ING Economics Department

Too little, too much

The diverse sectoral challenges of water

Executive summary

Water stress and flood risk pose the challenge

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1. Projected 2% annual demand growth for freshwater will lead to serious constraints

The global demand for water is expected to grow by 2% annually in the coming decades. Available data point to demand meeting reliable, accessible, sustainable supply levels by 2023. By 2040 the gap between demand and this sustainable supply would even be 50%. With agriculture presently consuming over 800 litres per dollar gross value added and energy over 300, current water usage in terms of efficiency is far from sustainable.

50% of world population live in 7 countries that are prone to both water stress and flooding

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2. One out of two countries is prone to 'water stress'

Of the world's 60 largest economies, 29 are prone to water stress implying that future water demand might outstrip supply. These countries account for 57% of the global economy and harbour the vast majority of several water intensive industries: 88% of coal mining, 80% of textile production and 74% of global agriculture. The competition for water is therefore expected to intensify beyond the traditional water-food-energy nexus. Responsible water usage by corporations and improved water efficiency in agricultural will be key to securing adequate water availability in the future.

Countries prone to water stress make up **57%** of the global economy

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3. At the same time, flood-prone zones need better protection

Seven countries, including the economic powerhouses United States, China and India, are prone to flooding as well as water stress. It is estimated that worldwide, 600 million people and their businesses, often in coastal cities that support economic growth of those countries, need better flood protection. There are good examples of governments taking appropriate action but partnerships with the private sector will need to be stepped up to find solutions that will save lives and the significant costs of damage from floods in the future.

Agriculture top water user at a global level

Water is everywhere but freshwater is not

The importance of water is unquestioned. There is no life without water and trends such as global warming and an increasing world population put water at the forefront. Water, for example, is a key pillar in the UN Sustainable Development Goals. The World Economic Forum identified water supply crises as one of the top risks with the highest impact on the planet in the 21st century.

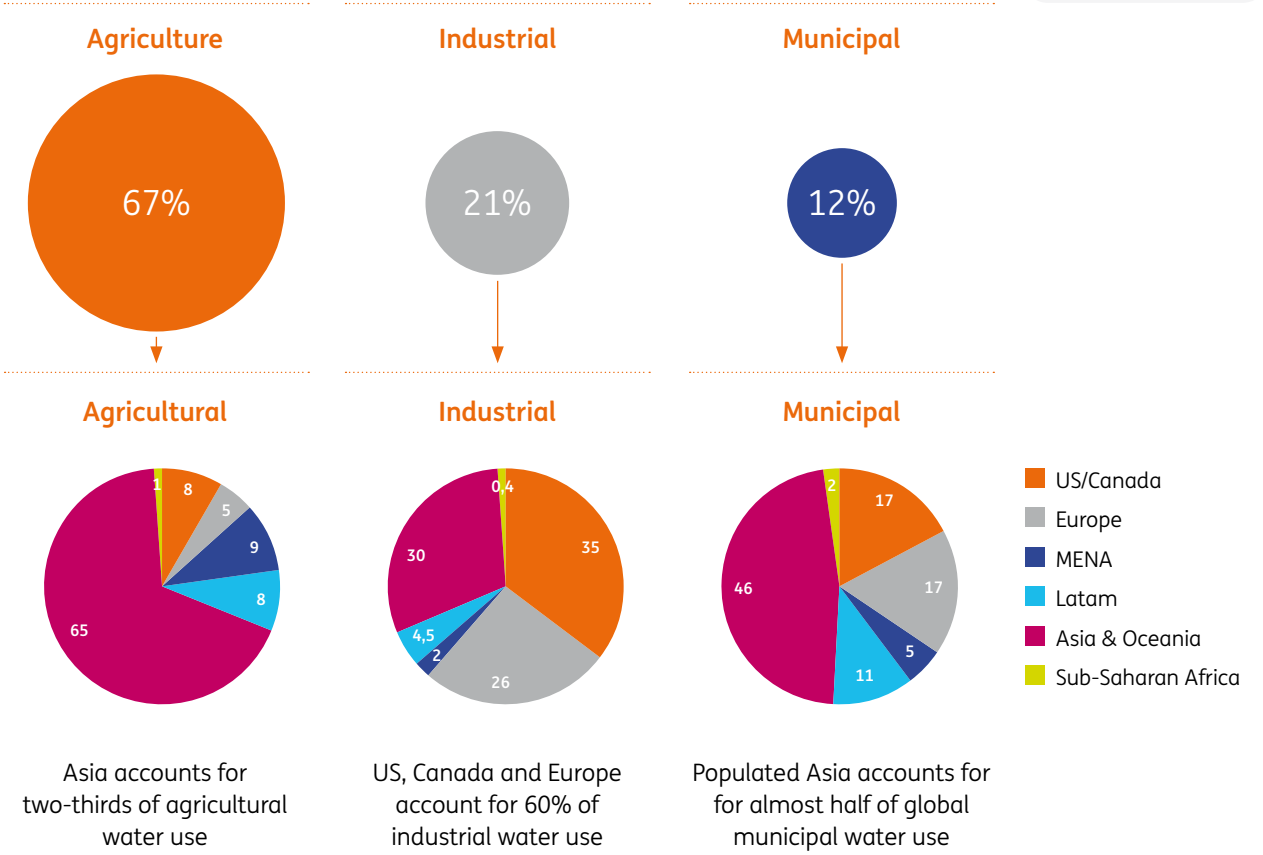
At first glance, water is seemingly abundant with oceans and seas accounting for 97.5% of water. This leaves freshwater, which is vital for life and used in many industrial processes, accounting for only 2.5% of the global water supply. Of this 2.5%, the majority is held in ice and glaciers and not readily available. Only groundwater and surface & atmospheric water can be obtained easily, and even then, it is not possible to reach a large proportion of groundwater. All in all, an estimated 0.1% of the water on earth can be obtained as freshwater.

Globally, agriculture currently consumes the most

Approximately 3,500 billion m3 of water globally is withdrawn every year from the fresh water resources. Most of this water (67%) is used in agriculture, mainly for irrigation purposes, while 21% is used for industrial purposes and 12% for municipal usage.

Global freshwater use
(% of total water usage)

Total use approx. 3,500 billion m^3 per annum



Asia accounts for two-thirds of agricultural water use

US, Canada and Europe account for 60% of industrial water use

Populated Asia accounts for for almost half of global municipal water use

Source: ING calculations, based on Aquastat.

Growing freshwater demand calls for responsible usage

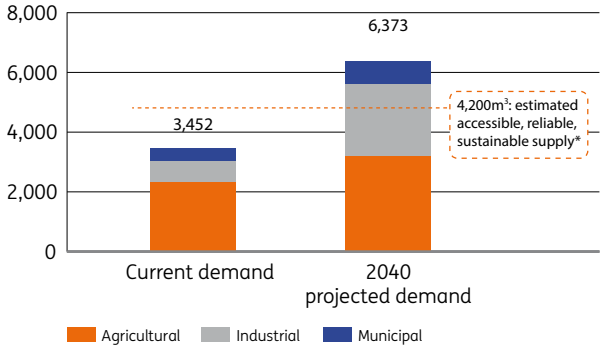
Industrialisation puts increasing pressure on water resources

With 24 of the 60 largest economies in the world classified as emerging markets (MSCI definition), many of these countries are likely to see economic development, resulting in the industrial sector becoming more prominent. Within the already growing demand for water due to population and economic growth in general, this trend will lead to an expected increasing share of industrial water usage, from 21% currently to an expected 38% in 2040. A large part of this will be consumed in the process of electricity production.

This demand growth is expected to lead to serious constraints. The influential report 'Charting our water future' of the 2030 Water Resources Group estimates existing (accessible, reliable, sustainable) freshwater supply at 4,200 billion m^3, which leaves a wide gap of 50% versus projected future demand of 6,400 billion m^3 in 2040. This clearly calls for responsible use of water across sectors and businesses.

Freshwater demand keeps on rising with fastest growth in industry

Billion m^3



Source: ING calculations, based on IFPRI, Aquastat.
* Supply estimate based on Charting our water future report: Existing supply which can be provided at 90% reliablity, net of environmental requirements.

Estimated compound annual growth rate of freshwater usage by sector towards 2040

4.4%	Industrial use
2.2%	Municipal use
1.2%	Agricultural use
2.1%	**Total**

Hundreds of litres of water are used for each dollar of value added

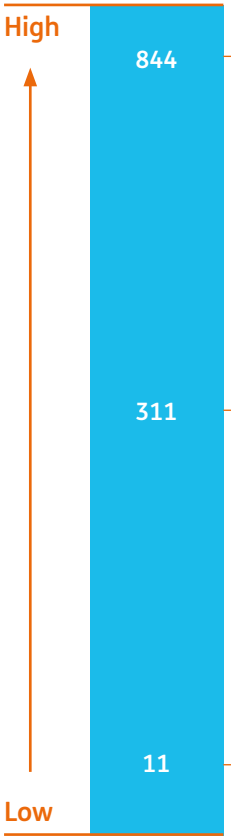
The real economic value of water is clearly not priced into production of goods today

Water use in terms of litres used per US$ value added provides an indication of water efficiency as well as water pricing for production within that sector. Whilst the global average for agriculture is a staggering 844 litres per US$1 value added, the water intensity gap between the developed and developing countries is also enormous.

For example, the Netherlands on average uses 7.4 litres for US$1 value added in agriculture. These extraordinary numbers in developing countries clearly indicate that no (serious) price is currently attached to water use, leading to significant wastage and a linear usage model. Pricing which reflects more closely the true economic value of water would be a driver that leads to conservation, and a circular model for water usage in the future.

Global water intensity by sector (direct use)

Litres/US$ value added (global average)



Agriculture

Variances in crop types, water efficiency levels and sectoral structure (large subsistence farmers based in developing nations versus industrialised farming in developed nations) creates deviations in water usage. India is a big user, accounting for 28% of global agricultural water usage. Countries with a high water intensity include Chile, Pakistan, Vietnam, Venezuela and Philippines with usage levels over 2,000 litres per $ value added.

Energy

Coal is the most water intensive electricity production sector closely followed by nuclear and natural gas. Solar and wind on the other hand use negligible amounts of water. In nuclear power, water is mainly used as a cooling medium and also controlling waste and risks of radiation. In terms of litres used, the industrialized countries, with US and China at the forefront, use by far the most water (both in absolute as well as relative terms).

Industrial (non-energy)

Water is used in the production of many goods. The most water-intensive sectors are paper and textile production (rough estimate 100 litres/$ value added). Metals mining and base metal production consume relatively large amounts of water for e.g. cleaning and cooling (rough estimate 20 litres/$ value added). Water is also a relevant, but in terms of direct usage smaller factor, in the chemicals and food & beverages sectors. Having said that, from a supply chain perspective food & beverages companies have a large role to play in improving agricultural water efficiency.

Source: ING calculations, based on Aquastat, Oxford Economics

Water, energy and food: three interconnected necessities

An integrated view of the three basic interconnected necessities

Water, energy and food are three intricately linked basic necessities of life. Water clearly is a key input for agricultural production and along the entire food supply chain, as well as for energy production. Energy is also required to produce and distribute food and water: for example in irrigation, groundwater pumping, processing and transport.

In a world of water scarcity, one in which agriculture and energy are the two most water-intensive sectors, a point will be reached where one basic necessity may need to be chosen over another.

Climate change will hit energy-related water use in multiple ways

- Not enough water: without enough water for cooling, power plants must cut back production or even shut down.
- Incoming water too warm: rising temperatures can make water supplies too warm for cooling, forcing power plants to reduce their electricity production when it's needed most.

Source: ucsusa.org

Energy mix and agricultural water efficiency are key

Over half of global electricity produced still comes from coal (around 40%) and nuclear (around 10%) sources, both of which are highly water intensive. With water supply uncertainty, investment in new water sources such as desalinization, deeper wells or longer pipelines is required – all of which increase the use of electricity. This vicious circle can only turn virtuous by incorporating the energy mix into strategies to improve water efficiency. Innovative cooling techniques and investment in renewables can make a substantial contribution.

On the agricultural side water use efficiency will need to increase through reducing water losses, increasing yields per drop, careful crop selection to match local water availability and decreasing agricultural water pollution, thereby increasing supply and decreasing demand.
A worst-case scenario in which freshwater and food security is lost would lead to major disruption in global food prices. Furthermore, it eventually could ultimately lead to social unrest and/or involuntary mass migrations.

Sustainable solutions

"Applying multiple use of cooling water instead of 'once-through cooling' could reduce the water footprint of thermoelectricity by more than two-thirds.
Adding to this, increasing wind and PV solar energy to 40% of the grid, the combined effect would be a 82% reduction of the water footprint and 27% decrease in consumptive water use".

Source: Rivers Network, Burning our Rivers, 2012

Majority of water intensive industries are located in countries prone to water stress...

Almost half of the 60 largest economies likely to face (extremely) high 'water stress'

Of the world's 60 largest economies, 29 are ranked "high to extremely high" for water stress risk by the World Resources Institute, using a 'business-as-usual'-scenario in terms of climate policy. Water stress occurs when demand for water exceeds the available amount during a certain period or when poor quality restricts its use. These 60 countries provide 57% of global GDP and consist of most of MENA, a large part of Asia, some Latin American countries and the US.

Several water-intensive sectors show high concentration of production in terms of gross value added in these 29 countries: 88% of coal mining, 80% of textile production and 74% of global agriculture are located in these countries.

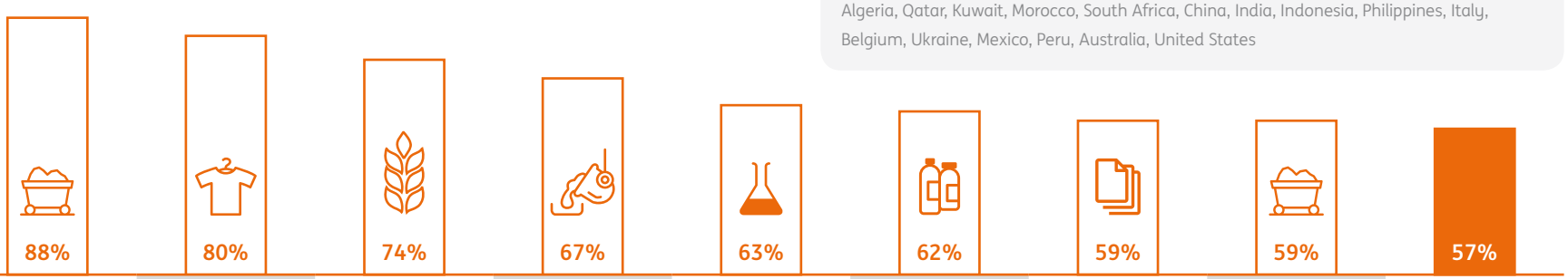
Extending the water-energy-food nexus

So not only energy and food are in competition for water. Other necessities of life such as clothing and base metals and chemical products are as well. Many industries in water-stressed countries are in competition over precious water resources.

Majority of water intensive industries are located in countries prone to water stress

Share of 29 countries* prone to water stress in world total, by sector

*29 countries which WRI indicate high to extremely high water stress (2040): Pakistan, Spain, Turkey, Greece, Portugal, Kazakhstan, Chile, Saudi Arabia, Iran, UAE, Israel, Singapore, Iraq, Algeria, Qatar, Kuwait, Morocco, South Africa, China, India, Indonesia, Philippines, Italy, Belgium, Ukraine, Mexico, Peru, Australia, United States



	coal mining	textiles	agriculture	base metal	chemicals / refining	F&B	paper production	metals mining	global GDP
Top-4 producers (of 29 countries prone to water stress, in terms of GVA)	China (53%)	China (40%)	China (30%)	China (43%)	China (27%)	China (25%)	US (22%)	US (12%)	US (12%)
	Australia (11%)	India (8%)	India (11%)	US (8%)	US (17%)	US (16%)	China (18%)	Australia(10%)	Australia(10%)
	US (8%)	Italy (5%)	US (6%)	India (6%)	S-Arabia (3%)	Mexico (3%)	Indonesia (3%)	China (6%)	China (6%)
	Indonesia (4%)	Indonesia (5%)	Indonesia (4%)	Italy (1%)	India (2%)	India (3%)	Italy (1%)	Chili (5%)	Chili (5%)

Source: calculations ING Economics Department, based on Oxford Economics, WRI

...and in countries already experiencing flooding

Almost one third of the world's largest economies are expected to experience (extremely) high flood risk

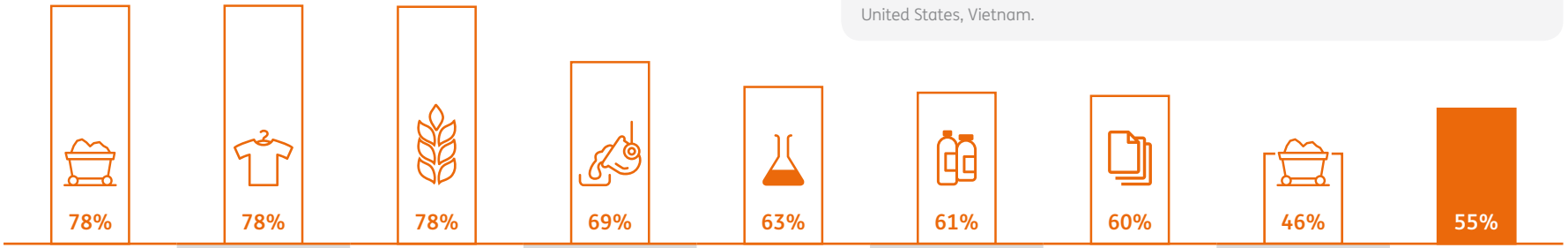
Many industries are in competition for water, but there are also regions where the main concern for businesses is to protect against too much water. Of the world's 60 largest economies selected for this report, 21 face high to extremely high flood risk, based on actual floods over 1985-2011. The picture for flood risks resembles the picture for water stress, with coal mining, textile manufacturing and agriculture being the sectors most prone to flood risk. Of course both water stress and flood risk can vary considerably between regions within countries, but the overall picture is that several water-intensive sectors are highly concentrated in countries prone to flooding.

7 out of 60 countries experience high water stress as well as flood risk. These countries are the United States, China, India, Indonesia, Philippines, Pakistan and Iran. Together they account for 42% of global GDP and half of the world population lives in these countries. Businesses that are located in the flood prone regions of these countries face two water challenges; how to get enough water for production and how to protect the business from flooding.

Majority of water intensive industries located in countries prone to flooding

Share of 21 flood prone countries* in world total, by sector

*21 countries that the WRI indicates as high to extremely high flood risk are: Austria, Bangladesh, Brazil, China, Colombia, Czech Republic, Hungary, India, Indonesia, Iran, Korea, Malaysia, Nigeria, Pakistan, Philippines, Romania, Switzerland, Thailand, United Kingdom, United States, Vietnam.



	coal mining	textiles	agriculture	base metal	chemicals / refining	F&B	paper production	metals mining	global GDP
Top-4 producers (of 21 'flood prone countries', in terms of GVA)	China (53%)	China (40%)	China (30%)	China (43%)	China (27%)	China (25%)	US (22%)	US (12%)	US (23%)
	US (8%)	India (8%)	India (11%)	US (8%)	US (17%)	US (16%)	China (18%)	Brazil (12%)	China (14%)
	Indonesia (4%)	Indonesia (5%)	US (6%)	Korea (6%)	Korea (3%)	Brazil (4%)	Brazil (4%)	China (6%)	UK (4%)
	Malaysia (4%)	US (5%)	Nigeria (4%)	India (6%)	India (2%)	India (3%)	Indonesia (3%)	Indonesia (5%)	Brazil (3%)

Source: calculations ING Economics Department, based on Oxford Economics, WRI (from Aquastat)

Climate change puts flood risk higher on the agenda

Impact of climate change on flood risk:

- sea levels to increase
- more extreme weather events
- increased rainfall

Global warming increases the risk of flooding

Global temperatures have increased by 1 degree Celsius from pre-industrial levels. Four million square kilometres of ice has melted as a result, causing the sea level to rise by 19 centimetres. That might not seem a lot but the potential influence of rising sea levels is certainly significant.
The two most vulnerable icecaps are the ones of Greenland and the West Arctic. If they were to melt completely then the sea level will rise by 12 metres, 7 from the Greenland ice cap and 5 from the Arctic one. Fortunately the sea level rise is not expected to rise anything like that in the foreseeable future but this does illustrate the importance of controlling global warming.

Example

New York: making a vulnerable city flood resilient

The damage from hurricane Sandy came as a surprise to New Yorkers. The city turned out to be extremely vulnerable as:

- New York has no defence strategy in terms of outer and inner defences such as dykes as well as water connections between the two;
- 9/11 had resulted in many companies moving their most valuable assets to their basements;
- New York's critical infrastructure and buildings like hospitals, power stations, sewage treatment and telecommunications are located near the water, without proper flood protection;
- Manhattan has a dense underground metrosystem that leads the water straight into the city.

Solution: The Big U

A 10-mile water protective system around Manhattan, called The Big U, is being built to protect the city from floods and storm water while also creating vibrant public and private spaces for the diverse communities of New York.

New York water facts	
Annual precipitation	1,130.2 mm
Population	8.4 million
Flood risk	Very high
Damage by Sandy	US$ 65 billion

As many as 600 million people need better flood protection

Vulnerability of coastal zones

Over the past three decades more than 2.8 billion people globally have been affected by floods and the statistics are expected to deteriorate as a result of climate change. Businesses have long been drawn to coastal areas as they provide resources and trading opportunities. Populations and economic activities in these costal zones are most vulnerable to flooding and house around 600 million people in need of better flood protection. If this is not provided, a swelling flow of environmental refugees will emerge, seeking shelter elsewhere in the country or even in other countries. Climate adaptation measures are therefore expected to increase in flood-prone cities around the world.

Population living at low elevation coastal zones

(million people and share in urban areas)

Region	Population (million)	Urbanisation (share living in urban areas)
Africa	56	55%
Asia	466	51%
Europe	50	80%
Latin America	29	79%
Australia & New Zealand	3	100%
North America	24	88%
Small Island States	8	87%
World	**634**	**57%**

Source: IIED.

Examples

Photo: www.kuiper.nl

Jakarta

Jakarta is sinking at an alarming rate of 7.5 (and some parts even 14) centimetres per year. Without intervention large parts of the city, housing four and a half million people, will be submerged by the sea. To address the sinking of Jakarta the government completed the National Capital Integrated Coastal Development master plan in November 2014. The plan consists of a broad set of measures including strengthening and raising the existing sea wall and in the long term the creation of an outer sea wall defence in the form of the Great Garuda, the National symbol of Indonesia.

The Netherlands

About 60% of the Netherlands lies beneath sea-level, the lowest village at a depth of 6.76 metres. Flood protection is of vital importance and the Dutch are renowned for it. The main strategies from the 2015 Deltaplan are:

- Raising and widening of dykes and dunes;
- Making room for rivers so they can overflow in controlled areas;
- Strengthen water storage capacities of cities;
- Create water overflows, for example from rivers to lakes and from lakes to the sea;
- Protect vital infrastructure.

Closing remarks

In this report, we link various data sources on water use and economic activity in the world's 60 largest economies, and a number of important sectoral issues have been quantified. 29 countries prone to water stress make up 57% of the global economy and currently account for 88% of value added in mining of coal and 74% of value added in agriculture.

These main findings lead to follow-up questions, such as:

- How to reflect the true value of water in economic decision making?
- Are governments sufficiently addressing and investing in water challenges through their current policies and regulations?
- To what extent has the private sector stepped up efforts to mitigate the impact of water challenges and can more be done?
- What opportunities could arise for different stakeholders in the water sector to support collaboration and public-private partnerships?

Given the significant demand for water across sectors and urgency with which the issue of water supply and use needs to be addressed, we believe these questions already have, and will continue to gain increasing attention. ING is committed to investigating the subject further through economic research and partnerships.

Appendix

World's 60 largest economies

	GDP (bln $)	Share in global economy	Global rank
Europe			
Germany	3,860	5.0%	4
United Kingdom	2,945	3.8%	5
France	2,847	3.7%	6
Italy	2,148	2.8%	8
Russia	1,857	2.4%	10
Spain	1,407	1.8%	14
Netherlands	866	1.1%	17
Turkey	806	1.0%	18
Switzerland	712	0.9%	20
Sweden	570	0.7%	22
Poland	547	0.7%	23
Belgium	535	0.7%	25
Norway	500	0.6%	26
Austria	437	0.6%	27
Denmark	341	0.4%	33
Finland	271	0.4%	39
Ireland	246	0.3%	42
Greece	238	0.3%	43
Portugal	230	0.3%	44
Kazakhstan	212	0.3%	47
Czech Republic	206	0.3%	50
Romania	200	0.3%	52
Hungary	137	0.2%	57
Ukraine	131	0.2%	58

	GDP (bln $)	Share in global economy	Global rank
US/Canada			
United States	17,419	22.6%	1
Canada	1,789	2.3%	11
Latin America			
Brazil	2,353	3.1%	7
Mexico	1,283	1.7%	15
Argentina	540	0.7%	24
Colombia	385	0.5%	30
Chile	258	0.3%	40
Venezuela	206	0.3%	49
Peru	203	0.3%	51
Middle East & Northern Africa			
Saudi Arabia	752	1.0%	19
Iran	404	0.5%	28
United Arab Emirates	402	0.5%	29
Israel	304	0.4%	36
Egypt	286	0.4%	37
Iraq	221	0.3%	45
Algeria	214	0.3%	46
Qatar	210	0.3%	48
Kuwait	172	0.2%	56
Morocco	109	0.1%	60

	GDP (bln $)	Share in global economy	Global rank
Sub-Saharan Africa			
Nigeria	574	0.7%	21
South Africa	350	0.5%	32
Angola	129	0.2%	59
Asia (excl. Middle East)			
China	10,670	13.8%	2
Japan	4,616	6.0%	3
India	2,050	2.7%	9
Korea	1,417	1.8%	13
Indonesia	889	1.2%	16
Thailand	374	0.5%	31
Malaysia	327	0.4%	34
Singapore	308	0.4%	35
Philippines	285	0.4%	38
Pakistan	250	0.3%	41
Vietnam	186	0.2%	54
Bangladesh	185	0.2%	55
Oceania			
Australia	1,444	1.9%	12
New Zealand	198	0.3%	53

Source: IMF, 2014 nominal data.

Colophon

Authors

Gerben Hieminga	ING Economics Department	gerben.hieminga@ing.nl	+31 6 8364 0072
Jurjen Witteveen	ING Economics Department	jurjen.witteveen@ing.nl	+31 6 8363 5786

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