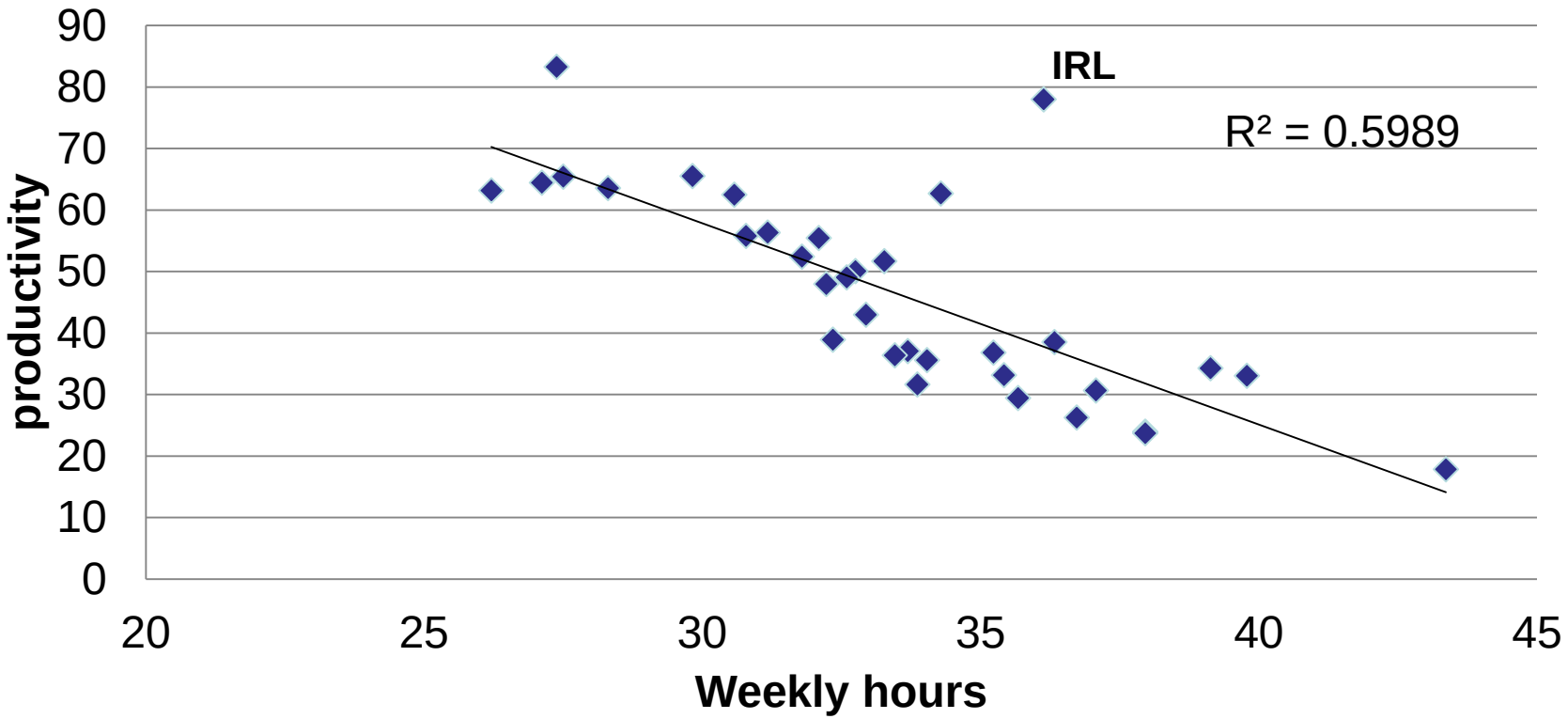
Overall employment

- Yet overall employment in more productive countries is as high as that in countries with lower productivity (or even more)
- Some of the gains from new technology are taken as increased leisure time, normally longer annual leave
- Challenge is how to make workers move from declining to expanding sectors, not how to create jobs for everyone

Weekly hours of work, 2016



Hourly labour productivity and weekly hours of work, 2016



Job creation

- Reducing hours of work is one way of keeping employment high
- But there are others
  - Companies invent new tasks as some get automated, e.g., bank cashiers now do “relationship banking” with customers
  - New jobs created in the sectors of the new technology, e.g., app development, robot repairing etc.
  - New jobs created in other sectors of the economy, e.g., carers for children, old people and pets; plastic surgeons

First two types of job creation

- The new tasks invented by companies are equivalent to new products: employment growth through increases in product variety
- The specialist jobs in the tech sectors are the complementary tasks to the new technologies
- These are most likely not enough to employ those who lose their jobs

Sector expansion

- Most new jobs will be created in service sectors where productivity growth is low (Ngai-Pissarides)
- In sectors where home production gets marketized as societies become wealthier
- Or in sectors whose products have income elasticity bigger than 1 (Rogerson and co-authors)
- Difficult to empirically distinguish between last two

Which sectors will create jobs?

- Likely sectors that will create jobs for above reasons:
  - Health and care
  - Education
  - Hospitality industry – leisure
  - Real estate management
  - Household services
  - Personal services

Wealthy aging societies

- Especially health and care will create jobs, because of higher demand for good quality health care and aging societies
- The leisure industry because of fewer aggregate hours of work and attractions of good service and “creativity”
- Household services, real estate management because societies become wealthy enough to specialise further and marketize “chores”

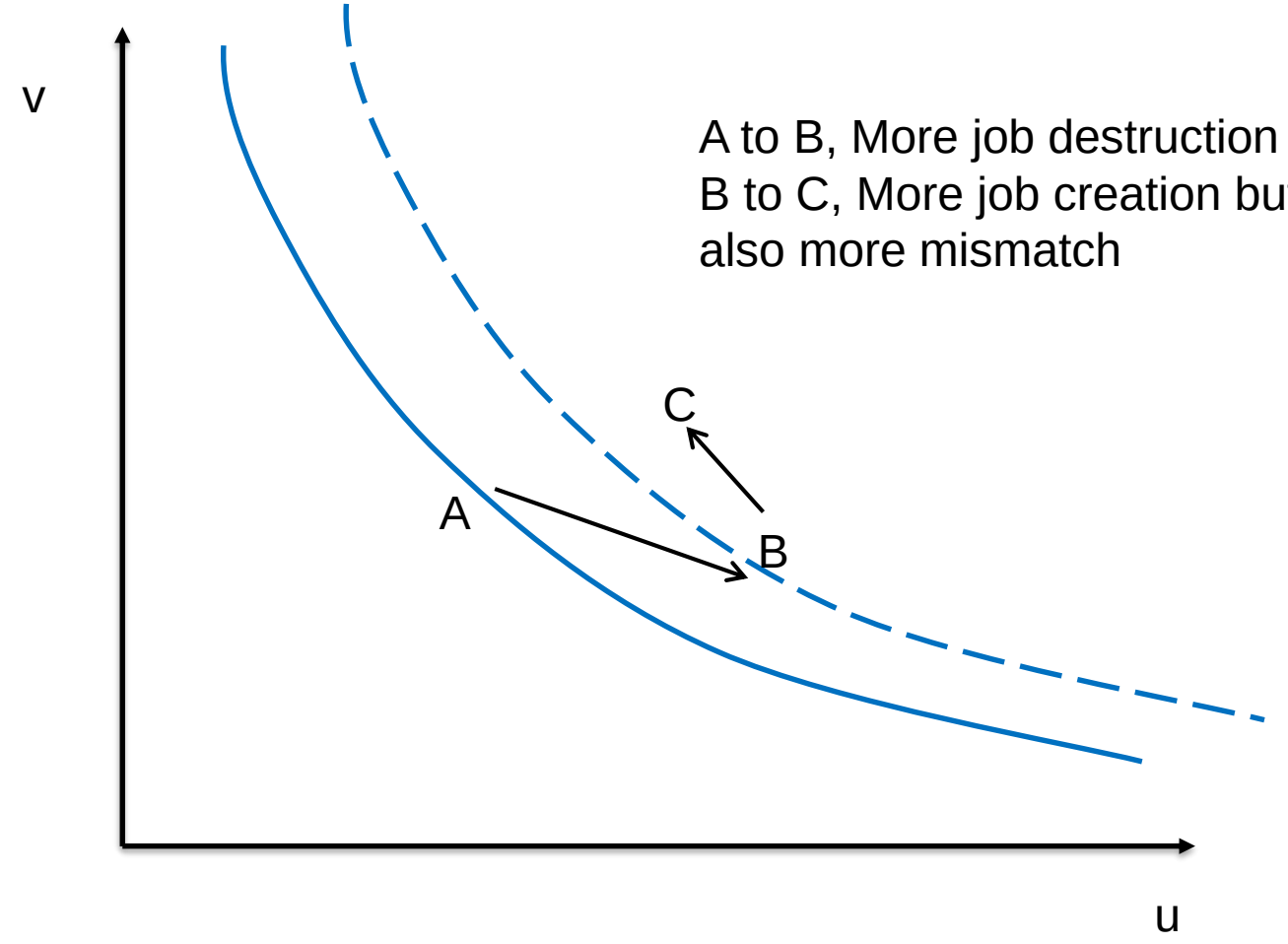
7. Worker transitions

Jobs lost, jobs gained

- Jobs that operate in predictable environments shut down
- These jobs require technical skills but not too dififucult to learn
- New jobs created that require strong technical background or “soft” skills, like customer relations, nursing care, coordination, telephone manners etc.

Back to the Beveridge curve

- News not good for the Beveridge curve
- More job destruction should shift it out – more mismatch will take time to bring it back in
- We should expect long periods of unemployment of those losing their jobs (in relation to what they experienced before – the displaced workers traditionally have low durations of unemployment)



The Beveridge Curve

How to deal with the transition

- Workers need to be trained – lifelong learning becomes important
- For new entrants, a portfolio of skills with ability to learn fast are more valuable than deep knowledge of one subject matter
- Job losers need to be supported by government to remain active in the labour market and not withdraw

Active policies: Training programmes

- General principle – “flexicurity”. Flexibility in the labour market with security provided by the government
- Most effective training is the one provided by private companies but with government subsidies because of risk of poaching
- Combination of on the job with off the job learning
- Not public sector training or entirely off the job!

Passive policies: Income support

- Governments should provide income security to give workers the chance to search for best match
- Most governments provide conditional income transfers and services, such as unemployment benefit
- Other benefits and transfers are unconditional, such as National Health Service in Britain or child benefit.
- Universal basic income (UBI) is an unconditional income transfer for all individuals over a certain age (18, 21?)

On conditionalities

- If government objective is to maximise utility of citizens subject to a budget constraint “targeted” transfers are optimal – identify the need and deal with it
- Problems with this approach – budget is not fixed (can tax more), administrative cost is high, identifying need is socially and economically costly

Universal Basic Income

- Has long history going back to Middle Ages and debated from time to time
- Currently interest revived because of support from Silicon Valley entrepreneurs as a way of dealing with tech disruption and job loss

In favour

- Simple to operate, unconditional, deals with poverty
- Gives breathing space for better job training, more extensive job search
- Gives more bargaining power to the worker
- Enables development of entrepreneurial or creative activity

Against

- Expensive if it is to provide sufficient social safety net for groups in most need, e.g., should a single person receiving as much as family of four headed by a disabled person?
- Work disincentives – depends on level. Current measures are generous but have effective conditionalities
- Several experiments were abandoned too soon to provide good data because of politics or high cost

Evaluation

- A guaranteed minimum income is a good idea – minimum wage for those in work, something less for those out of work
- Extend the minimum entitlement to those out of the labour market because we now know that they spend a lot of their time doing “home production”
- On top entitle those in need to targeted benefits, such as health, education, disability, job search

Thank you for listening