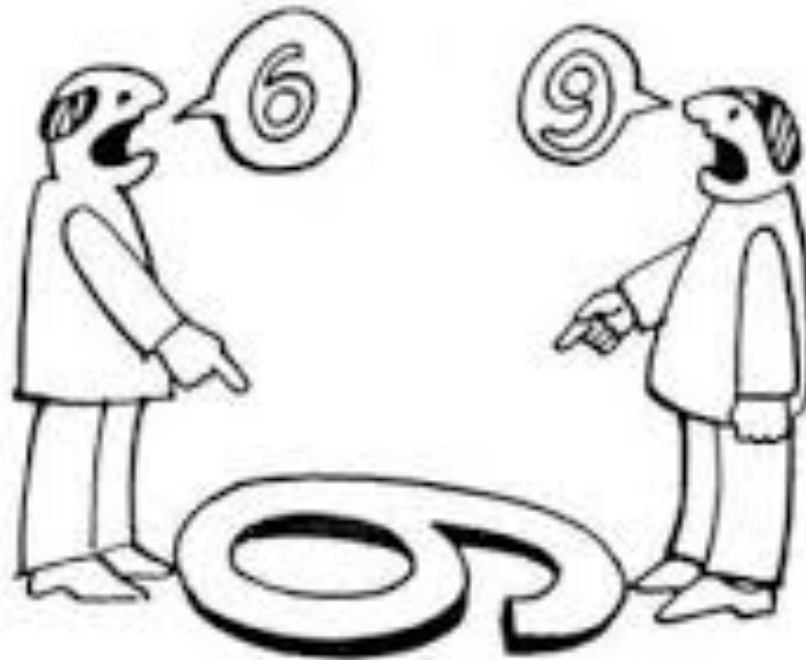


Percepcija i samopercepcija biotehnologije u Hrvatskoj

Antonio Starčević, Prehrambeno–biotehnološki fakultet Sveučilišta u Zagrebu, Kabinet za bioinformatiku, astar@pbf.hr



***DISCLAIMER:** The findings, interpretations and conclusions expressed herein are those of the author and do not necessarily reflect the view of the Faculty of Food Technology and Biotechnology.

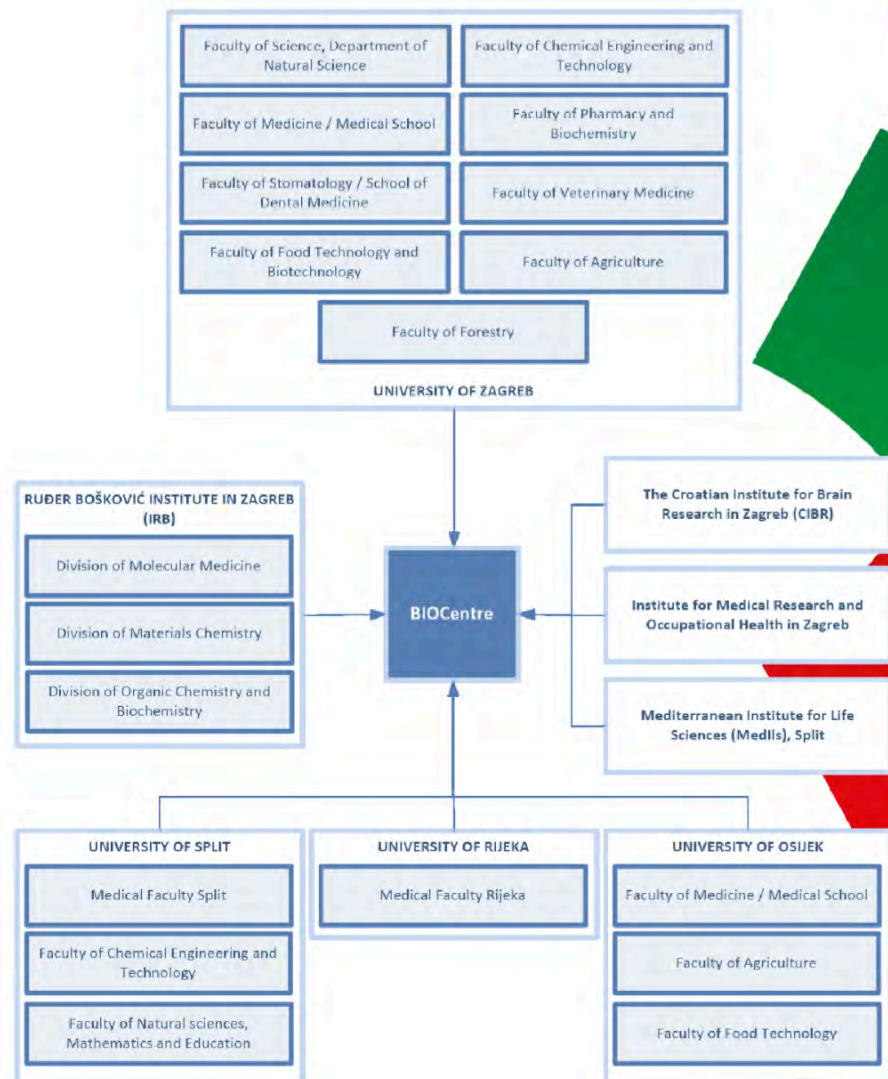
Samopercepcija

IZVORI:

- Inkubacijski centar za bioznanosti i komercijalizaciju tehnologije (BIOCentar) – prezentacija
- Dettenhofer et. al. “Current state and prospects of biotechnology in Central and Eastern European countries. Part II: new and preaccession EU countries (CRO, RO, B&H, SRB)”, 2018.



Croatian biotechnology science and research system and stakeholders



Biosciences in Croatia

- 36,6% of all R&D groups in Croatia are engaged in biosciences
- 47,1% persons engaged in R&D in Croatia are working in biosciences
- 43,9% published research papers in Croatia are in the field of bioscience
- 42.7% of total domestic investments in R&D are investments in the field of bioscience

Proof-of-Concept Programme managed by HAMAG-ICRO as indicator of Biotechnology startups in Croatia

POC Programme project portfolio for BIOCentre

Contracted						
Applicant type	NO Value	NO Count	YES Value	YES Count	Total	Count
PRIVATE	983.679,95 €	21	281.449,37 €	7	1.265.129,32 €	28
PUBLIC	1.549.061,91 €	41	641.554,03 €	18	2.190.615,94 €	59
Total	2.532.741,86 €	62	923.003,40 €	25	3.455.745,26 €	87

POC Projects per technology sector

Contracted						
Applicant type	NO Value	NO Count	YES Value	YES Count	Total	Count
Biotechnology & Pharmaceuticals	1.645.773,16 €	40	750.926,68 €	20	2.396.699,83 €	60
Food technology	886.968,70 €	22	172.076,73 €	5	1.059.045,43 €	27
Total	2.532.741,86 €	62	923.003,40 €	25	3.455.745,26 €	87

Proof-of-Concept Programme managed by HAMAG-BICRO as indicator of Biotechnology startups in Croatia

POC Private Sector projects by county

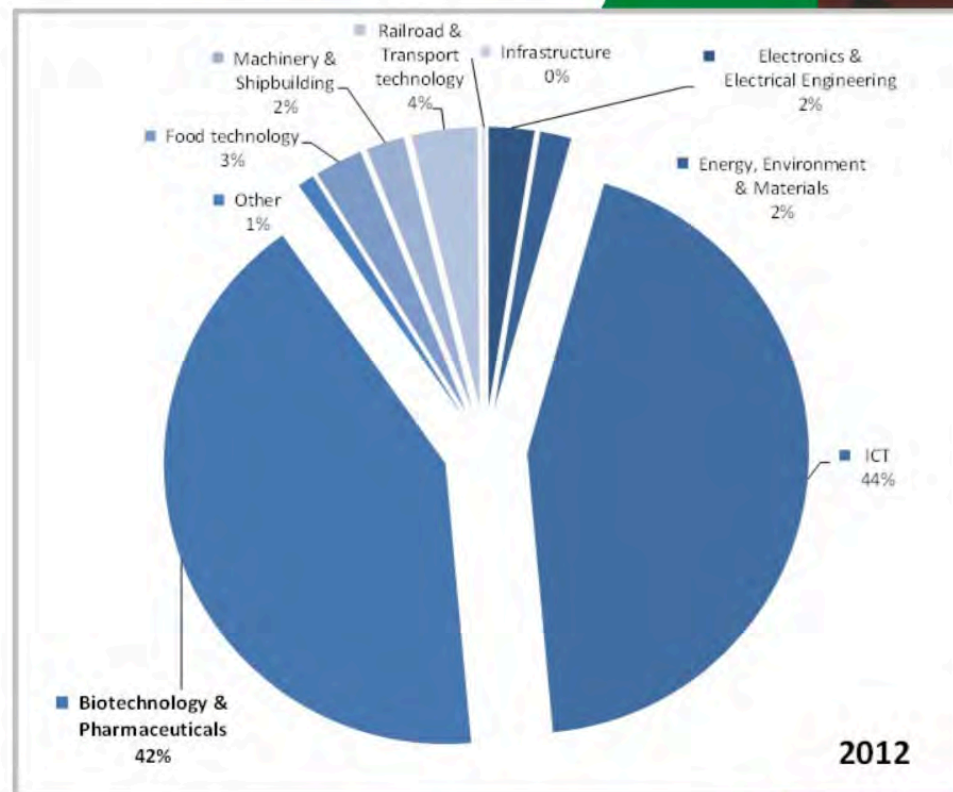
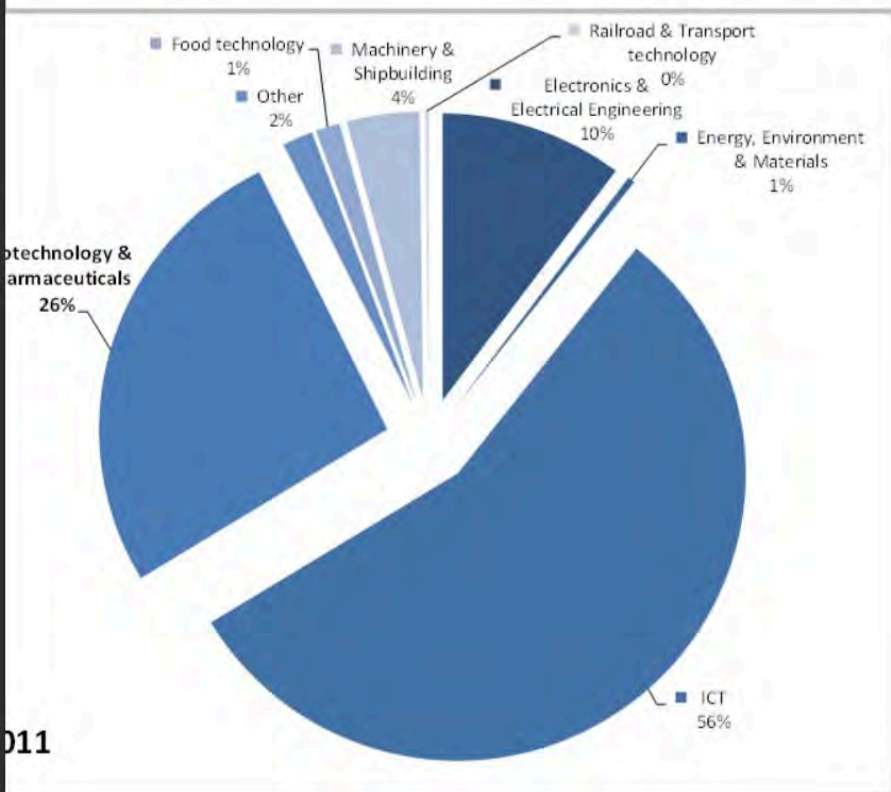
Counties with Private Sector Projects	Biotechnology & Pharmaceuticals	Food technology	Total
Međimursko-bilogorska županija		42.105,26 €	42.105,26 €
Grad Zagreb	310.565,16 €	69.298,29 €	379.863,45 €
Međimurska	87.540,92 €	37.297,24 €	124.838,17 €
Vukovarsko-srijemski	138.815,79 €		138.815,79 €
Šibenik-karlovacka	69.702,86 €	53.012,61 €	122.715,47 €
Zadar	62.631,58 €		62.631,58 €
Varaždinska	56.751,18 €	84.210,53 €	140.961,71 €
Krapinsko-zagorska	235.303,16 €	17.894,74 €	253.197,89 €
Total	961.310,65 €	303.818,67 €	1.265.129,32 €

Source: Croatian Agency for SMEs, Innovations and Investments (HAMAG-BICRO)

Business R&D expenditures per type and technology sector in Croatia for 2011 – 2012

Technology sector	BASIC	APPLIED	DEVELOPMENT	Grand Total
2011	813.735,42 €	22.387.131,99 €	35.197.186,12 €	58.398.053,53 €
Electronics & Electrical Engineering	- €	2.433.472,54 €	3.557.336,73 €	5.990.809,27 €
Energy, Environment & Materials	- €	- €	233.441,66 €	233.441,66 €
Food technology	- €	3.388.969,93 €	29.122.206,86 €	32.511.176,79 €
Information technology & Pharmaceuticals	448.750,73 €	14.653.141,86 €	274.837,75 €	15.376.730,35 €
Other	291.012,81 €	- €	710.898,31 €	1.001.911,12 €
Food technology	- €	794.620,19 €	- €	794.620,19 €
Machinery & Shipbuilding	73.971,88 €	1.014.751,14 €	1.297.448,55 €	2.386.171,57 €
Road & Transport technology	- €	102.176,34 €	1.016,25 €	103.192,59 €
2012	321.726,59 €	5.972.502,49 €	57.192.817,96 €	63.487.047,05 €
Electronics & Electrical Engineering	- €	381.440,14 €	1.279.256,30 €	1.660.696,44 €
Energy, Environment & Materials	- €	417.181,04 €	718.160,04 €	1.135.341,08 €
Food technology	- €	780.924,31 €	27.244.591,27 €	28.025.515,58 €
Information technology & Pharmaceuticals	321.726,59 €	914.010,54 €	25.188.535,34 €	26.424.272,48 €
Other	- €	334.585,34 €	276.917,23 €	611.502,57 €
Food technology	- €	1.373.555,16 €	377.359,69 €	1.750.914,86 €
Machinery & Shipbuilding	- €	592.891,78 €	804.171,63 €	1.397.063,41 €
Road & Transport technology	- €	1.091.488,39 €	1.303.826,47 €	2.395.314,86 €
Infrastructure	- €	86.425,77 €	- €	86.425,77 €
Grand Total	1.135.462,01 €	28.359.634,48 €	92.390.004,08 €	121.885.100,58 €

Structure of R&D Expenditure per Technology sector in Croatia for 2011-2012



Some of the Croatian R&D performing companies

Company	Sector	Investment into R&D		
		2011	2012	Total
AMALGEN D.O.O.	Biotechnology & Pharmaceuticals	144.635,73 €	71.318,13 €	215.953,86 €
BAGHEERA D.O.	Biotechnology & Pharmaceuticals	98.797,06 €	- €	98.797,06 €
Bc Institut za oplemenjivanje i proizvodnju bilja d.d.	Food technology	449.336,92 €	432.105,12 €	881.442,03 €
BELUPO d.d.	Biotechnology & Pharmaceuticals	796.264,46 €	325.533,88 €	1.121.798,33 €
BIOZYNE d.o.o.	Biotechnology & Pharmaceuticals	- €	69.331,17 €	69.331,17 €
CEDEVITA d.o.o.	Food technology	255.604,08 €	292.451,00 €	548.055,08 €
GENERA d.d.	Biotechnology & Pharmaceuticals	16.517,00 €	204.871,50 €	221.388,50 €
GENERA ISTRAŽIVANJA D.O.O.	Biotechnology & Pharmaceuticals	193.455,89 €	233.396,36 €	426.852,24 €
Gen-info d.o.o.	Biotechnology & Pharmaceuticals	- €	103.799,69 €	103.799,69 €
GENOS D.O.O.	Biotechnology & Pharmaceuticals	142.740,86 €	107.622,06 €	250.362,92 €
JGL D.D. RIJEKA	Biotechnology & Pharmaceuticals	130.994,14 €	458.339,11 €	589.333,25 €
KALI TUNA D.O.O.	Food technology	89.679,19 €	- €	89.679,19 €
LUKAČ D.O.O.	Food technology	- €	318.729,88 €	318.729,88 €
NEVA D.O.O.	Food technology	170.923,40 €	176.385,03 €	347.308,43 €
PLIVA HRVATSKA D.O.O.	Biotechnology & Pharmaceuticals	13.376.391,93 €	24.632.133,69 €	38.008.525,62 €
PODRAVKA d.d.	Food technology	- €	531.243,83 €	531.243,83 €
Total		15.865.340,67 €	27.957.260,43 €	43.822.601,10 €


Dettenhofer et. al. Part I

- Biotechnology is a key sector of **research** and **innovation**, which could substantially contribute to the development of **high-tech industries**, progress, and the well-being of society.
- Part I focused on Central Europe (CZ, H, PL, SK)
- Part II focused on selected new and pre-accession EU countries (**CRO**, RO, B&H and SRB).
- These selected **eight countries** are a **representative sample** of the whole CEE region

Part I

- The CEE countries have significantly contributed to the foundations of early biological discoveries (**strong tradition**).
- **Modern BT** work mainly **restricted to the academic settings** within the CEE countries, had a slower start, for-profit companies were only realizable in the period after 1989.
- Regarding H2020 funds, V4 countries still lag behind more developed EU members.

Major challenge: Bridging the **gap** between the functioning of the **academic** and **research** environments, with that of the profitable **private sector BT** companies!

20  M. DETTENHOFER ET AL.

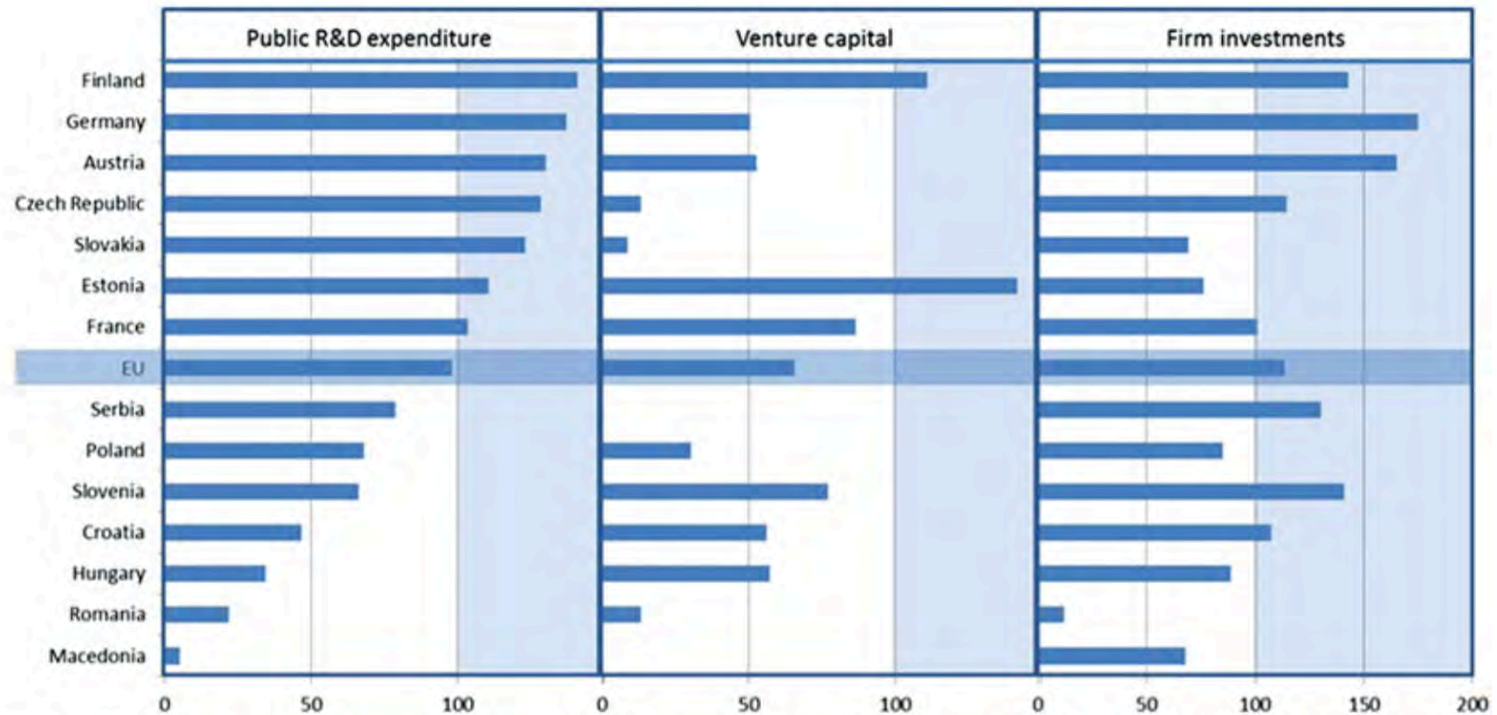


Figure 7. Comparison of selected European countries by the interactive tool of the European Innovation Scoreboard within selected indicators such as Public R&D Venture capital and Firm investments (change in performance 2016 to 2010 – performance relative to EU average in the year 2010 (in %) [2].

Dettenhofer et. al. Part II

- New EU member-states of **Croatia** and Romania, plus the preassessment EU states of Bosnia and Herzegovina, and Serbia.
- One of the first to dedicate itself to the current state of BT in this part of Europe (**unexplored**)!
- In contrast to the V4 countries, the BT sector is **not as mature**!

Part II

- In Croatia, BT developed within the **pharmaceutical industry** (Pliva) and emerging **food industry**.
- Research and engineering development of advanced production processes have their **roots due to the Croatian Nobel laureates** (Lavoslav Ruzicka and Vladimir Prelog), and the formation of the national research Ruđer Bošković Institute (RBI)!

- **Historic growth of the industry** resulted in a demand for a new generation of engineers and the founding of a **separate department of Faculty of Food Technology and Biotechnology (FFTB)** at University of Zagreb in 1956. In 1980, FFTB became an independent faculty of the University of Zagreb!
- Most of these **visionary initiatives** were due to the late professor **Vera Johanides**. FFTB is a co-founding member of European Federation of Biotechnology.
- Since the beginning of the BT PhD program in 1967, about **470 PhD degrees** have been awarded.
- **The University of Rijeka in 2007** founded the Department of BT as a research and teaching unit, and received national and European accreditations for teaching BSc, MSc and PhD students. At the Faculty of Chemical Engineering and Technology (FCET), University of Zagreb, BSc and MSc degrees are offered in environmental engineering.

Research in BT in Croatia

- Low in patents
- Participation in EU FP7 and H2020 lags behind, mostly partners, capacity for coordination limited
- Croatian research activities in BT are related to the projects financed by national government funds and European Structural and Investment Funds, which usually are **not resulting in new industrial processes.**

- The economic effects of the BT-based industry in Croatia are significant, mostly oriented to food and beverages productions, pharmaceuticals, and Adriatic fish production (sea farming).
- Biofuel production, mostly biogas, is growing but is still below EU expected levels.
- Unfortunately, developed education and research infrastructure in Croatia is **not followed by public and private R&D investments, and systemic national long-term objectives** and regulatory policy.

- In Croatia, **investment in R&D has stagnated since 2009**. This **trend might widen both technological and economic gap between Croatia and other EU countries**. In a context of rising labor costs and a small share of technology-intensive goods in total exports (less than half of the EU-27 average), Croatia and other Western Balkan countries will **need to count more on research and innovation to increase the export competitiveness** of their national economies. For that to happen, governments will need to spend more in research and innovation.
- The economy of Croatia is now a **service-based economy** and this sector accounts for 70 percent of total GDP. The industrial sector is responsible for 25 percent of Croatia's GDP, with **agriculture, forestry, and fishing accounting for the remaining 5 percent**. Annual GDP growth in 2004-2008 was 4.1 percent on average. Growth is primarily driven by domestic demand, credit growth, and large capital inflows.
- Biggest investment in Biotech R&D since independence are Dept. for Biotechnology in Rijeka (Est. 2008, > 20 Mil EUR) and BIOCenter Zagreb (2011, > 20 Mil EUR Invested).

Percepcija

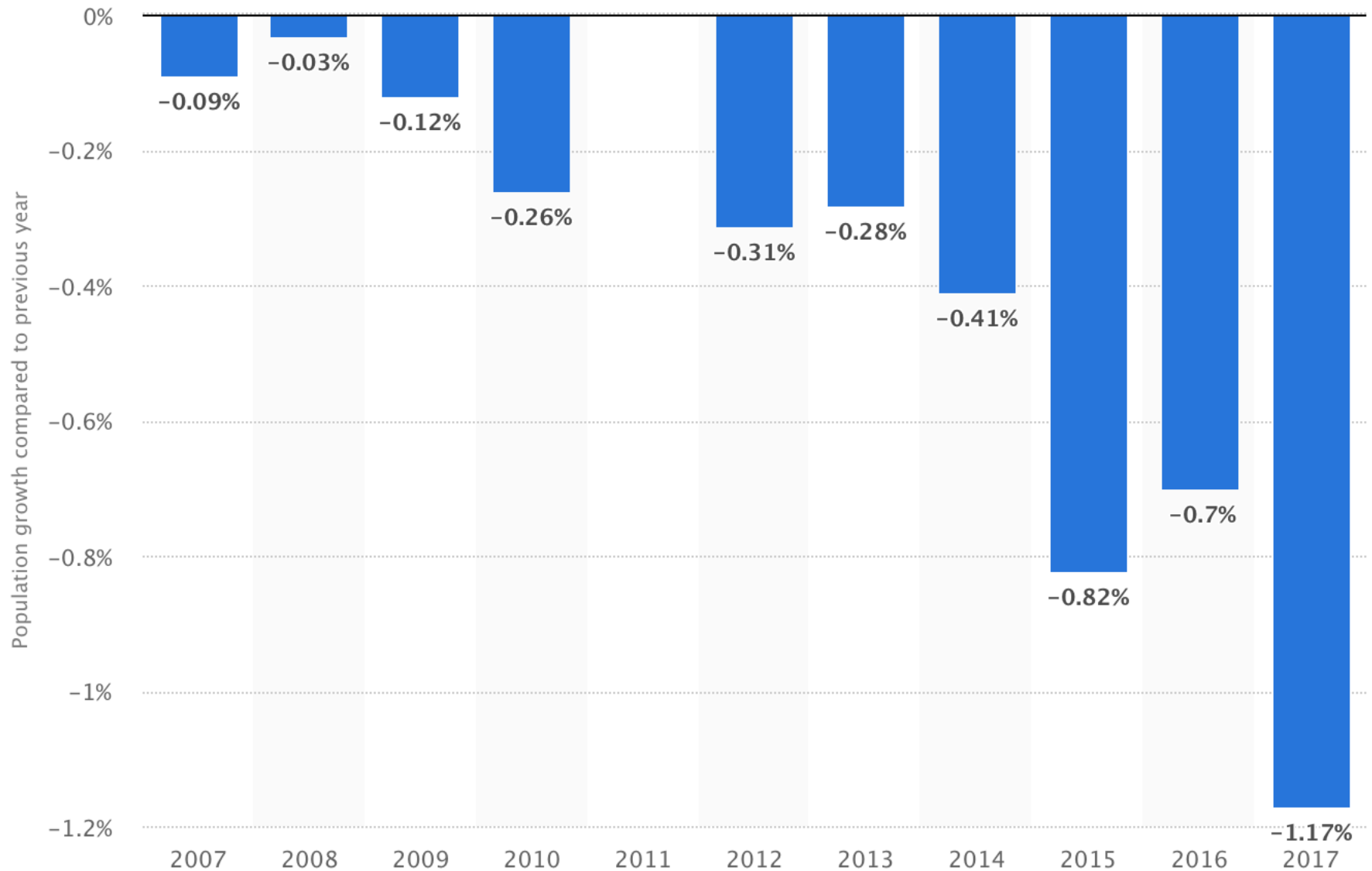


WORLD BANK TECHNICAL ASSISTANCE PROJECT (P123211), Dec. 2013

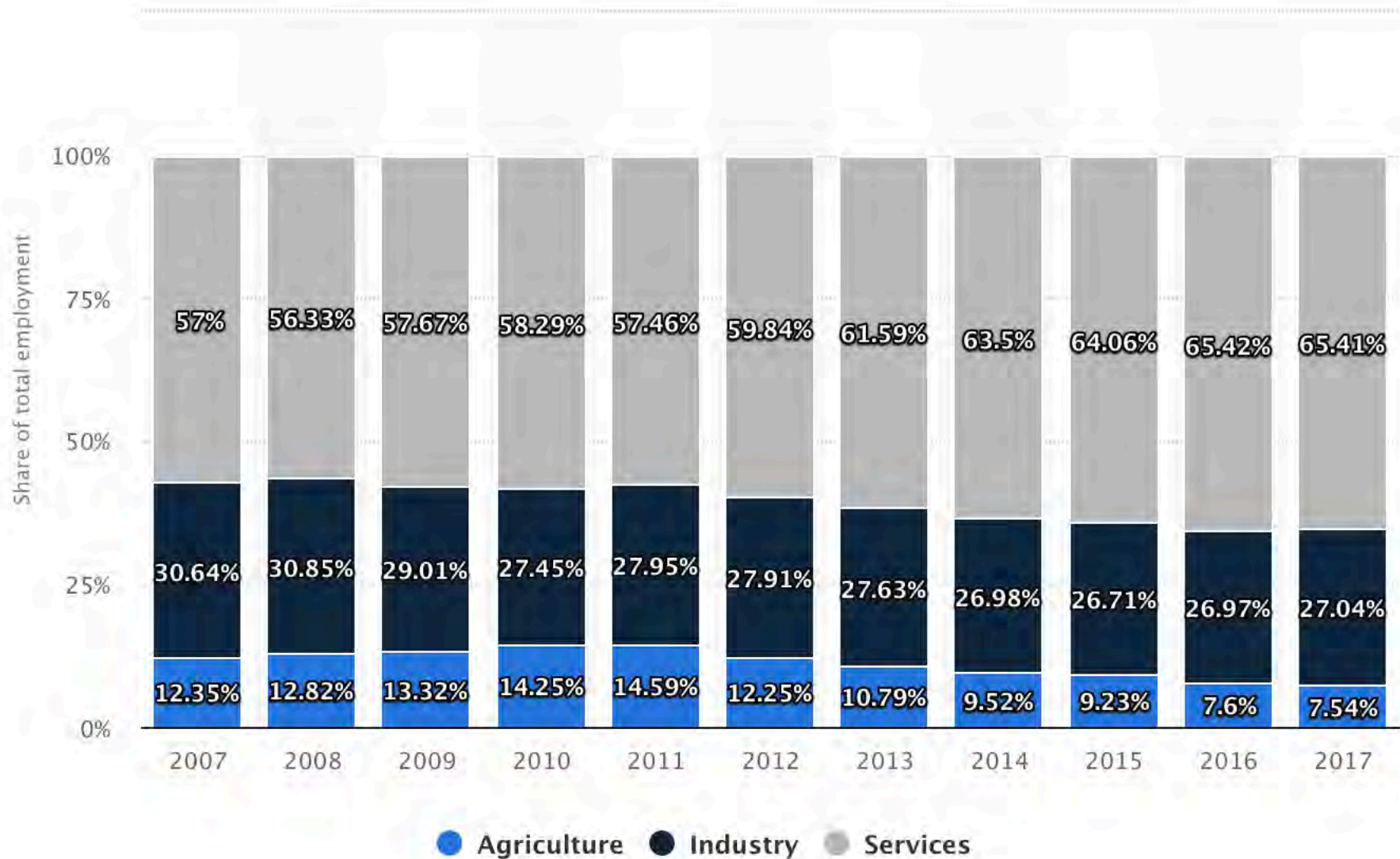
- “Each year that **Croatia lags behind** the R&D investment efforts of other nations, the more the current gap is compounded. **R&D cannot be seen as just another government program** sponsored by one ministry in competition with other budget demands. Rather, it should be acknowledged as a critical investment for economic growth, jobs, and higher living standards”.

- “Intensified efforts are needed to **stimulate R&D and innovation by the private sector. Government pronouncements and advisory councils are insufficient** if obstacles to entrepreneurs are not fully understood and addressed.”
- “Human capital building is critical, **requiring efforts to promote science and technology education in the country, keep the expensively educated talent within the country.** At the same time, it is necessary to intensify efforts to incorporate diaspora talent by promoting modern research infrastructure, challenging career prospects and attractive remuneration.”

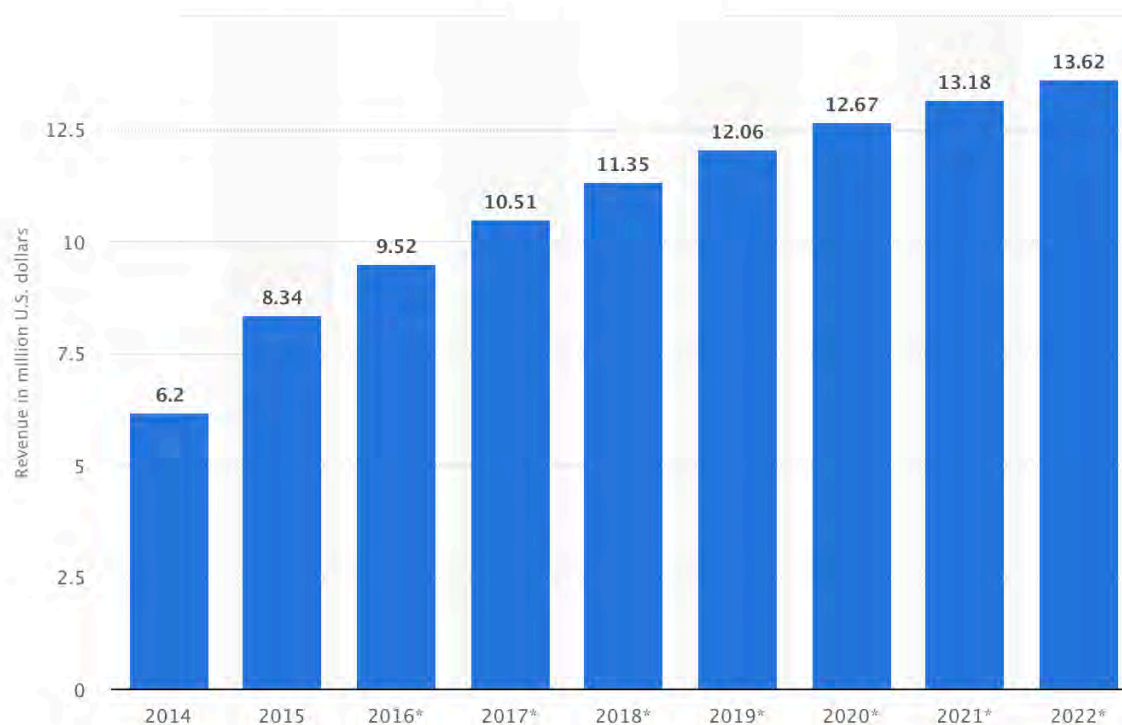
Croatia: Population growth from 2007 to 2017 (compar



Croatia: Distribution of employment by economic sect



Research, experimental development on biotechnology revenue in Croatia from 2014 to 2022 (in million U.S. dollars)



Data visualized by  tableau

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MORE INFORMATION

This statistic shows the revenue of research and experimental development on biotechnology in Croatia from 2014 to 2015, with a forecast to 2022. It is projected that the revenue of research and experimental development on biotechnology in Croatia will amount to approximately 13.6 million U.S. dollars by 2022.

This statistic was automatically created using the well-proven Statista forecast algorithm based on similarity parameters to existing analyst forecasts. The basis for the original forecasts is a combination of time series forecasts, driver forecasts (GDP, population etc.) from

Bayer maintains a global network of R&D locations, which employ more than 14,000 researchers. In 2017, we increased our research and development investment by 3.1% (Fx adj.) to €4,504 million. We plan to invest around €4.1 billion in R&D in 2018.

 [Download](#)

Information on Research and Development in 2017

	R&D expenses		R&D expenses before special items		Share of R&D expenses		R&D expenses before special items		R&D employees	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
	€ million	€ million	€ million	€ million	%	%	% of sales	% of sales	FTE	FTE
Pharmaceuticals	2,787	2,888	2,736	2,724	63.3	64.1	16.7	16.2	7,934	8,138
Consumer Health	259	240	234	228	5.9	5.3	3.9	3.9	331	368
Crop Science	1,164	1,166	1,156	1,120	26.4	25.9	11.7	11.7	5,631	5,174
Animal Health	140	155	140	145	3.2	3.4	9.2	9.2	308	333
Reconciliation	55	55	55	55	1.2	1.2	5.2	4.7	9	28
Total	4,405	4,504	4,321	4,272	100	100	12.4	12.2	14,213	14,041

2016 figures restated

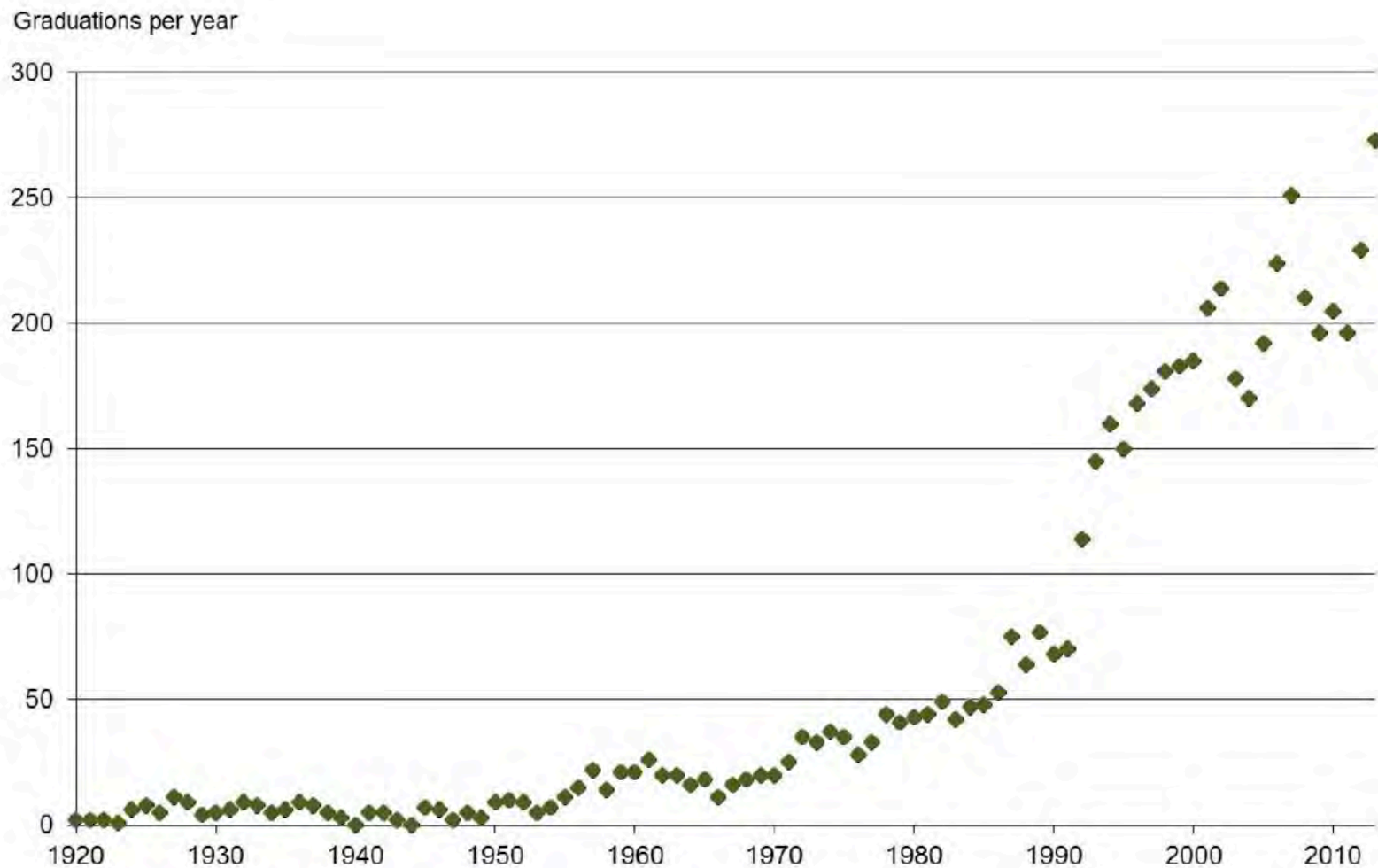


Figure 1.3 PhD graduations at Wageningen University.

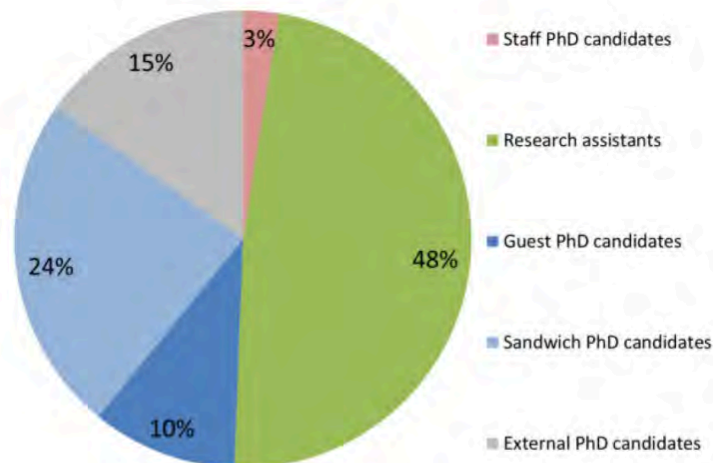


Figure 2.2 Present composition of the PhD population at Wageningen University.

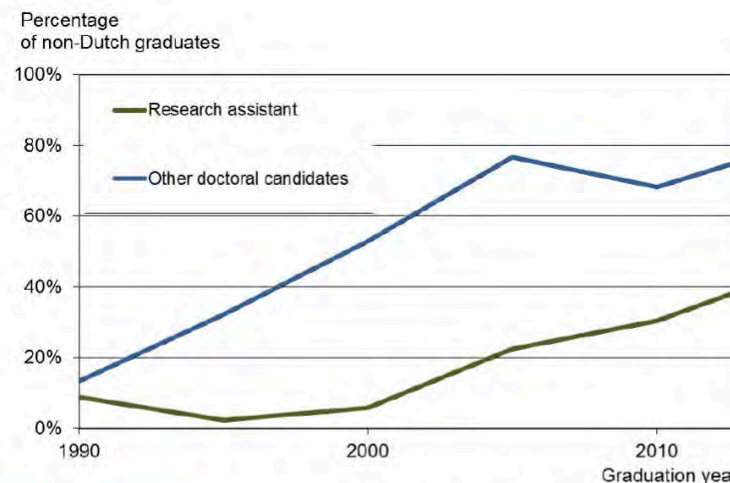


Figure 2.3 Internationalisation of PhD candidates at Wageningen University by PhD type.

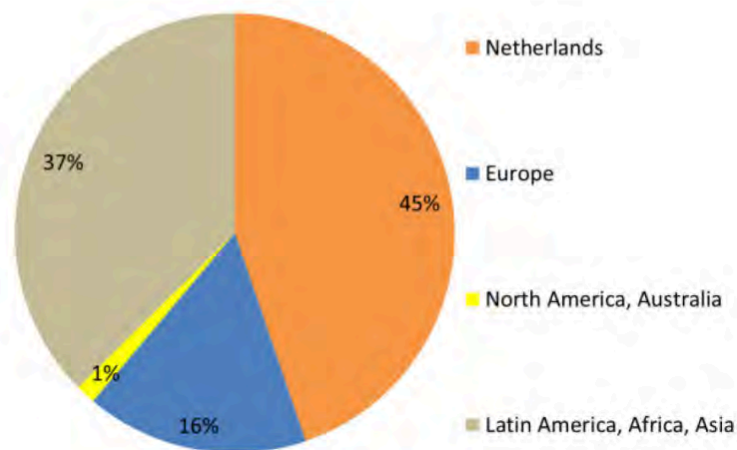


Figure 2.4 Origin of present PhD candidates.

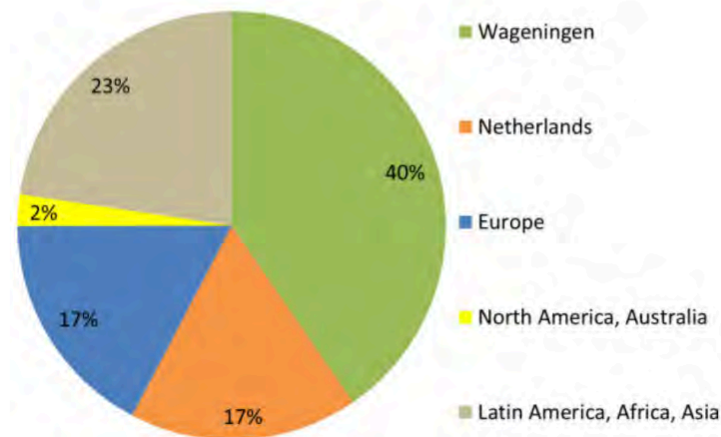


Figure 2.5 Previous education of candidates.

R&D and Innovation Trends

- **Investments in R&D in Croatia are low** compared to similar countries in terms of income level. In 2011 (Table 1), Croatia's gross R&D expenditures (GERD) were 0.75 percent of GDP.
- This is **considerably below the average** of the EU-27 of 2.03!
- Based on Eurostat data for 2011, **Croatia lags significantly behind comparable countries** that recently joined the EU: Slovenia (2.45 percent), the Czech Republic (1.84 percent), Estonia (2.38 percent), and Hungary (1.21 percent).

Human resources and brain drain

- In terms of human capital in science and technology (S&T) and innovation, **Croatia shows moderate strength**. In 2011, the **Croatian scientific community** consisted of around 1,552 full-time equivalent (FTE) researchers per million inhabitants, **which is less than half of the EU-27 average** (3,171 researchers per million inhabitants in 2010).

- **The number of researchers has been decreasing over time**, notably due to emigration and the lack of new R&D jobs, especially for young researchers.
- With a 0.63 percent share of researchers in the total labor force, Croatia is at 65 percent of the European average of 0.97 percent.
- The **demand for scientists** is, however, very **uneven across sectors**. **Public higher education institutions and research institutes together employ more than 80 percent of Croatian researchers.**
- **Universities and R&D companies are rarely seen as sources of information** for innovation: **only 6.9 percent of firms in Croatia would look to universities for innovation, and 3.9 percent would seek it from R&D companies.** This further explains a weak usage of domestic knowledge by Croatian firms.

- According to a recent report by the European Commission, **universities largely rely on individual initiatives and lack a consistent institutional approach** for technology transfer.
- Most of the **universities have neither their own university R&D strategy nor technology transfer infrastructure**.
- To date, there is **no clear legal or regulatory framework** covering the field of intellectual property rights (IPRs) and technology commercialization in universities.
- For example, IPR ownership and commercialization rights for inventions are stipulated by the Labor Act, which refers primarily to the inventions and relations between inventors (employee) and employers, and **gives the rights of appropriation to the employers**.
- There are **no clear guidelines or legal framework regarding spinoff** creation by scientists, whether public servants or researchers.
- **Nor is there guidance regarding incentives to researchers** to participate in technology transfer activities (e.g., **recognition in curricula**; researchers' rights to participate in licensing revenues and equity participation in new firms).

S&T Outputs and Innovation Performance

- According to this bibliometrics study Croatia shows the **highest levels of scientific publication (SCOPUS) in WBC**, where it is the country with the most publications each year and the highest total for the period 2003-2010.
- In terms of **quality**, however, Croatian scientific research shows a **performance close to the regional average and significantly below the EU-27** averages. The average citation impact for Croatia during the period is almost 0.65, while it is 0.62 for the WBCs and 1.31 for the EU-27.

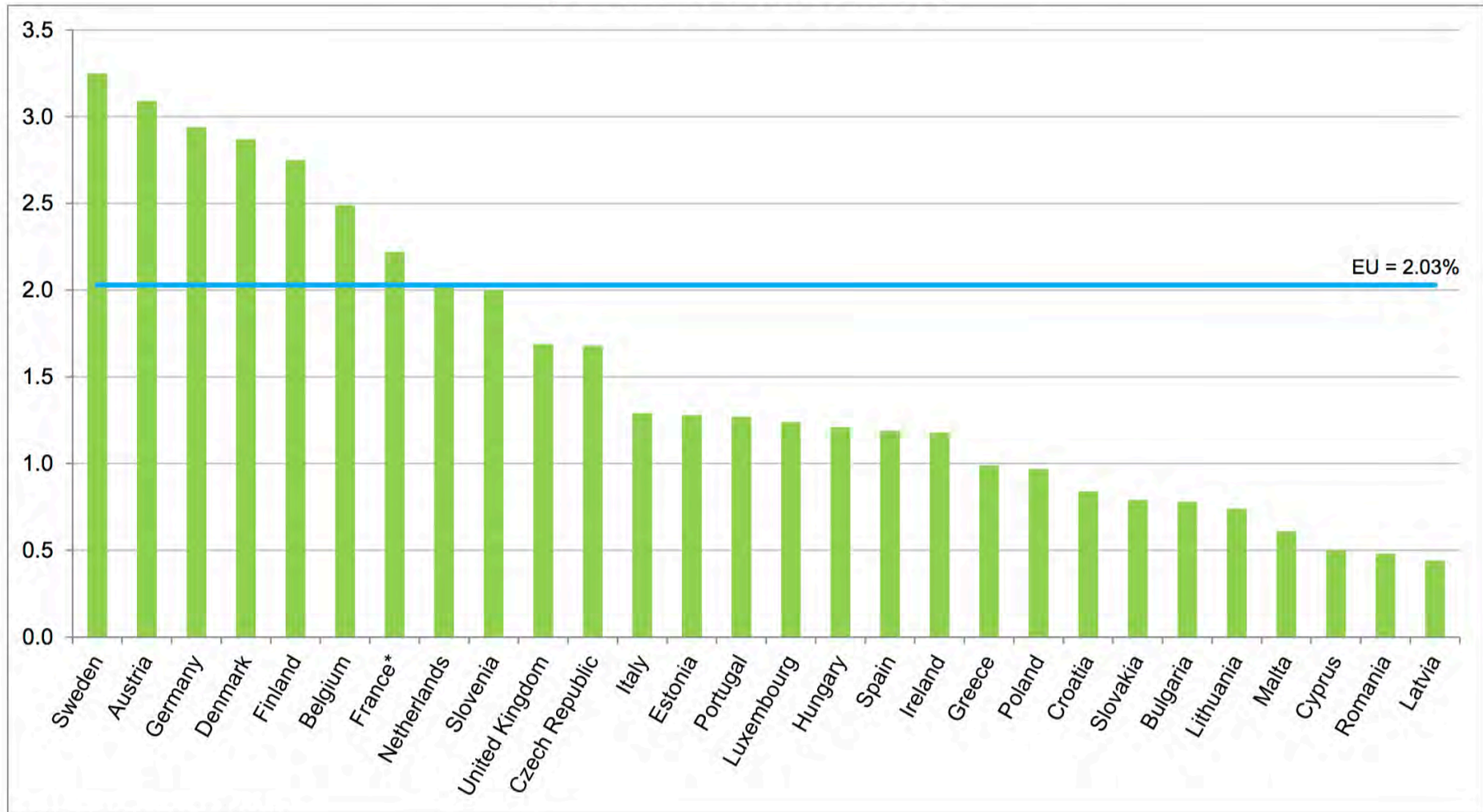
Eurostat – 1 December 2017

R&D intensity above 3% in Sweden and Austria

In 2016, the highest R&D intensities were recorded in Sweden (3.25%) and Austria (3.09%), both with R&D expenditure above 3% of GDP. They were closely followed by Germany (2.94%), Denmark (2.87%) and Finland (2.75%). Belgium (2.49%), France (2.22% in 2015), the Netherlands (2.03%) **and Slovenia (2.00%)** registered R&D expenditure between 2.0% and 2.5% of GDP. At the opposite end of the scale, ten **Member States recorded a R&D intensity below 1%:** Latvia (0.44%), Romania (0.48%), Cyprus (0.50%), Malta (0.61%), Lithuania (0.74%), Bulgaria (0.78%), Slovakia (0.79%), **Croatia (0.84%)**, Poland (0.97%) and Greece (0.99%).

R&D intensity in the EU Member States, 2016

(R&D expenditure as % of GDP)



* 2015 data instead of 2016

Deloitte – Croatia Corporate R&D Report 2014

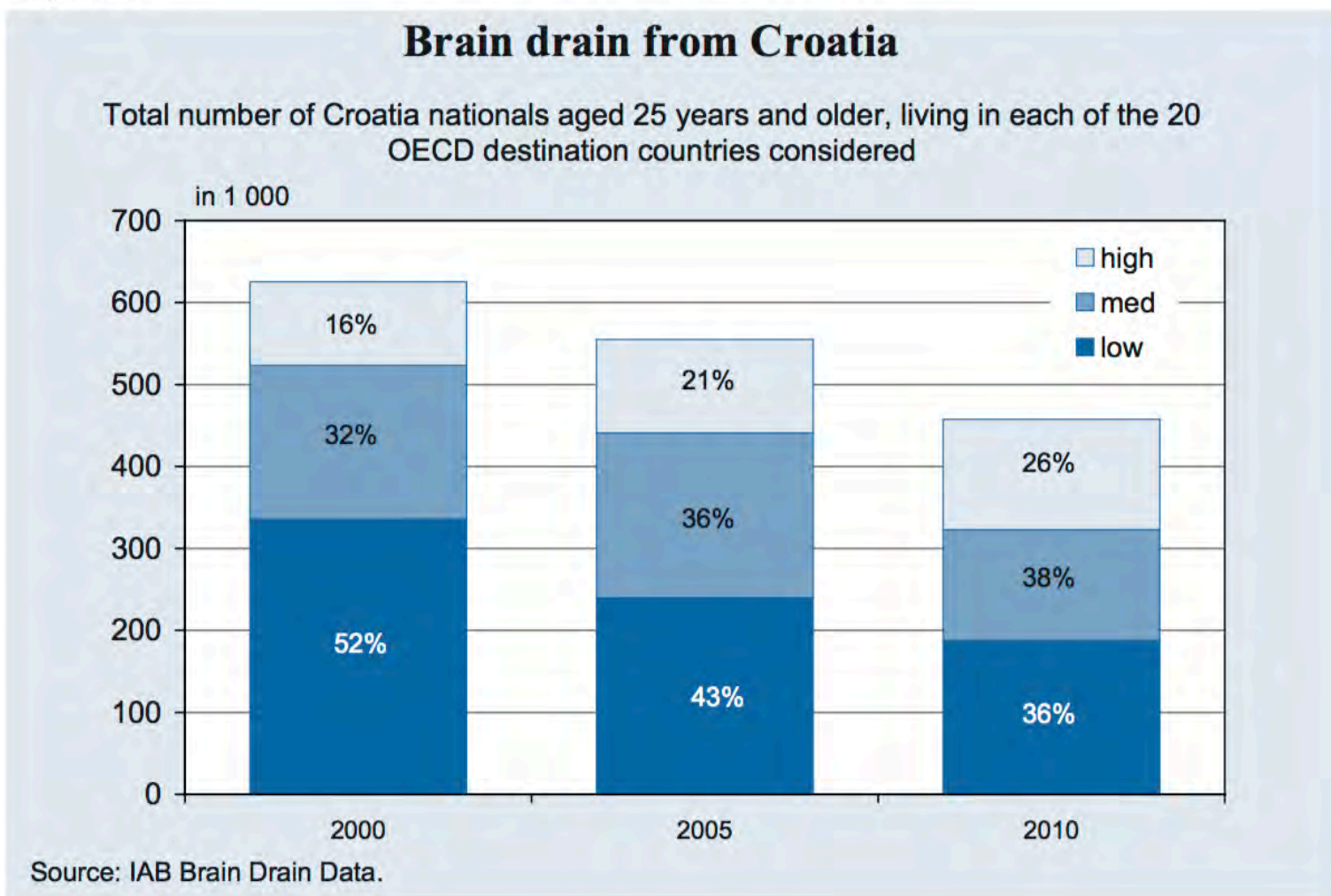
- Croatia has major task in catching up with other member states on this front.
- **Investments in R&D are proving to be inefficient** in Croatia, with **30 times fewer patent** applications per million inhabitants compared to the EU average.
- Croatia's **economy** is **dominated by low and medium/low technology sectors** and production. The private sector is **technologically weak**
- Insufficient collaboration between the public and business sectors.
- According to the World Economic Forum's Global Competitiveness Report 2013-2014, **Croatia ranked 76th of 148 countries in terms of university/ industry collaboration** in R&D.

Focus – Innovation Policy for Croatia

- Croatia risks sliding down to the category of **‘modest innovator’** in the European Union. In order to increase Croatia’s innovation capacity, a combination of both the right framework conditions and an active innovation policy that mobilizes R&D expenditure in the private sector seems appropriate.

"odljev mozgova" - "Mozak vani ništa ne vrijedi! Kilo mozga je dvije marke".

Figure 3



Brain drain – phenomenon that highly skilled people leave the country!

Strategy?







Bureaucracy







Figure 1 from Spatial decoupling of agricultural production and consumption: quantifying dependences of countries on food imports due to domestic land and water constraints
Marianela Fader et al 2013 Environ. Res. Lett. 8 014046 doi:10.1088/1748-9326/8/1/014046

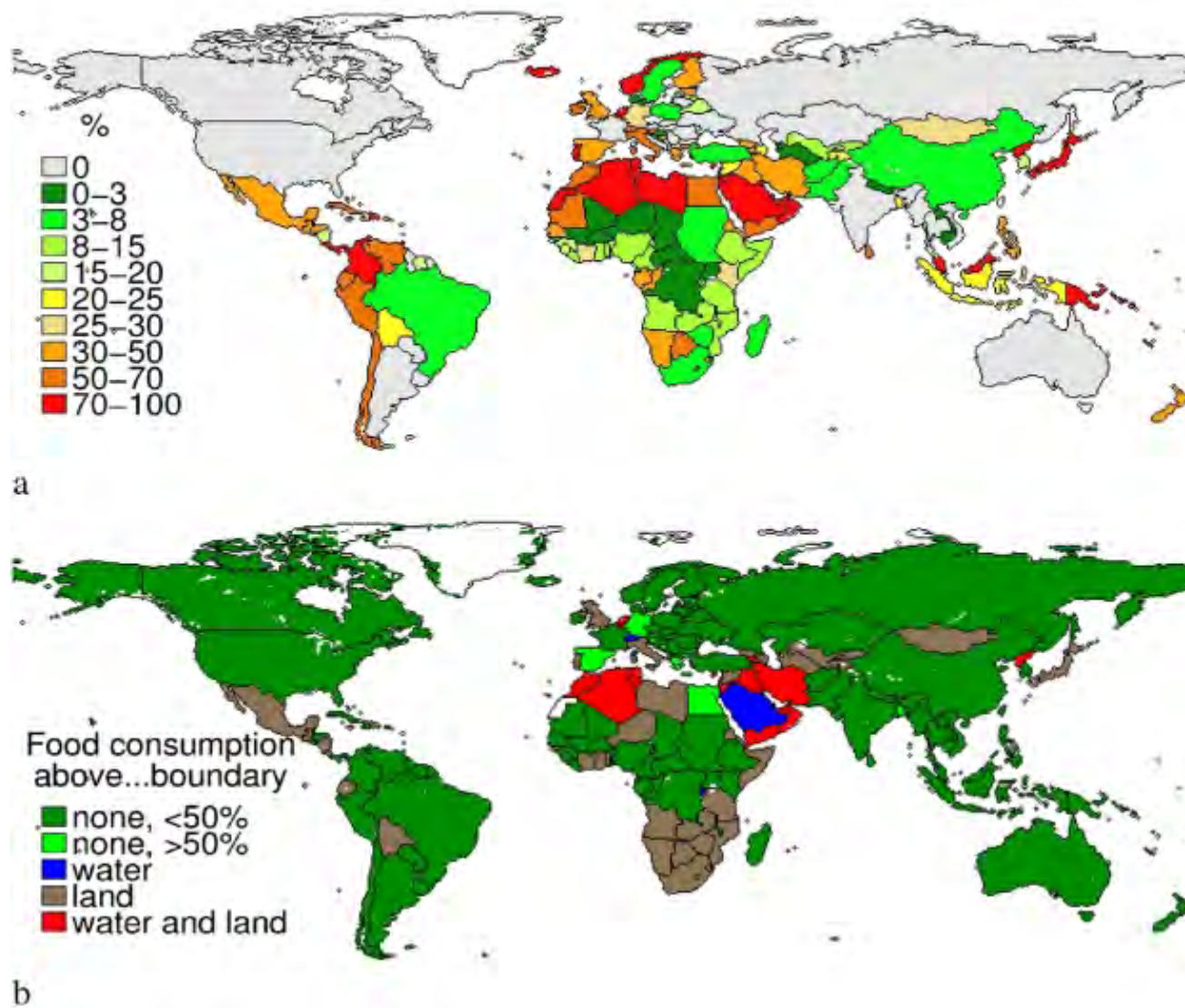


Figure 5 from Spatial decoupling of agricultural production and consumption: quantifying dependences of countries on food imports due to domestic land and water constraints

Marianela Fader et al 2013 Environ. Res. Lett. 8 014046 doi:10.1088/1748-9326/8/1/014046

