

An IIER presentation
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The 21st century

The future of
energy and societies

(or: when energy and resources upset Cobb-Douglas)

Amsterdam, 25 October 2016

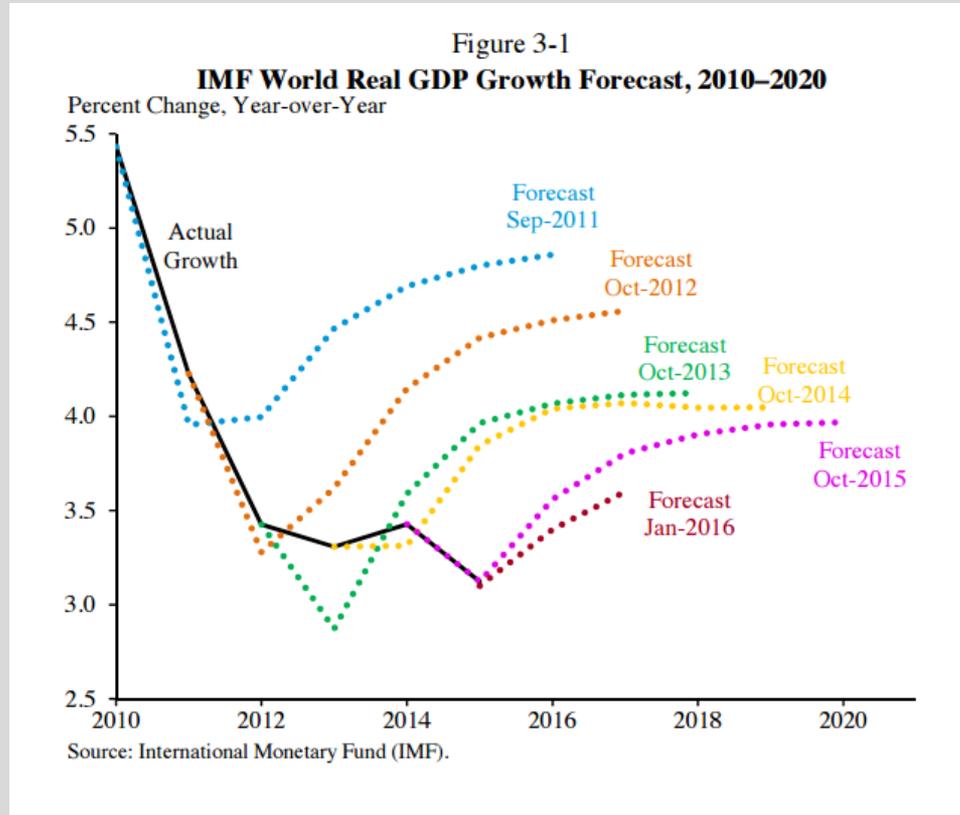
Content Overview

1. The Current Reality
2. Background and Shortcomings of Current Economic Views
3. IIER's Economic Model
4. What it takes to grow
5. Consequences for our societies

1.

The Current Reality
Getting to Growth is Tough

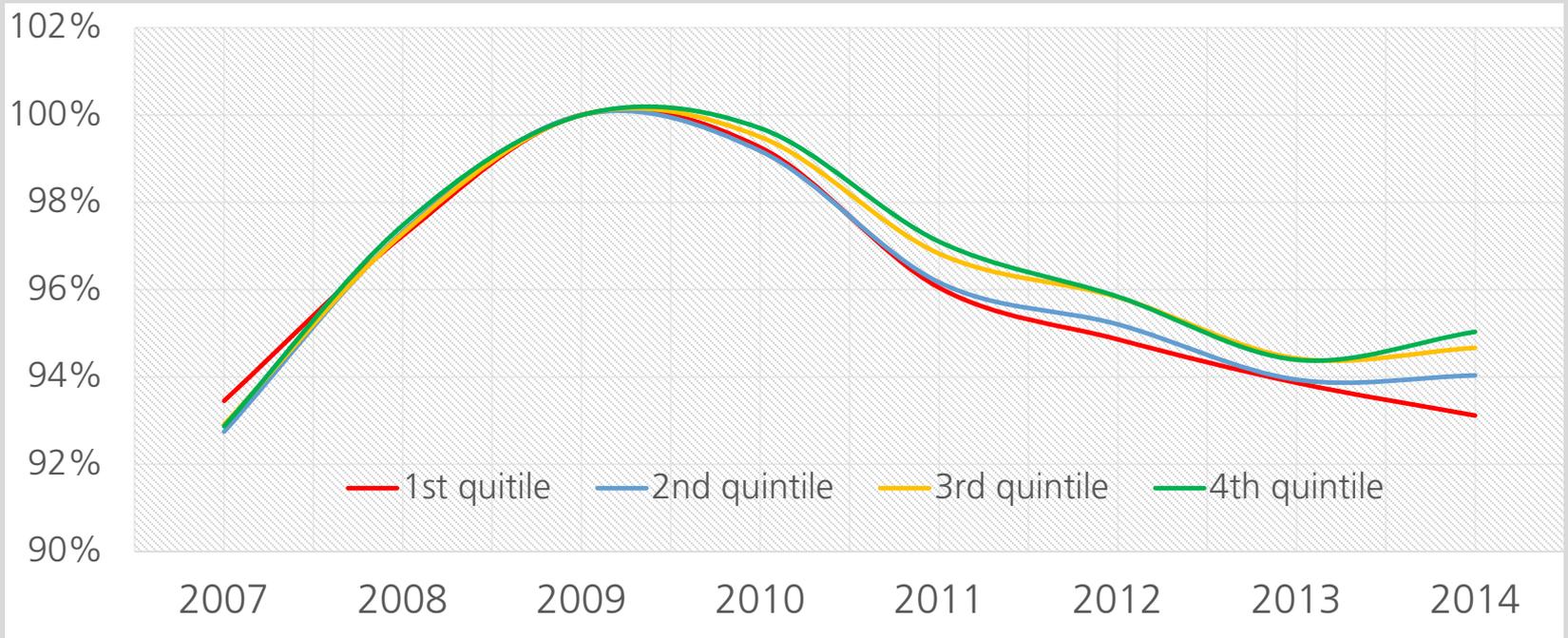
Growth Predictions vs. Reality



During the past years, growth prediction for almost all economies – and on global level – were constantly overoptimistic, and most countries grew at a slower pace than anticipated during the recovery since the 2008/9 crisis

Euro zone household incomes

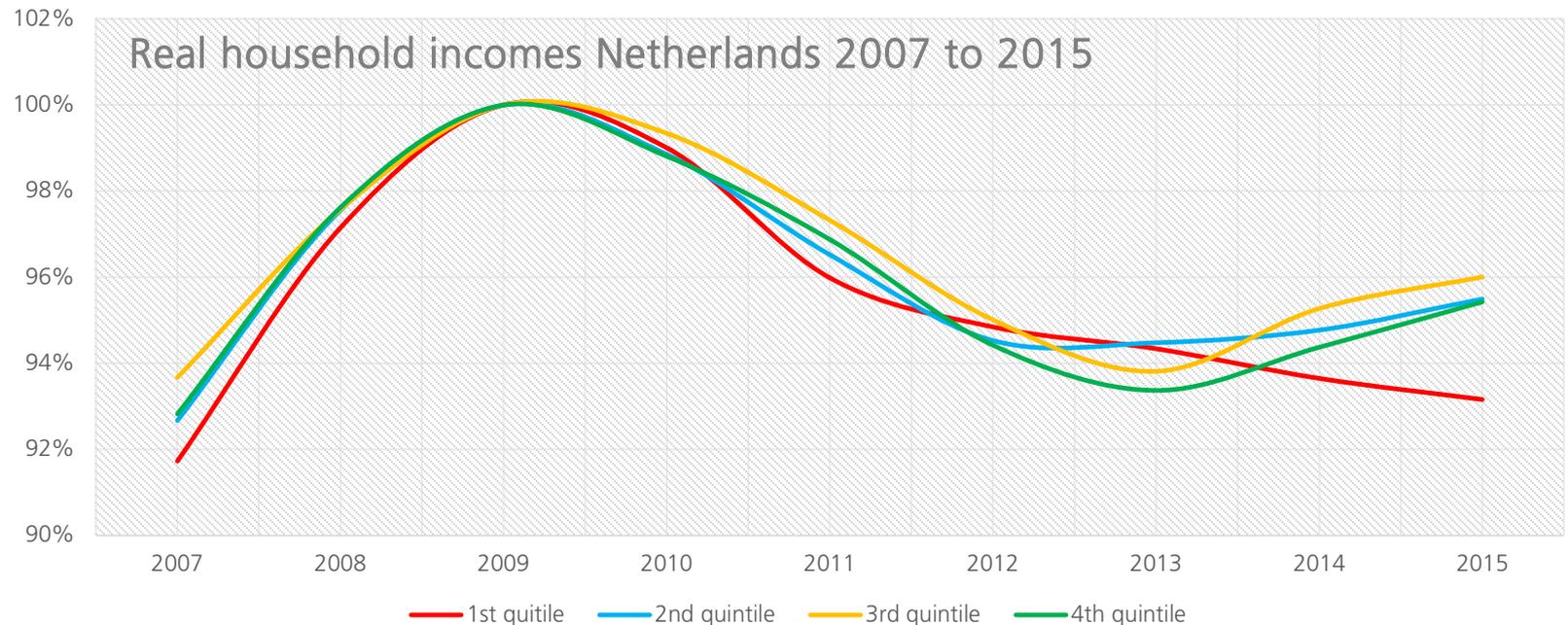
For most households in advanced economies, real incomes have shrunk or stagnated, in the U.S. since the year 2000, in Europe since 2009



Source: Eurostat (real household incomes)

The Netherlands follow the pattern

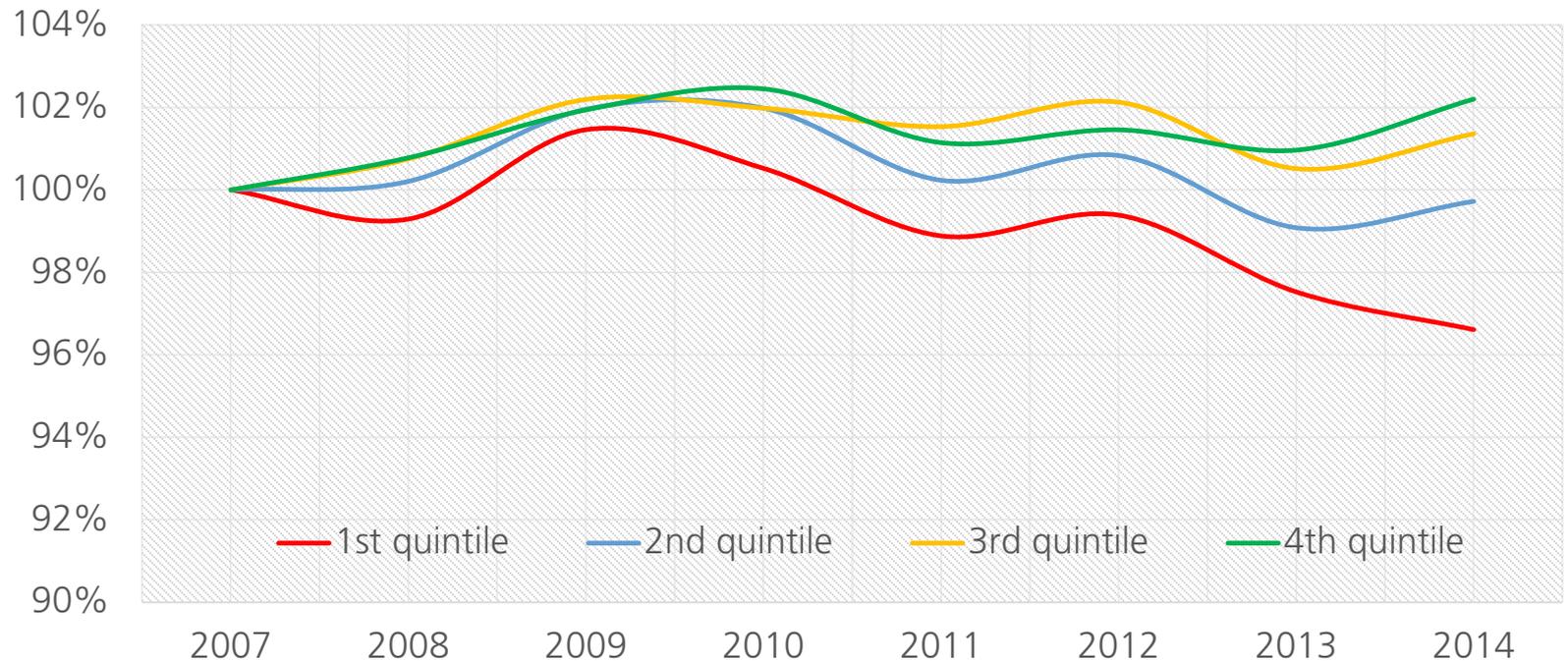
Dutch real incomes are very much in line with the rest of the Euro zone, after a strong rise until 2008, they have since been shrinking



Source: Eurostat (real household incomes)

Germany, the “powerhouse”

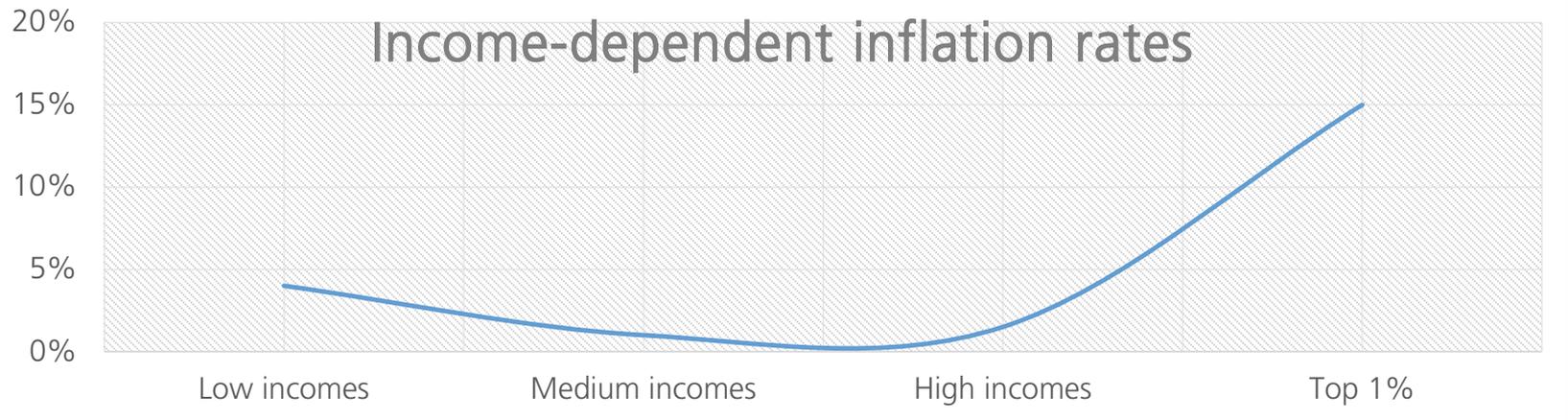
Even in Germany, one of the most successful European economies in recent years, real incomes were flat or shrinking for most people



Source: Eurostat (real household incomes)

Averaged CPI data masks losses

Average CPI numbers mask that core essentials of low income households (and those of the 1%) are appreciating much faster than the average



Source:
BLS

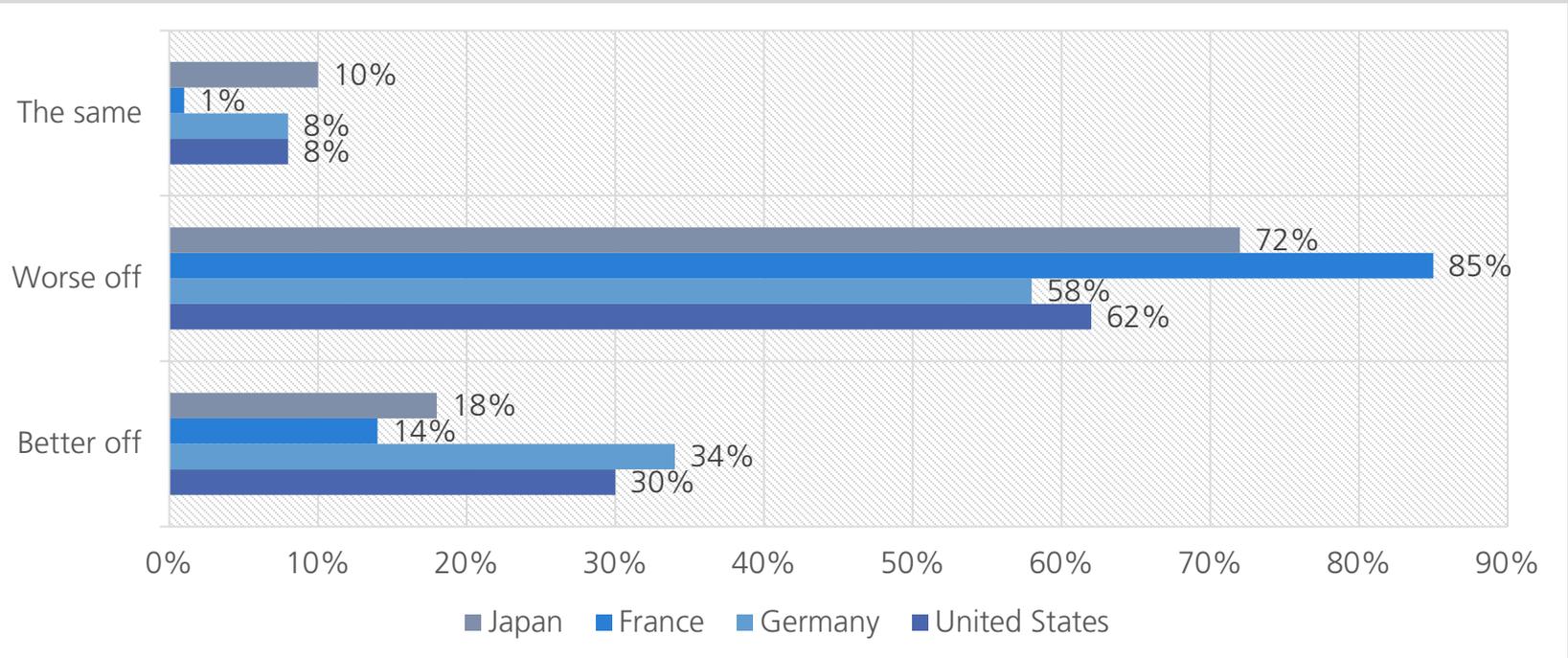
- Food
- Energy
- Transportation
- Health care
- Rent
- Education

- Mortgages
- Electronics
- Travel
- Communications

- Luxury real estate
- Luxury goods
- Collectibles
- Investments

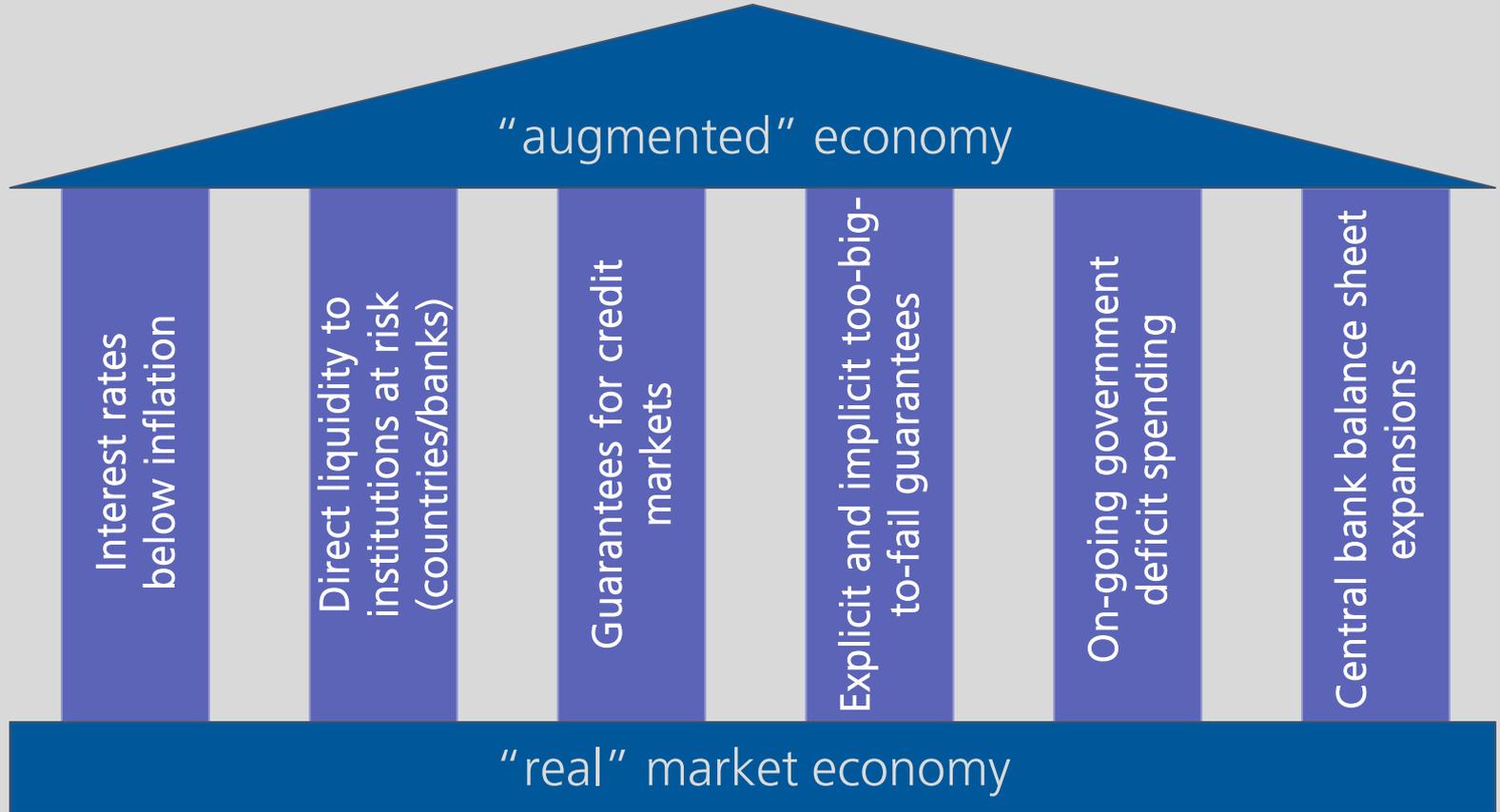
What people think of the future

When asked about the economic prospects of their children ("how will they be financially?") a majority expects a shrinking economy



Source: Pew Research 2015

...despite unprecedented interventions



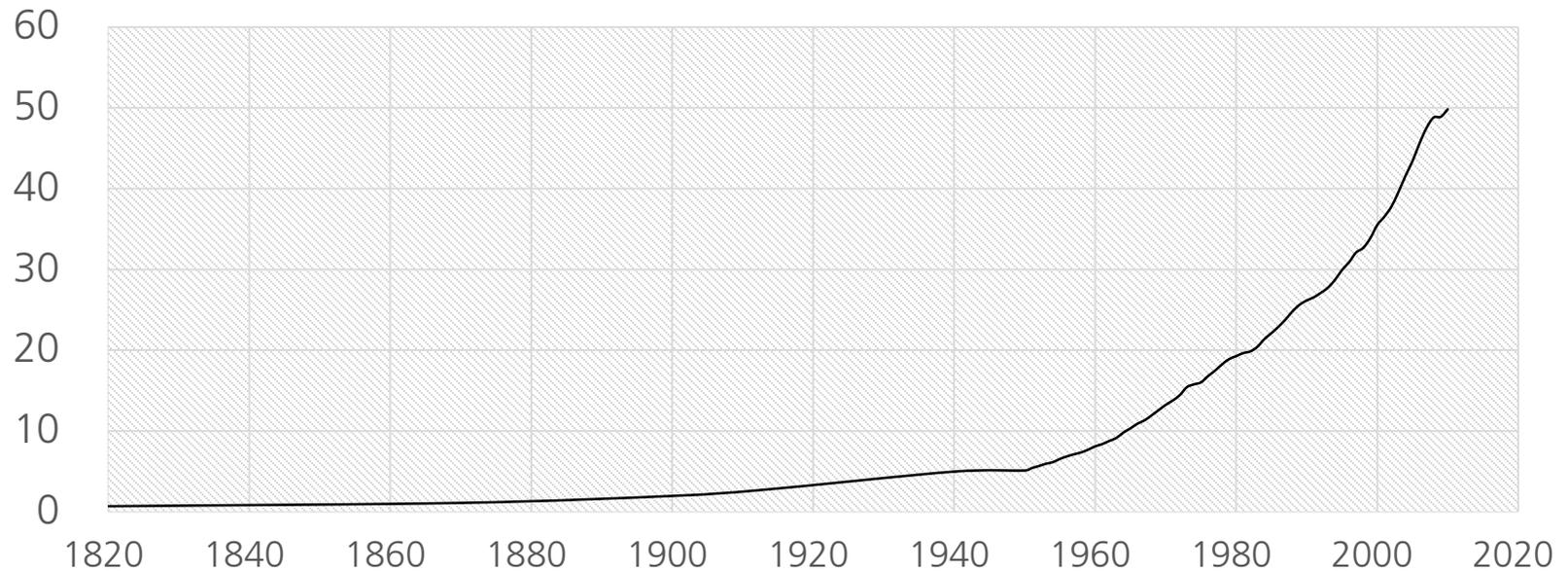
2.

Background and Shortcomings of Current Economic Views

The past 200 years were just amazing

Between the years 1820 and 2010, the global economy grew 77-fold, with only very few (short) interruptions

Global GDP in trillion 1990\$ from 1820-2010

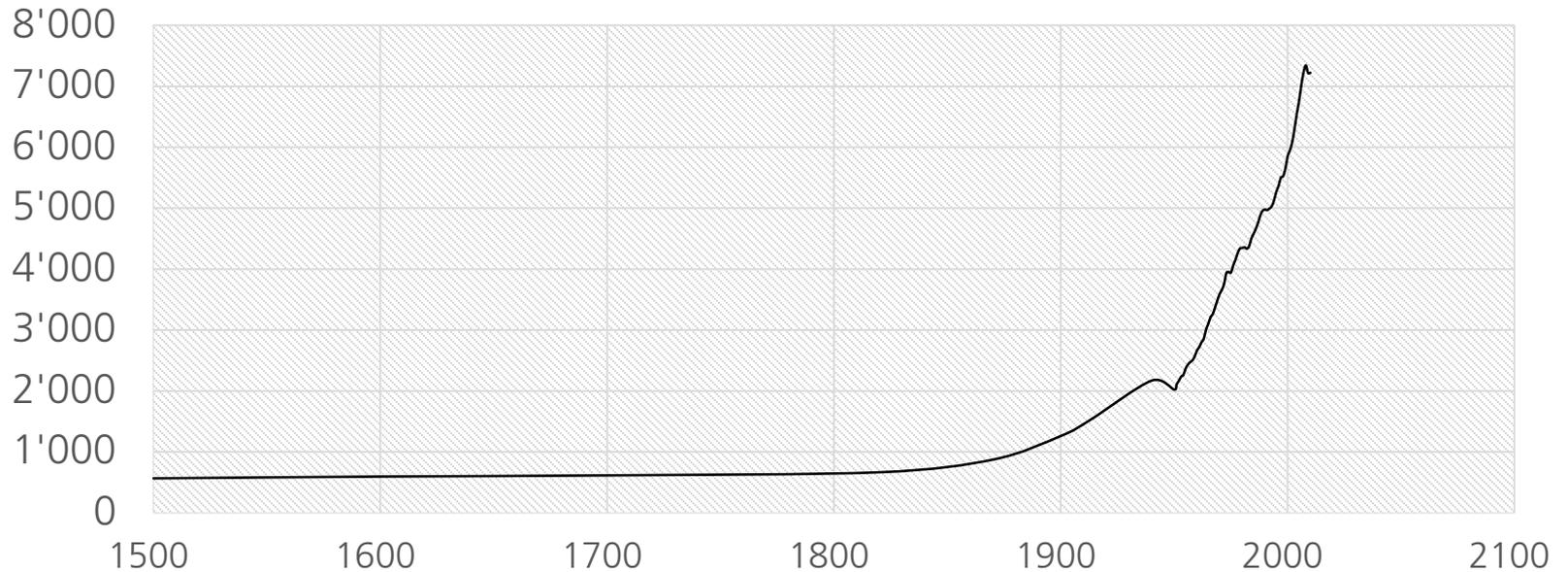


*Sources: Angus Maddison, World Bank, IIER

Most impressive: per capita GDP growth

Even more impressive was that during this period, while going from less than 1 billion humans to around 7 billion, per capita incomes also exploded

Global GDP per capita 1500-2010 in 1990\$



*Sources: Angus Maddison, World Bank, IIER

Economics interpretation of the data

Almost all economic forecasting is based on variations of a Cobb-Douglas style production function ($Y = AL^\alpha K^\beta$) where output (GDP) is a product of available factors **labor** and **capital** (typically a grouped category for existing and new infrastructure), further enhanced by growing **factor productivity**. This is largely consistent with the experience of the past 250 years until 2008.



Economics vs. ecosystems science

Economic science

- Simplified models
- No integration of natural science
- Looks at recent history (200 years)
- Little to no interconnection between elements
- No/weak feedback loops outside supply/demand view
- No inclusion of breakpoints

Ecosystems science

- Complex systems
- Integrates physics, chemistry and biology
- Includes long-term human ecosystem history
- Highly interconnected components
- Strong feedback loops
- Systemic failure risks accepted and integrated

In reality, our human economic system is nothing but a (very complex) ecosystem with many more parameters

Critical areas in economic science

Production function

- Economic theory assumes that economic output is primarily driven by human labor, capital, supported by ever-improving factor productivity, ignoring other factors

Substitution theory

- Economic theory assumes that there is always an equivalent or better substitute for inputs that become scarcer (too expensive), and that supply and demand always regulate switchovers with a beneficial outcome

Views on finance

- Economic theory has conflicting views on credit. While basic theory sees credit as neutral, other schools (e.g. Keynesian) acknowledge a role in demand generation based on credit volume growth

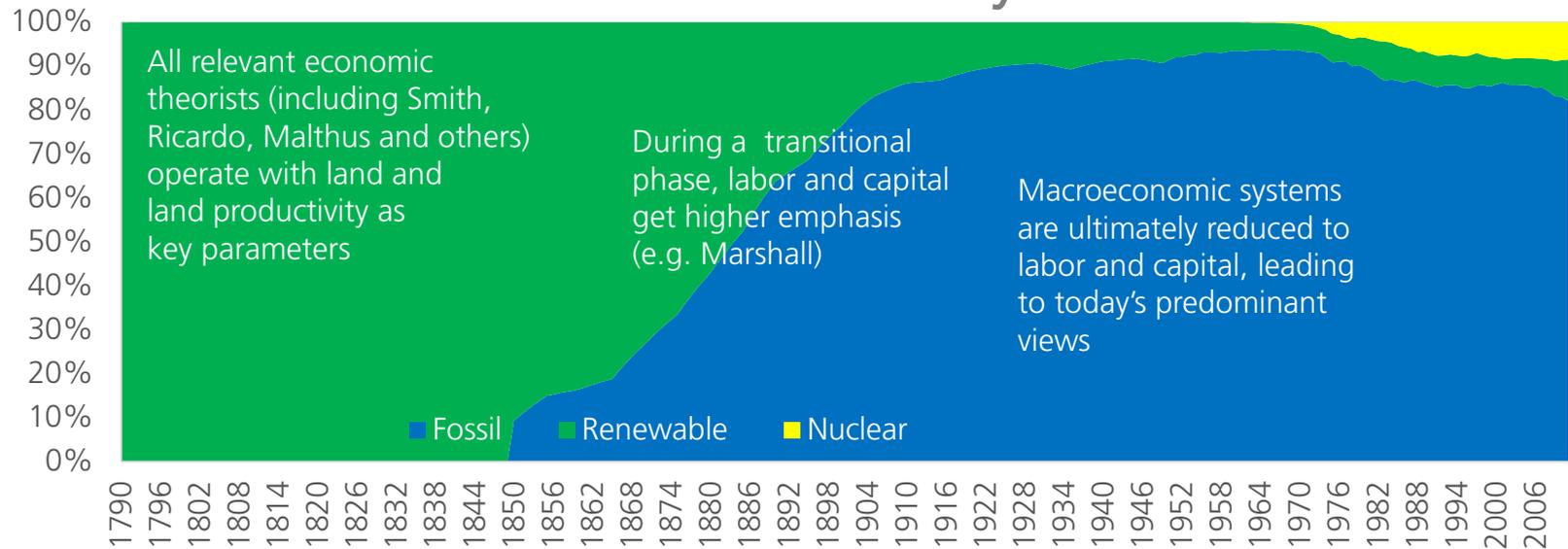
Macroeconomic modeling issues

- Behavioral science is not at all integrated except for supply/demand views
- Financial dynamics are not integrated
- Physical limits of a finite planet are not integrated

How economic science evolved

Before the broad arrival of fossil fuels, economic theory was based on land and productivity. Only after the introduction of fossil fuels (equaling to access to millions of years of past biomass production), the limiting aspect of those resources became (we think: temporarily) irrelevant.

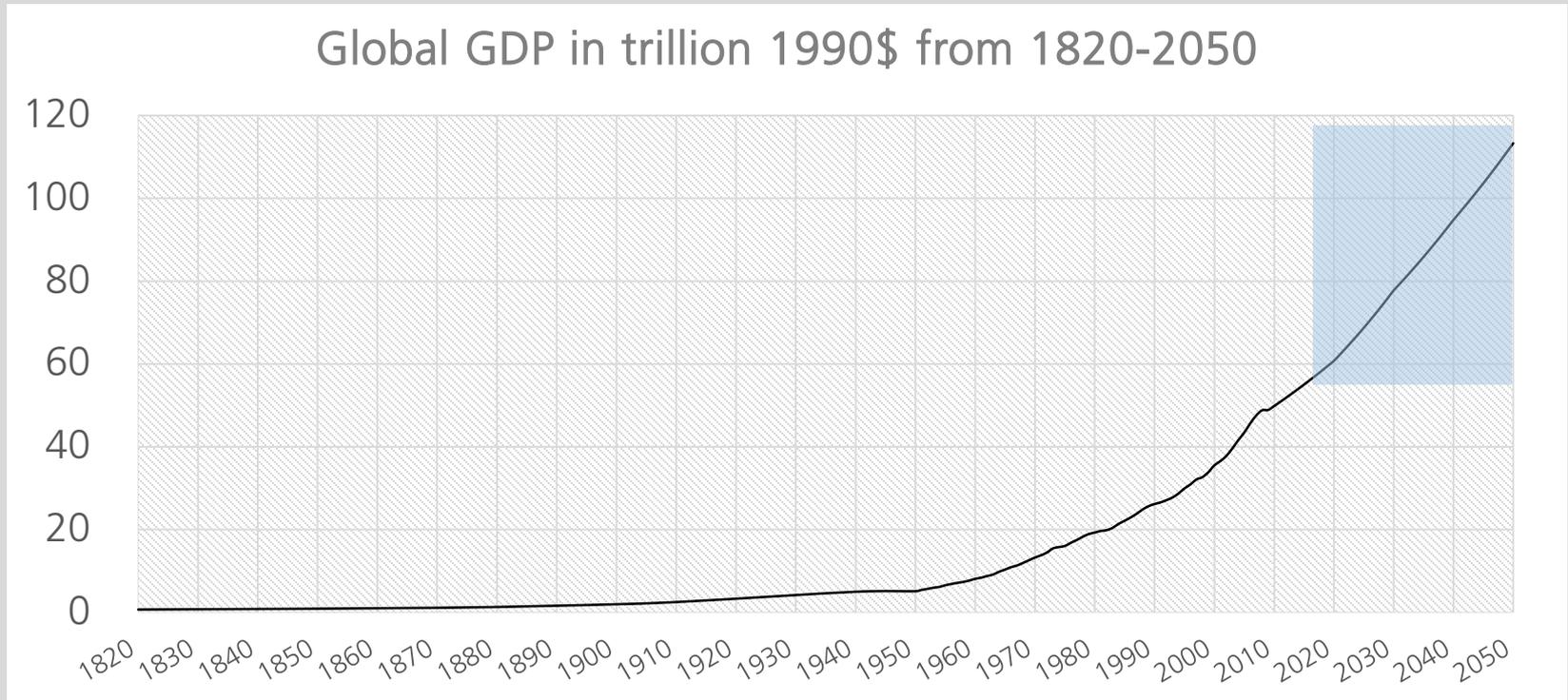
Energy share by source* vs. predominant economic theory



*Source: EIA (U.S. energy mix)

This is what macroeconomics expects

Even most conservative macroeconomic forecasts project more than a doubling of global GDP between 2015 and 2050 in real (inflation-adjusted) terms



*Sources: Angus Maddison, World Bank, IIER, OECD, The Economist Intelligence Unit

...but at one point, there are limits



Global GDP patterns from 0 A.D. Source: Angus Maddison, IIER calculations

Predominant macroeconomic theory has us locked into a view describing an unrealistic and ecologically dangerous future based on 250 years of fossil fuel use (a.k.a. industrialization)

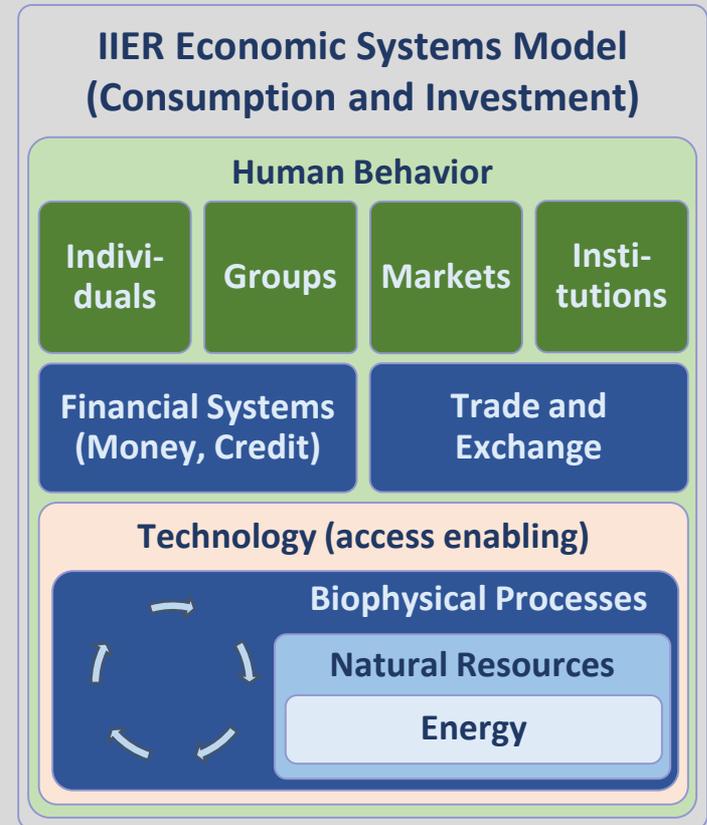
3.

IIER Economic Model

IIER economic (and ecosystem) model

IIER's Economic Systems Model identifies challenges:

- Economic activity today is largely (>95%) tied to resource and energy conversions
- We have used credit as a turbo charger for fast resource access
- Both systems are exhausted
- Today, human behavior is driving ups and downs



What truly drives growth



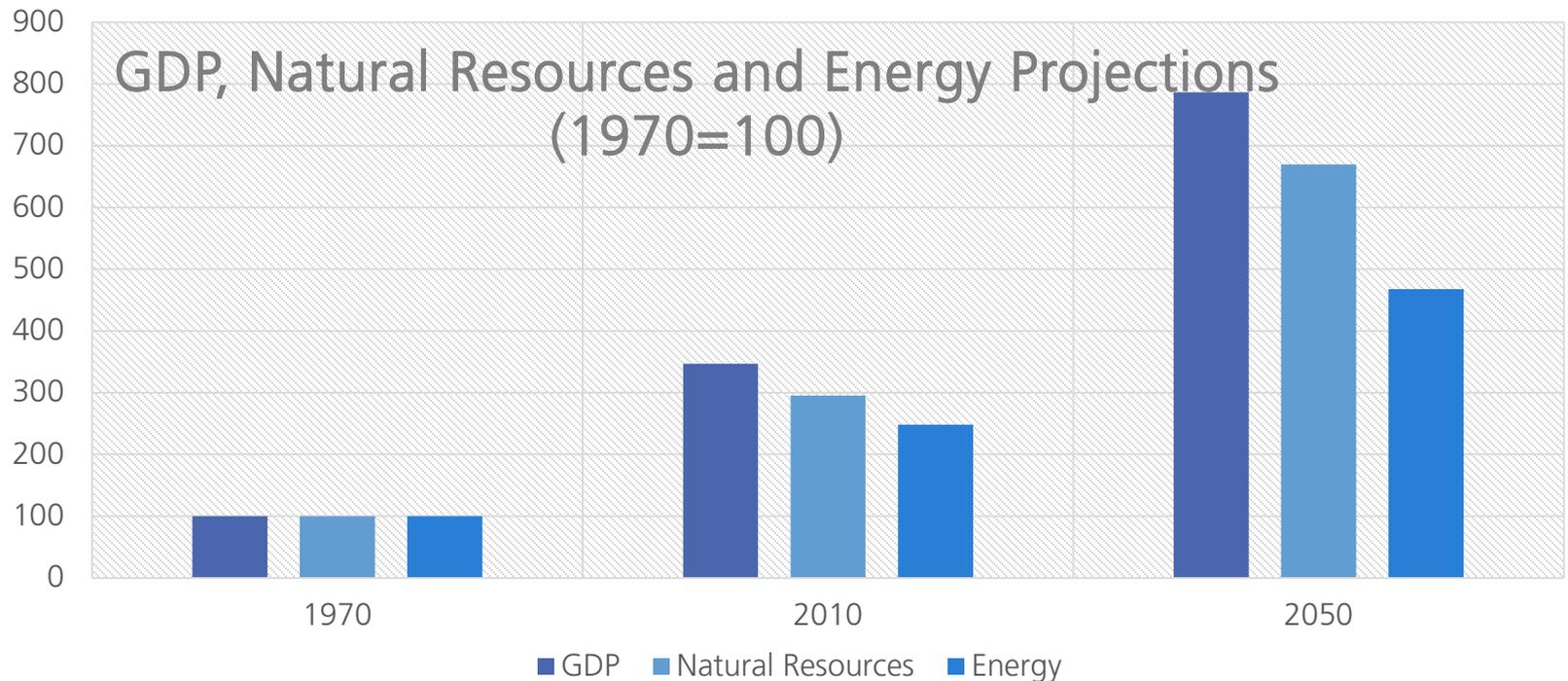
Key drivers

- Energy and resource availability and affordability (ERoEI/RRoEI*)
- Credit availability and conditions
- Human future expectations

*Energy/Resource return on Energy Investment determines the output received from one unit of energy input. This amount is irreversibly declining

More growth = more resources

Economic growth is directly related to resource and energy conversions, with very limited potential for quick efficiency gains. An (unrealistic) 2% growth target would almost double their use by 2050.

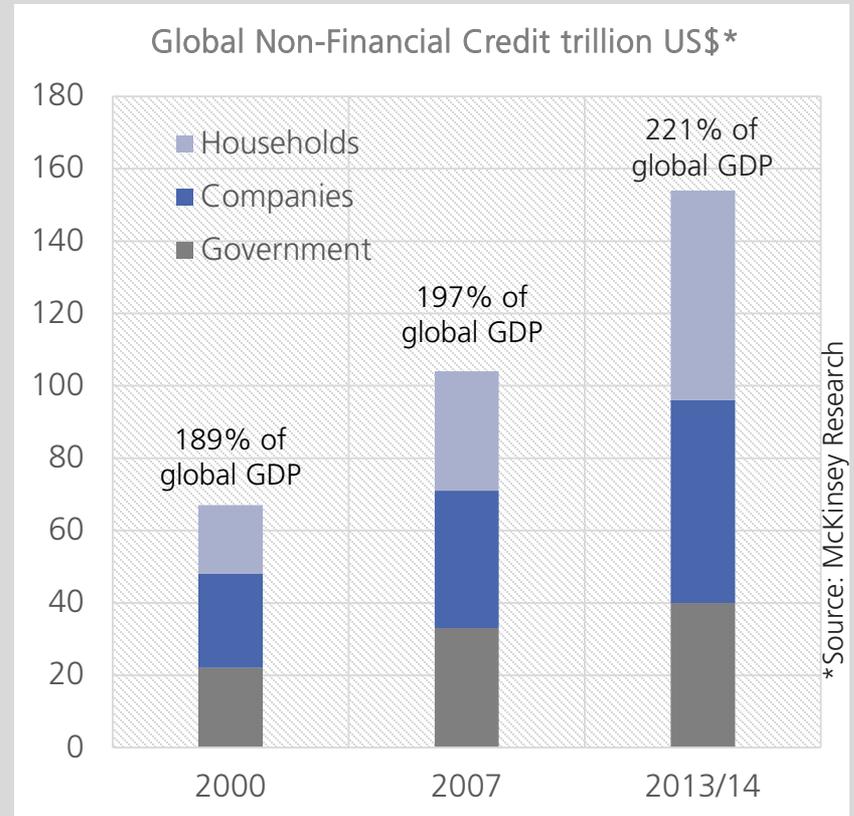


Sources: World Bank, UNEP, IIER modelling

More credit = more resource access

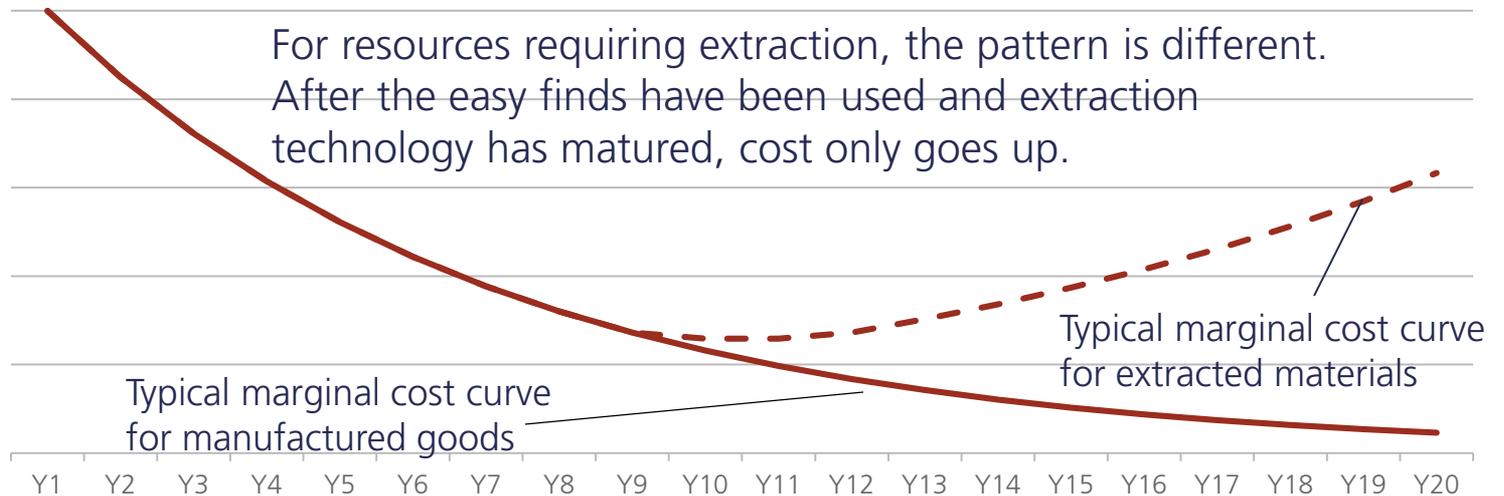
For all periods since the 1970s, credit volumes have grown faster than GDP

- Since 2008, credit growth has further accelerated despite large write-offs in advanced economies
- By now, all advanced and most emerging economies have almost reached their feasible debt limits



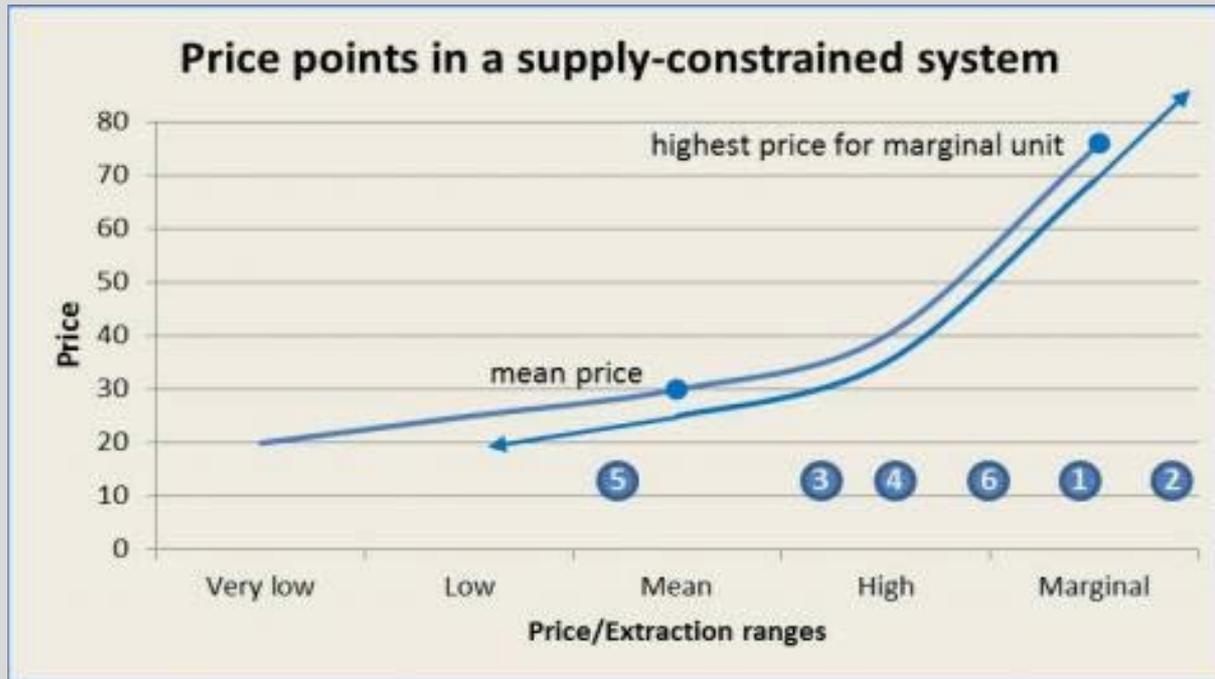
Marginal cost is irreversibly growing

In most production environments, we are used to constantly shifting price curves, leading to lower and lower cost for goods, based on improvements in technology and efficiency.



Commodity prices become volatile

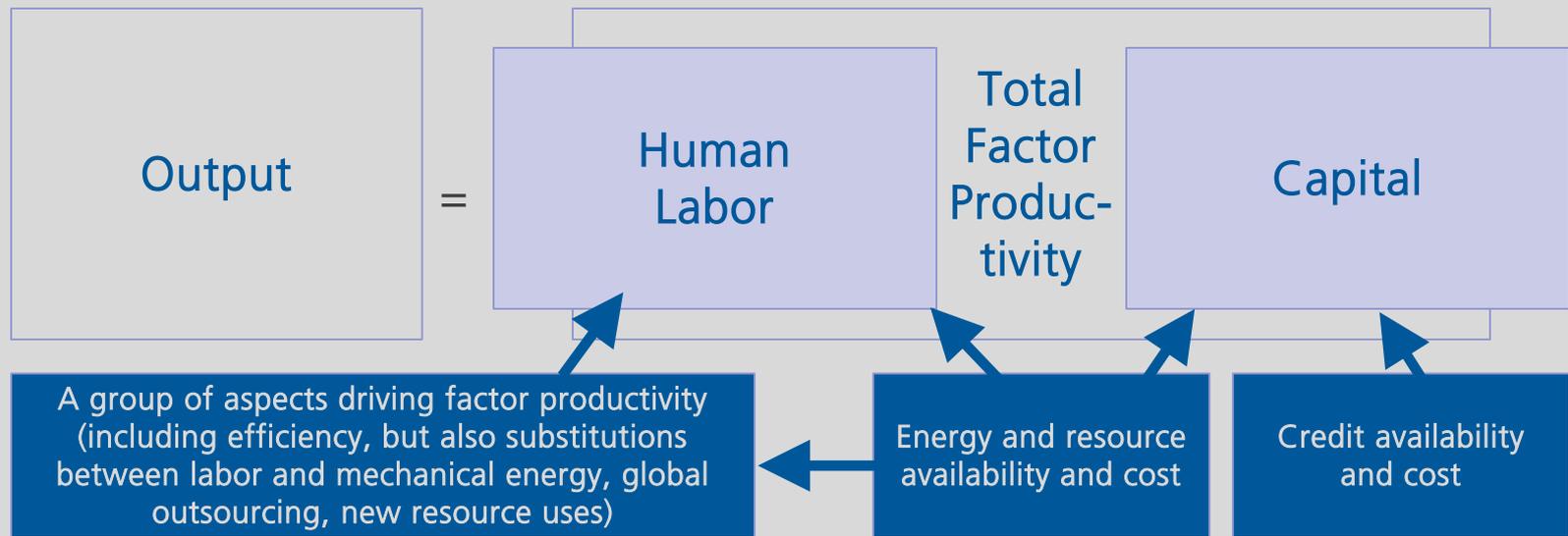
With market prices at the point of **highest marginal extraction cost** in an equilibrium situation, they fluctuate heavily



- 1 marginal unit price
- 2 demand driven price
- 3 cost of marginal units at lower demand point
- 4 (as 3)
- 5 undershoot on price

Economists missed those connections (as they imposed no limits until recently)

The key drivers behind the (dependent) Cobb Douglas variables can be identified as 1. natural resources (including energy), 2. credit availability and, to a certain degree 3. technology progress

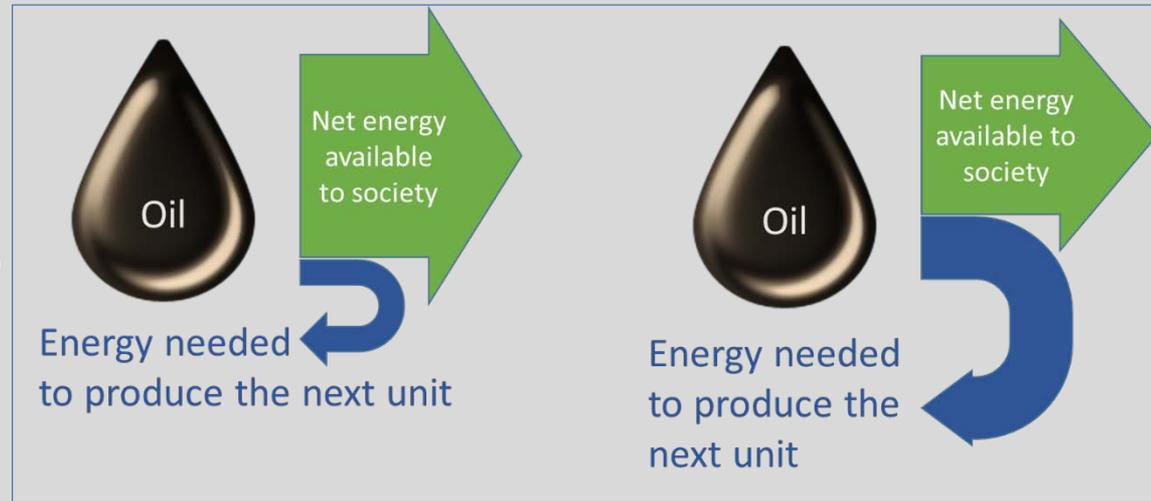


Ultimately, economic activity is hard-limited by current and past land availability and productivity, which has very limited elasticity.

The quality of energy matters a lot

For all energy (and resource) extractions, it matters what arrives on societal level

The higher the net benefit, the larger our economy



4.

Why a resource-constrained
(and greener) future
will be smaller

What enabled industrial societies



Industrial activity needs stability and favorable conditions in many areas

They are currently in danger in most places around the world

Advanced economies today



Advanced economies have seen a large de-industrialization process during the past 40 years.

Conditions are becoming less and less favorable.

Advanced economies soon



With the introduction of renewables, more tension within and between countries, and shrinking credit availability, conditions deteriorate even further.

China equally sees deterioration



China has picked up more than 40% of global primary materials processing due to more attractive conditions. But: even China is struggling to keep its economy growing.

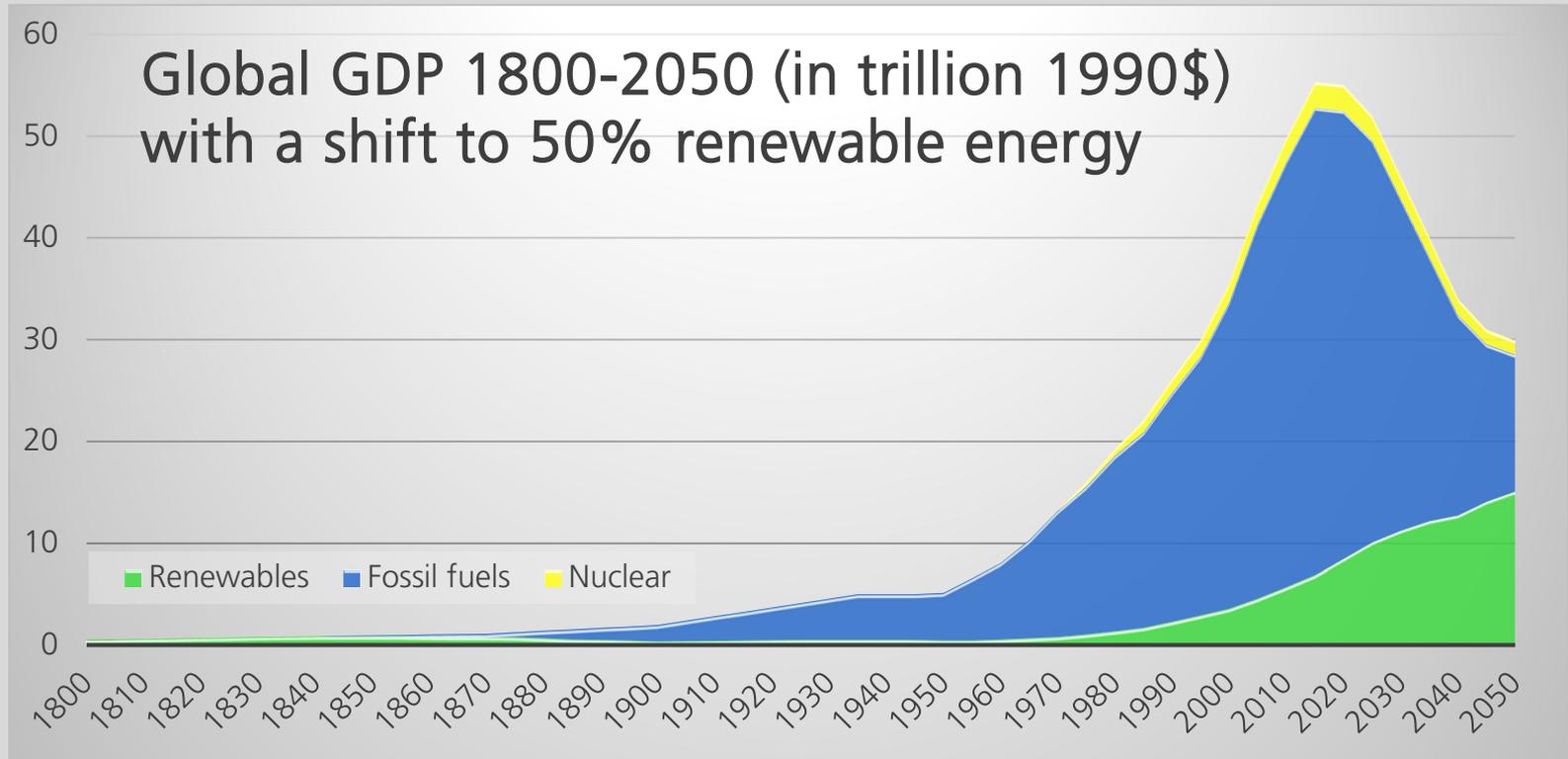
For poor economies, it is too late



Developing economies have the worst conditions to enable stable industrial societies, and typically, they are worsening, not improving.

How it all fits together

Once more difficult-to-extract fossil resources and renewables come into the energy mix at larger scale, they begin to push our economic system down



*Source: Angus Maddison, World Bank EIA, IIER models

The renewables' Achilles heel: density

Fossil fuels



Convenience food



Grow from scratch



Use renewable energy



20th century fossil fuels compare to renewables like convenience food to a meal where you prepare your food from farm to table

But isn't solar PV cheaper than ever?

With shrinking solar PV panel cost, many people believe that eventually, we will arrive at a “zero cost energy” environment. Nothing is further from the truth:

Large parts of the price drops were one-time effects

- Between 2005 and 2015, Asia's PV market share grew from 10% to 90%, moving manufacturing away from Europe;
- China provided large subsidies supporting this market takeover;
- Solar PV panels today are produced with the cheapest non-renewable inputs (energy and resources) available globally;
- Most feasible manufacturing scale-up improvements have taken place by now.

Solar Power extracted via PV panels isn't the whole meal

- PV electricity as a source is incompatible with the needs of stable grid-based electricity unless heavily mitigated (“enriched and condensed”);
- As soon as we introduce solar power at scale, the largest part of the cost won't be the manufacturing of panels, but the mitigation of fluctuations and provision of fallback capacity and storage.



Energy quality matters a lot

For all energy (and resource) extractions, it matters what arrives on societal level

The higher the net benefit, the larger our economy

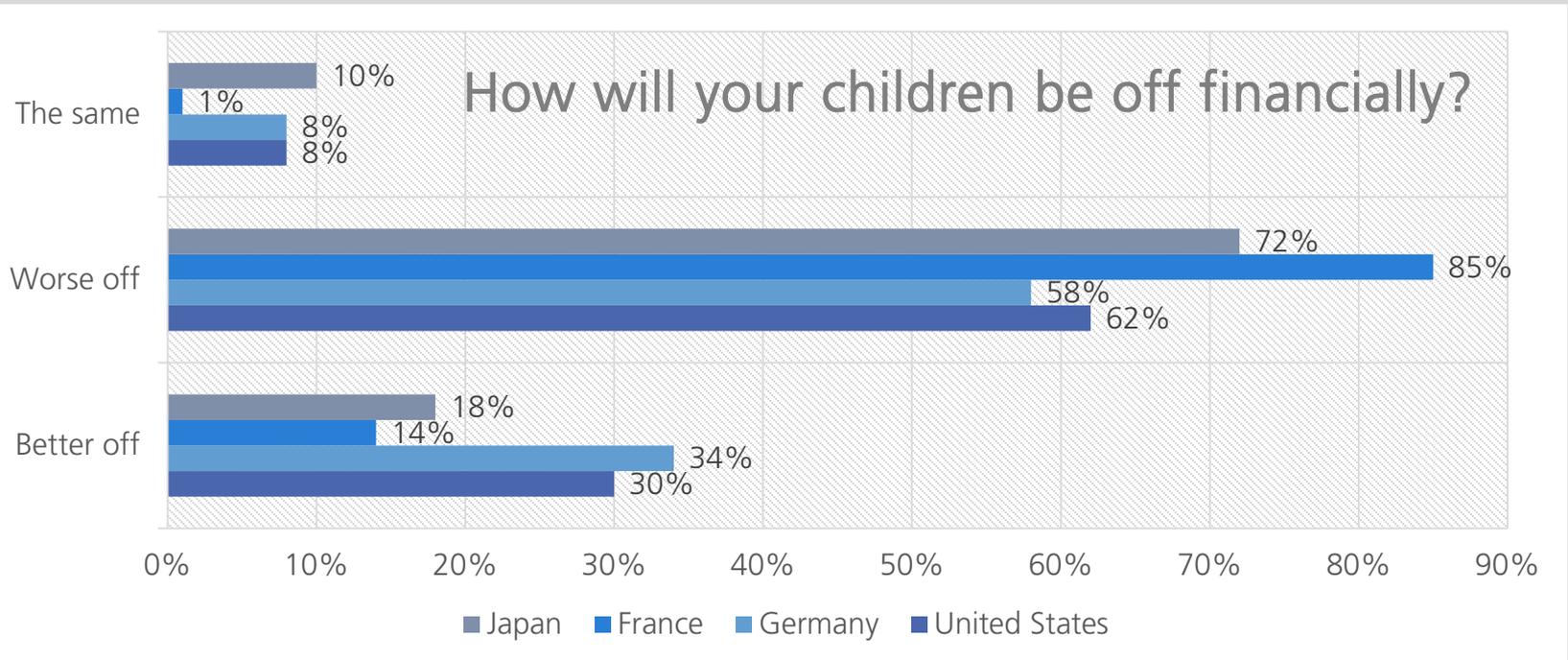


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What is happening
to societies?

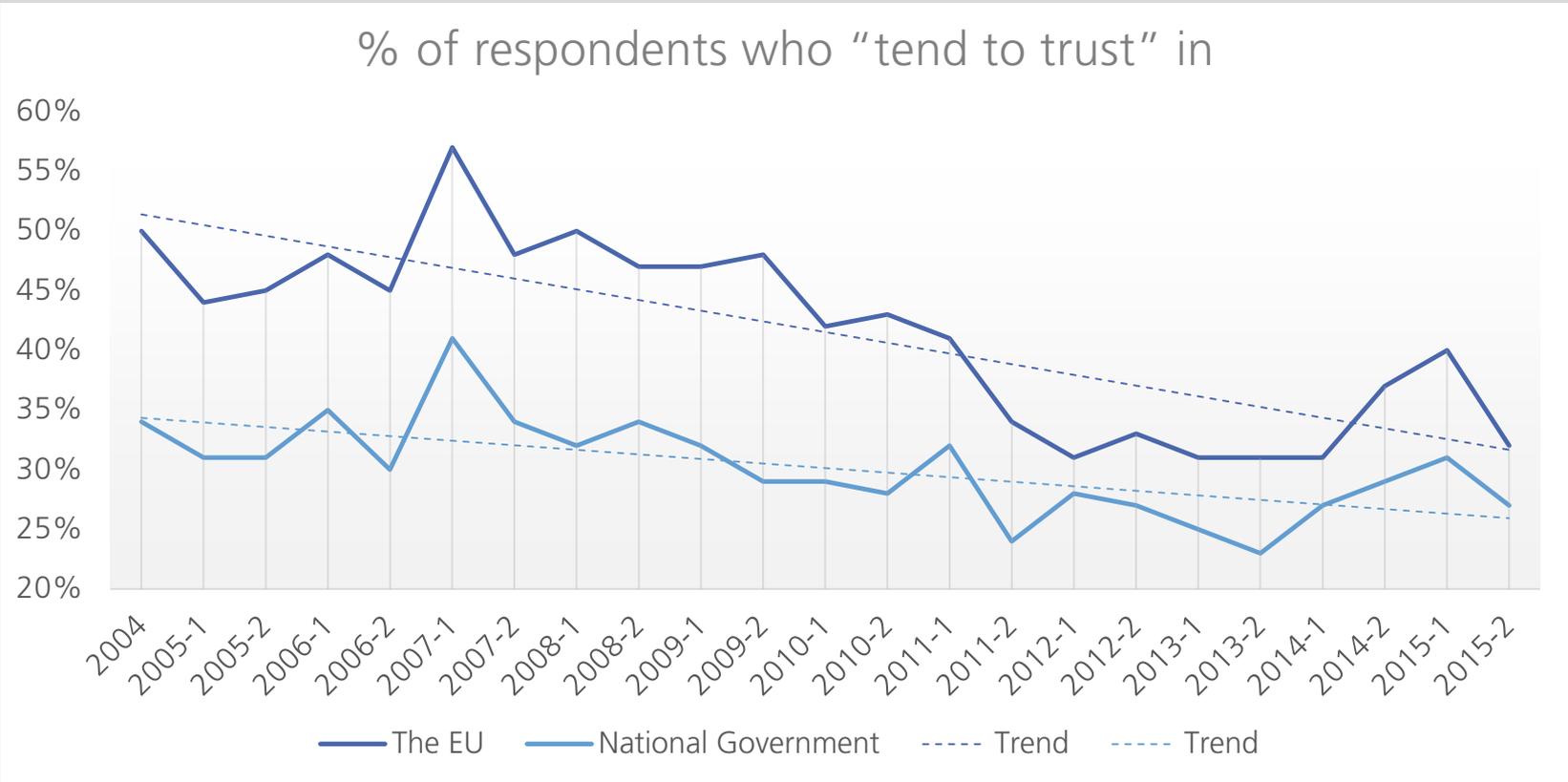
People feel they are not taken seriously

While a majority intuitively guesses that the times of growth are over, most politicians still focus on “restarting the growth engine.”



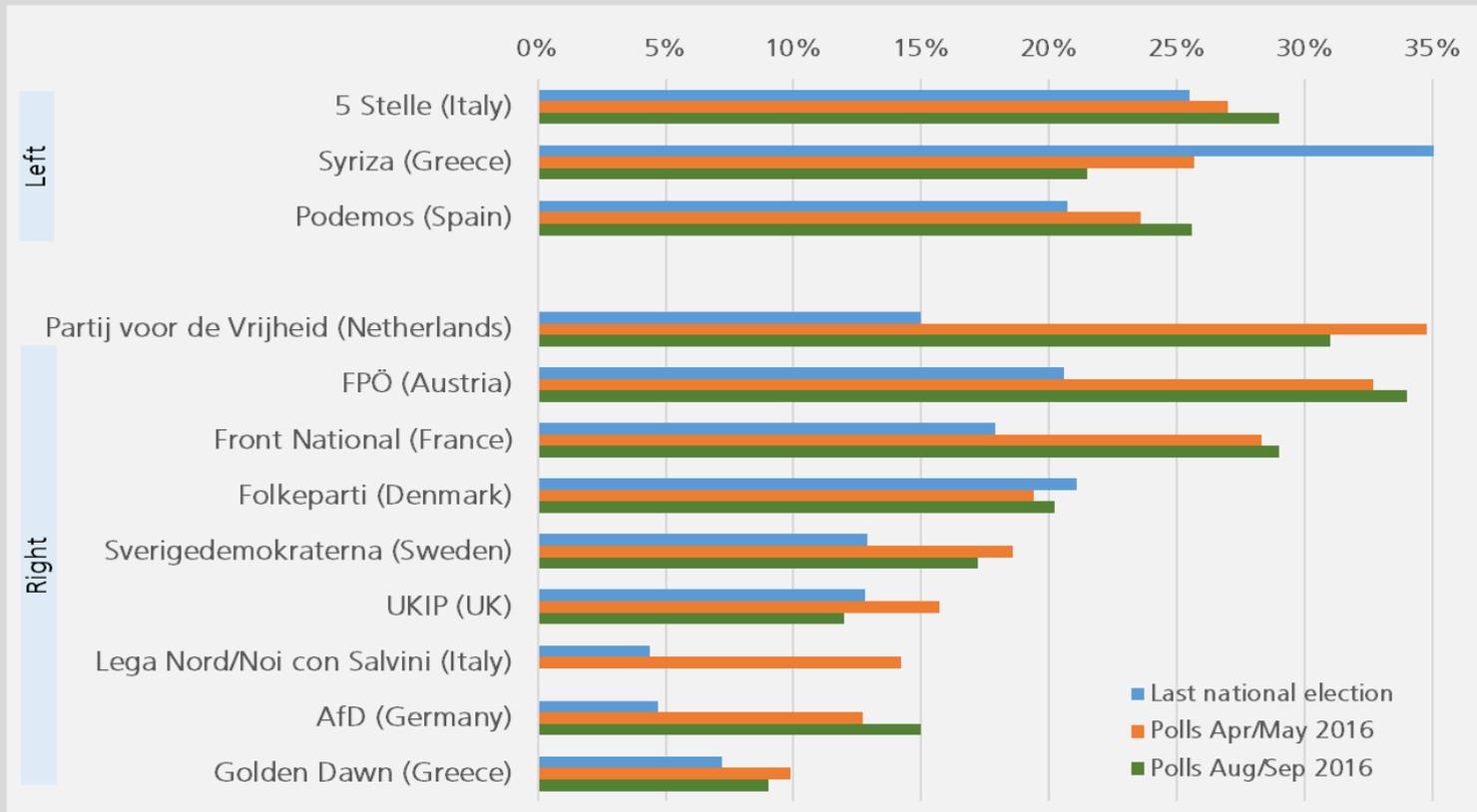
Source: Pew Research 2015

Consequence 1: Disenfranchisement

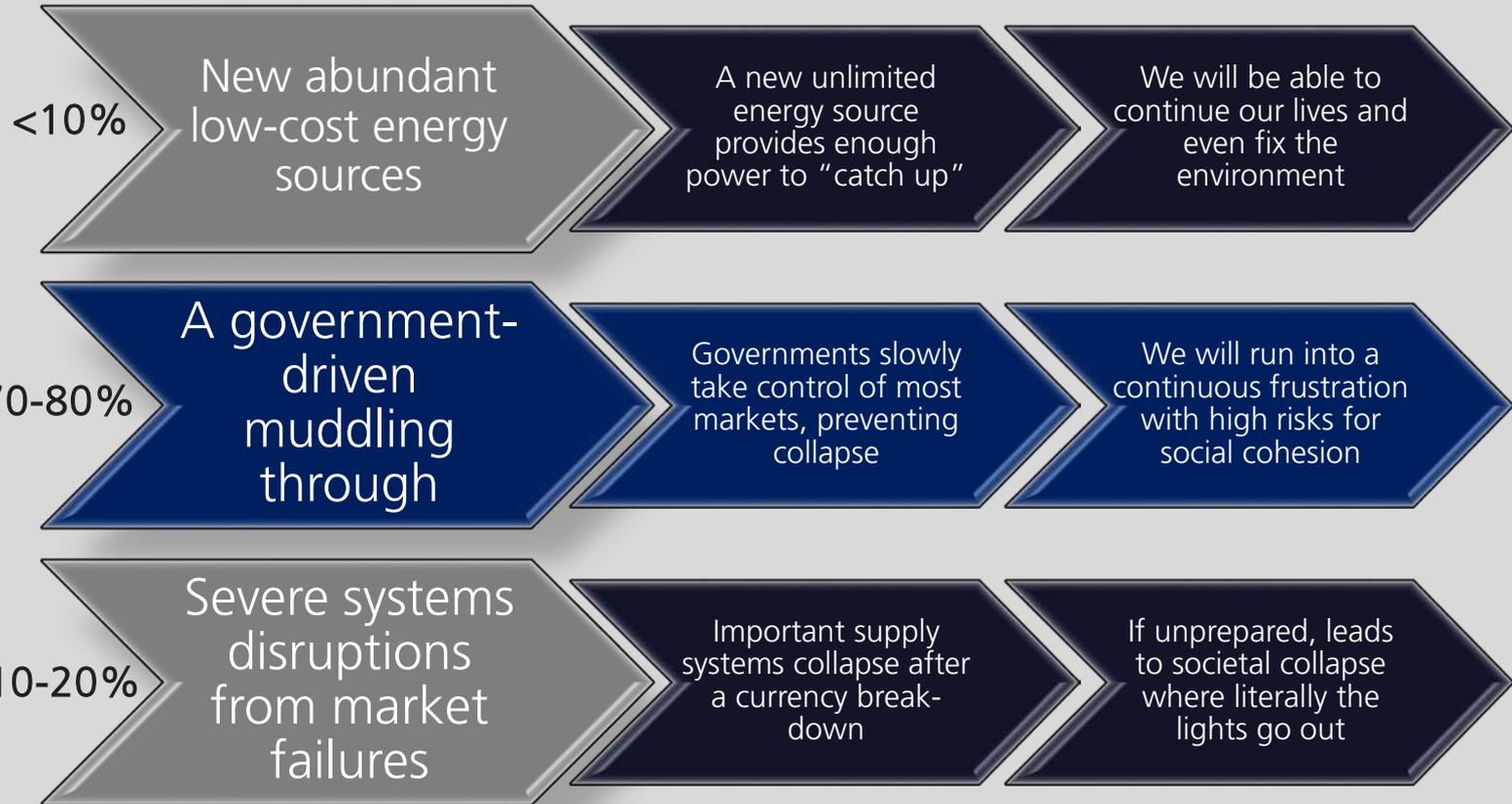


Source: Standard Eurobarometer 84 (2015)

Consequence 2: rise of extremism



IIER 2009 scenarios saw this coming



How will “muddling through” continue

Will we accept that the future will look different than the past and find back to a societal dialogue resolving the problem?



Will we further increase fighting and blaming and the search for pseudo-solutions, ending up with society falling to pieces?

IIR initiatives

Almost 10 years of IIER

The Institute for Integrated Economic Research, founded in 2007, is a non-profit research organization focused on developing an unbiased view of global economic processes.

IIER tries to re-focus economic research away from individual subsystems, towards a broader understanding of the larger forces driving overall progress or retreat. The global economic crisis that began in 2008 is a good example of why this is necessary - traditional economic science neither provided the ability to predict the current downturn, nor does it sufficiently explain the mechanisms at work.

IIER is an academia-type institution without a political or economic agenda, bound to science rather than opinion. Over the past decade, IIER has developed a macroeconomic model that works, and is building tools to help society plan for a resource-constrained future.

IIER has been right about almost everything in economics during the past 10 years, including resource/energy price dynamics, failure of economic systems to fully recover despite continued heavy-handed interventions, and, unfortunately, the quick rise of extreme parties.

In order to curtail negative implications on society, IIER is currently starting a more public outreach campaign in addition to its scientific efforts.

Science and Technology Projects (1)



resource models

- Energy- and resource-based economic planning and modeling tools with sub-models for water, energy, land use, and agriculture
- Under development with Stanford and Imperial



low tech inventors

- A platform/scholarship approach for sharing and patenting low-tech inventions that can be implemented in poor areas around the world
- Working on implementation plan

Science and Technology Projects (2)



iier economics prize

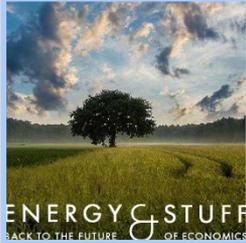
- Provide grants and prizes for young economists who integrate economics with natural and behavioral sciences, as well as finance
- **Concept ready, seeking funding**



iier faculty

- Establish a IIER faculty as part of a renowned university, with a full curriculum and master textbook, plus online courses for free study
- **Raw concept ideas**

Societal Impact Projects



energy & stuff

- A website/social media project educating people about resource constraints affecting growth and “living with less”, creating a positive spin on limits
- Launch: Oct-2016



Whose fault?

- Establish a teaser campaign aimed at deflecting people’s urge to blame someone for growing anxiety about the future.
- Concept ready, seeking funding for pilot

Please help us (and societies) getting through this difficult period. Read more on:

www.energyandstuff.org

Support us: <http://www.energyandstuff.org/launch/donate.html>