The affiliation game of Saudi Arabian higher education & research institutions

Analysing development of affiliation practices in the Highly Cited Researchers™ list from Clarivate™ between 2014-2022

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SIRIS | A·C·A·D·E·M·I·C

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Executive Summary

At the end of March 2023, EL PAÍS published an article, reporting that the Highly Cited Researcher Rafael Luque, a full-time civil servant of the University of Córdoba in Spain, had been suspended from employment and salary for the next 13 years, for the incorrect scientific affiliation of his research production.

This is, to the best of our knowledge, the first time that such a decision is taken by a university. It is likely to have an important impact not only in Spain but around the world, as universities reconsider the rights and obligations of their academic staff at a time of growing global competition.

In the weeks after this case was reported, **we published a study**, in which we contextualised such affiliation practices within the **Highly Cited Researchers™ list produced by Clarivate™**, a list of around 7000 researchers who stand out by having published, over the last decade, multiple papers which are amongst the top 1% more cited - so called "highly cited papers".

We showed that the case of the Highly Cited Researcher (henceforth HCR) Rafael Luque, who **indicated a Saudi Arabian university, instead of the University of Córdoba as primary affiliation**, **was not unique in Spain**: in 2022 a surprisingly high number of Highly Cited Researchers affiliated to a Saudi Arabian institution, indicate Spanish institutions as secondary affiliations (11 HCRs, thus the second country behind only China, which appears as secondary affiliation for 12 HCRs). As a consequence we analysed the affiliation history of those 11 Spanish HCRs.

For universities, employing a HCR is considered a mark of quality of the research ecosystem and increases attractiveness. **It also impacts the university's ranking within the ShanghaiRanking's Academic Ranking of World Universities (ARWU)**, since the number of HCR is one of its indicators. In practice, adding a single **Highly Cited Researcher HCR might result in a university gaining more than 100 places**[1]. In the report, we therefore also showed how such switches of affiliations affected some of the Spanish universities.

The attention drawn by the press around the topic led to further cases being questioned, notably in the Spanish context, where, **investigations of EL PAÍS showed that many of the HCRs obtained financial incentives to switch their affiliation to a Saudi Arabian institution, without having to switch employer**[2]. A case of an **intermediary agency**, which received commissions for convincing HCRs to switch their

[1] ShanghaiRanking's ARWU includes five other indicators but are far harder for a university to influence: whereas you can hire a Highly Cited Scholar to increase your score in the HiCi indicator, a Nobel Prize must be working in your university when they are awarded the prize for this to count.

[2] M.Ansede (18/04/2023), Saudi Arabia pays Spanish scientists to pump up global university rankings. *EL PAÍS*. https://english.elpais.com/science-tech/2023-04-18/saudi-arabia-pays-spanish-scientists-to-pump-up-global-university-rankings.html

affiliation, was also revealed[3]. As a consequence, **institutional ethical committees** have been seized to assess the affiliation practices and formulate recommendations[4].

The present report aims at going more in depth into the topic of Saudi Arabian affiliations in the HCR list by looking this time at the **entire timespan between 2014-2022**, understanding the evolution of affiliation practices of Saudi Arabian institutions, and investigate more in depth the **cases of the 8 countries, which appeared most often in secondary affiliations of Saudi Arabian HCRs** between 2014-22. The main results from the study are the following ones:

- We show that **Saudi Arabia**, with 109 Highly Cited Researchers in 2022 has a 5 to **10 times higher share of HCRs amongst its researchers (0.44 %) compared to countries such as Spain, Germany or France**, and twice as high than Switzerland and the Netherlands, which have some of the highest share of HCRs amongst its researchers.
- The **number of HCRs primarily affiliated** to a Saudi Arabian institution has been **growing** from 27 in 2014 to 109 in 2022, while the secondary affiliations have fallen from 129 in 2014 to 10 in 2020. As a reminder, since 2014 ARWU no longer takes into account secondary affiliations for its ranking.
- **75 % of Saudi Arabian HCRs in 2022 have a second foreign affiliation**; far higher than for the other countries we looked at, where foreign secondary affiliations accounted for 0-13%. The share of foreign second affiliations depends on the institution: it is especially high for King Abdulaziz University (81%) and King Saud University (82%), while it is only half as high for the King Abdullah University of Science & Technology (41%). Most Saudi Arabian universities are not concerned by this phenomenon. From the **274 HCRs affiliated to Saudi Arabian institutions between 2014-22**, there were **only 64 HCRs** which indicated **solely Saudi Arabian institutions in their affiliations.**
- The **8 countries, which appeared most often in secondary affiliations of Saudi Arabian HCRs between 2014-2022** were: **China** (44 HCRs), **Spain** (19 HCRs), **USA** (16 HCRs), **Turkey** (14 HCRs), **India** (13 HCRs), **UK** (12 HCRs), **Italy** and **Germany** (both 11 HCRs). Those represent 139 HCRs out of the of the **total 210**

[3] M.Ansede (20/04/2023), Un catedrático capta con su empresa tapadera a científicos españoles para que mientan y digan que trabajan en una universidad saudí. EL PAÍS. https://elpais.com/ciencia/2023-04-20/un-catedratico-capta-con-su-empresa-tapadera-a-cientificos-espanoles-para-que-mientan-y-digan-que-trabajan-en-una-universidad-saudi.html

[4] EFE (19/04/2023) ^, Universidades investigará malas praxis de científicos con centros saudíes, *LA VANGUARDIA.* https://www.lavanguardia.com/vida/20230419/8908008/universidades-investigara-malas-praxis-investigadores-centros-saudies.html

M.Ansede (20/04/2023), Los científicos de la institución del químico Damià Barceló piden su suspensión cautelar tras su implicación en el escándalo de la trama saudí. *EL PAÍS.* https://elpais.com/ciencia/2023-04-27/los-cientificos-de-la-institucion-del-quimico-damia-barcelo-piden-su-suspension-cautelar-tras-su-implicacion-en-el-escandalo-de-la-trama-saudi.html

M.Ansede (20/04/2023),One of the most internationally cited scientists, Ai Koyanagi, forced to renounce her controversial contract with a Saudi university. *EL PAÍS.* https://english.elpais.com/science-tech/2023-04-20/one-of-the-most-internationally-cited-scientists-ai-koyanagi-forced-to-renounce-her-controversial-contract-with-a-saudi-university.html

different HCRs, stemming from 41 countries, who have indicated Saudi Arabia as their primary affiliation and a foreign institution as a secondary affiliation, between 2014-2022. In **relative terms,** compared to the total number of HCRs in the country those **numbers are particularly high for Turkey (in 2022, 67% compared to its own number of HCRs), India (13%) and Spain (11%).**

- For each of those 8 countries we identified the main countries which appear in secondary affiliations for HCRs primarily affiliated to the country, and vice versa the main countries appearing in primary affiliations, when a researcher indicates the country as a secondary affiliation. In most cases it is the same country that appears in primary and secondary affiliation. This is common in many countries since researchers often have fully legitimate double affiliations to e.g. a university and research centre or hospital. Saudi Arabia had just one such case in the past 9 years.
- The **affiliation history in the Highly Cited Researchers™ list from Clarivate™ of the 139 HCRs from the 8 countries have been analysed in depth** and is described in this report. Being aware of those cases will hopefully help institutions **identify affiliation details that should be corrected** and thus ensure that the **credit** (amongst others an increase in the HiCi indicator of the ShanghaiRanking's ARWU) is **correctly attributed to the main employer** of those Highly Cited Researchers[5]. More importantly, investigating these cases is important for **ethical, and possibly legal**, reasons: indicating an affiliation that is not that of your main employer in a database or a scientific publication is questionable if not downright unacceptable.
- Looking at all those cases helped to understand better **the patterns of affiliation switches and identity 3 main models of affiliation switches**:
    - **Model 1 (*When primary becomes secondary* model*)*,** for cases where after several years of primary affiliation with one institution, the HCR switches their primary affiliation to secondary affiliation, leaving the place to the Saudi university. This happened for **49% of the analysed cases**.
    - **Model 2 (*The rollercoaster careers* model)** represents affiliation practices with strong fluctuations by e.g. switching each year affiliation order or having affiliations to various Saudi Arabian universities. This happened for **9% of the analysed cases**.
    - **Model 3 (*The True Saudi?* model)** stands for cases where HCRs enter the HCR list from the beginning with a Saudi university as primary affiliation and a foreign institution as secondary affiliation; they never make any switches. The emphasis in this model is on the question mark in the model name, as from the data alone it is not clear if it's either a fully legitimate case where the main employer is the Saudi Arabian university or a case where the switch was made before the publication of the final HCR list. This happened for **42% of the analysed cases**.

[5] We underline that we do not take position on the current role of rankings in higher education. Indeed, we agree with many commentators that they have become unduly influential and that their methodologies are often questionable (for more on this, see the section *"An issue of Research Integrity?"* below).

- **Some countries seem to favour some of the affiliation switch models**, as e.g. for India and Turkey where the large majority of cases were Model 3, while in most cases in Italy or Spain the affiliation switches followed Model 1.
- We **highlight some cases of universities, whose position in the ShanghaiRanking's ARWU has been affected by potential gaming practices of Saudi Arabian universities.** We show how lower ranked universities with few HCRs can be deeply affected wit**h changes of ranks of over 100 places.**

This report, together with the investigations by journalists, brings to light specific cases of questionable affiliation practices by around 1% of researchers within a single list representing 0.1% of all researchers in the world. While this might sound very anecdotal, it touches upon the heart of a broad range of topics, which are subject to ongoing debate in the field of research: **research integrity, research quality assessment, relevance of rankings and scientometric indicators, or precarity of academic research careers**. And all of this is set within a wider context of **geopolitical influence, use of soft power, and competition for talent**.

Gaming practices and misleading affiliations feed suspicions about the **reliability of science, and undermine the remarkable work done by most scientists the world over. Correct affiliation practices** are one small bit of a general effort to maintain **scientific integrity and earn trust in science** from both decision makers and the general public.

Introduction

A highly mediatic case

In Spring 2023, a major focus was placed on the case of Rafael Luque, who was employed at the University of Córdoba, but who indicated King Saud University as his primary affiliation in the 2022 Highly Cited Researchers™ (HCR) list from Clarivate™ [6]. Our recent report aimed at contextualising the case better and tried to understand if a similar pattern can be found for other Highly Cited Researchers in Spain in 2022.

The context our previous report: Understanding better Rafael Luque's case and focus on similar Spanish cases in 2022

On **March 31, 2023, EL PAÍS published an article** which explained that the highly cited chemist **Rafael Luque has been suspended from employment and salary for the next 13 years**. **The university sanctioned Luque for signing his studies as a researcher at other institutions, such as King Saud University in Riyadh (Saudi Arabia) and the Peoples' Friendship University of Russia in Moscow, despite having a full-time civil servant contract with the University of Córdoba in Spain.**

The articles states the following:

*He has featured on the list of the world's most cited researchers, compiled by the specialist company Clarivate, for five years. Institutions all over the world compete to hire scientists like Luque, who can move a center up hundreds of positions in international academic rankings such as the influential Shanghai ranking, thusly attracting more students and more funding. "Without me, the University of Córdoba is going to drop 300 places [in the Shanghai ranking]. They have shot themselves in the foot," said Luque, who attributed his suspension to "pure envy." [...] "I have never felt supported by the University of Córdoba, even though **I put it on the Shanghai ranking. Being in the ranking is entirely due to me**."*

In our recent report[7] we proof-checked these declarations about the potential impact on the ShanghaiRanking's Academic Ranking of World Universities (ARWU) of the University of Cordoba's decision as well as having a wider look at Spanish and Saudi Arabian affiliations and researchers in the Highly Cited Researchers™ list from Clarivate™. We notably showed that the decision of the University of Cordoba to suspend Rafael Luque, a Highly Cited Researcher (HCR) since 2018, will not cause a drop of 300 ranks in ShanghaiRankings's ARWU. On the contrary, it is the bad affiliation practice of this researcher that explains why the University of Cordoba is not currently ranked 601-700 instead of 801-900. The reason is that since 2019

[6] M. Ansede (02/04/2023), One of the world's most cited scientists, Rafael Luque, suspended without pay for 13 years. *EL PAÍS.* https://english.elpais.com/science-tech/2023-04-02/one-of-the-worlds-most-cited-scientists-rafael-luque-suspended-without-pay-for-13-years.html - the original article in Spanish appeared on 31/03/2023

[7] *The affiliation game between Spanish and Saudi Arabian higher education & research institutions*, SIRIS Academic, April 2023

Rafael Luque has indicated the University of Córdoba as secondary affiliation and King Saud University as primary affiliation. Only primary affiliations are taken into account by ShanghaiRanking's ARWU. In the report we also showed that amongst the Highly Cited Researchers of Saudi Arabia, a surprisingly high number, 11 HCRs or over 10% of all Spanish HCRs, indicate Spanish institutions as secondary affiliations (second behind only China, which appears as secondary affiliation for 12 HCRs). Moreover we showed that 7 out of the 11 HCRs entered the HCR list with a Spanish institution as primary affiliation, but soon after changed it to the Saudi Arabian institution.

The attention drawn by the press around the topic led to **further cases being questioned**, notably in the Spanish context, where, through **investigations of EL PAÍS**, it was revealed that many of the HCRs obtained **financial incentives** to switch their affiliation to a Saudi Arabian institution, without having to switch employer[8]. A case of an **intermediary agency, which received commissions** for convincing HCRs to switch their affiliation, was also revealed[9]. As a consequence, **institutional ethical committees** have been seized to assess the affiliation practices and formulate recommendations[10].

It is important to underline that the affiliation issues of highly-cited researchers to Saudi Arabian institutions is not a new question. Various articles and blogposts were written by researchers on the topic in the past years[11] and we ourselves described it in a study into the history of rankings at the time.

[8] M.Ansede (18/04/2023), Saudi Arabia pays Spanish scientists to pump up global university rankings. *EL PAÍS*. https://english.elpais.com/science-tech/2023-04-18/saudi-arabia-pays-spanish-scientists-to-pump-up-global-university-rankings.html

[9] M.Ansede (20/04/2023), Un catedrático capta con su empresa tapadera a científicos españoles para que mientan y digan que trabajan en una universidad saudí. EL PAÍS. https://elpais.com/ciencia/2023-04-20/un-catedratico-capta-con-su-empresa-tapadera-a-cientificos-espanoles-para-que-mientan-y-digan-que-trabajan-en-una-universidad-saudi.html

[10] EFE (19/04/2023) ^, Universidades investigará malas praxis de científicos con centros saudíes, *LA VANGUARDIA*. https://www.lavanguardia.com/vida/20230419/8908008/universidades-investigara-malas-praxis-investigadores-centros-saudies.html

M.Ansede (27/04/2023), Los científicos de la institución del químico Damià Barceló piden su suspensión cautelar tras su implicación en el escándalo de la trama saudí. *EL PAÍS*. https://elpais.com/ciencia/2023-04-27/los-cientificos-de-la-institucion-del-quimico-damia-barcelo-piden-su-suspension-cautelar-tras-su-implicacion-en-el-escandalo-de-la-trama-saudi.html

M.Ansede (20/04/2023), One of the most internationally cited scientists, Ai Koyanagi, forced to renounce her controversial contract with a Saudi university. *EL PAÍS*. https://english.elpais.com/science-tech/2023-04-20/one-of-the-most-internationally-cited-scientists-ai-koyanagi-forced-to-renounce-her-controversial-contract-with-a-saudi-university.html

[11] Yudhijit Bhattacharjee, Saudi Universities Offer Cash in Exchange for Academic Prestige.Science334, 1344-1345(2011).DOI:10.1126/science.334.6061.1344

Megan Messerly, Citations for Sale, The Daily Californian (2014)

A problem of Institutional Affiliation

What is an affiliation?

At the centre of those cases is the question of a.) institutional affiliations of researchers and b.) the position of the affiliation in the Highly Cited Researchers's list, namely primary or secondary affiliation.

In the simplest cases, the affiliation corresponds to the main employer of the researcher, typically the institution paying the salary and the environment of the research.

However, it happens quite frequently that the salary is paid by an institution while the laboratory itself is hosted by another institution. A classical case is that of French "mixed research units" (UMRs) where the lab and the staff are paid in part by one (or several) research organisations and one (or several) universities. In such cases, being able to indicate more than one affiliation is a logical way to acknowledge the contribution of several institutions.

In fact, as shown below in this report, the majority of secondary affiliations are usually from the same country, mostly distributed between researcher centres and universities. For those cases, if the researchers were to indicate the university as primary affiliation, this would increase the ranks of those universities in the ShanghaiRanking's ARWU, without having an impact on the research institutions or hospitals (which are, by definition not ranked)[12].

There are other specific situations which might lead to indicate several affiliations:

1. the rare case of multiple appointments whereby a single individual holds an appointment with 2 universities or research performing organisations, which typically requires their agreement
2. the specific case of some funding institutions which require the affiliation as a condition for the funding. Funding typically comes from public sources (national or international funding schemes by public authorities) or private philanthropy.In more rare cases institutions provide funding to researchers not employed within the institution and neither doing research within it.
3. the case of the use of large scientific instrumentation of another institution[13].

The case of funders is where the grey area starts: while the common practice for funders is to ask for an acknowledgement in the publication and **not an affiliation**, this

[12] Practices in this respect vary from country to country. In France, an official letter from the Ministry of Higher Education, Research and Innovation asked researchers in similar situations (for example researchers employed by a national research organisation but working within a laboratory of a university) to indicate the university as their primary affiliation from 2019 onwards. This caused much discussion in the scientific community.

[13] It is usual to share or rent expensive instruments needed for research, usually upon payment of a service fee. Often what is done in those cases is either acknowledging the institution and their respective technicians in the acknowledgment section, or if the contribution went beyond technical support, the person from the other institution is listed as co-author of an article.

condition was placed by the Saudi institutions analysed here as a requirement for the obtention of research fellowships.

Determinating an affiliation in the Highly Cited Researchers™ list

The Highly Cited Researchers™ list from Clarivate™ listed approximately 7,200 Highly Cited Researchers (HCRs) from 69 countries in 2022, amongst whom 4,000 are in specific fields and about 3,200 for cross-field performance. Highly Cited Researchers are those researchers who are amongst the top 1% by citations per Essential Science Indicators™ (ESI) field and year, for articles published in the 10 years before the list is published.[14] Some HCRS are recognized in multiple research fields: 219 are named in two fields, 28 are named in three fields and 4 are named in four fields in 2022[15]. While Clarivate counts them multiple times in their analysis, we will count them just once in our report.

Each researcher in the list has a primary and optionally a secondary affiliation. The way Clarivate determines the affiliation of the Highly Cited Researchers is the following[16]:

- Clarivate uses as a first draft for the affiliation(s) the institution(s) on the scholarly record of the HCRs.
- then, during a month-long validation period, Clarivate attempts to contact researchers on multiple occasions using the contact details they provide on their highly cited published papers. They provide them a personalised survey link to request that they verify how they would like their name to appear on the HCR list, along with the locations of their primary and, if applicable, any secondary research affiliations. Clarivate sends out reminders to the researchers on multiple occasions to verify their details over the period prior to launch.

Clarivate is aware of the impact of their HCR list. In a recent post they summarise the incentives to achieve Highly Cited Researcher status in some nations and research systems[17]:

- *higher remuneration*
- *recruitment to other institutions (which benefit institutions in the Academic Ranking of World Universities, since the number of Highly Cited Researchers represents 20% of an institution's score for ranking)*
- *offers to become affiliated researchers at other institutions in exchange for payment and a researcher's agreement to preferentially list the contracting*

[14] https://clarivate.com/highly-cited-researchers/methodology/
[15] https://clarivate.com/news/clarivate-names-worlds-influential-researchers-with-highly-cited-researchers-2022-list/
[16] https://clarivate.com/news/clarivate-statement-on-highly-cited-researcher-affiliations/
[17] thttps://clarivate.com/blog/highly-cited-researchers-2022-using-deeper-qualitative-analysis-to-help-spot-research-misconduct/

institution regularly on publications (this represents a shortcut to higher placement in the Academic Ranking of World Universities)

To account for this, since 2022, Clarivate indicates affiliated or guest researchers, as Research Fellows or Associates, by adding an asterisk on their list:

*An **asterisk** accompanying a primary affiliation indicates that the Highly Cited Researcher is **associated with this institution through a research fellowship**. This rarely occurs since **most researchers follow the established tradition of using the secondary affiliation for such appointments** and reserve the primary affiliation slot for their main employer. **There may well be such associations for other Highly Cited Researchers that have not been brought to our attention**.*
This year [in 2022] we extended the identification of affiliated or guest researchers, designating these as Research Fellows or Associates. These individuals were not counted in our own ranking of nations or institutions.[18]

In 2022 44 HCRs from Saudi Arabia (more details in report below) and 2 HCRs from Taiwan were marked with such an asterisk.

[18] https://clarivate.com/highly-cited-researchers/faq/

Why does the Highly Cited Researchers list attract so much attention?

One of the reasons that universities are so attentive to the HCR list is that it factors in the computation of their rank within the ShanghaiRanking's ARWU, which, for better or worse, has become an important element of their overall visibility.

Methodology of the ShanghaiRanking's ARWU

The ShanghaiRanking's Academic Ranking of World Universities (ARWU) takes into account around **2500 of the world's top universities** which qualify by virtue of having Nobel laureates, Fields medallists, Highly Cited Researchers, or papers published in Nature or Science. In addition, universities with a significant number of papers indexed by Science Citation Index-Expanded (SCIE) and Social Science Citation Index (SSCI) are included. Out of these institutions, **1000 are ranked**.

The indicators and weightings as applied by ARWU 2022 methodology are as follows[19]:

Indicator	Indicator	Code	Weight
Quality of Education	Alumni of an institution winning Nobel Prizes and Fields Medals	Alumni	10%
Quality of Faculty	Staff of an institution winning Nobel Prizes and Fields Medals	Award	20%
	Highly cited researchers in 21 broad subject categories, based on Highly Cited Researchers™ list issued in November 2021	HiCi	20%
Research Output	Papers published in Nature and Science between 2017 and 2021	N&S	20%
	Papers indexed in Science Citation Index-Expanded (SCIE) and Social Science Citation Index (SSCI) in 2021	PUB	20%
Per Capita Performance	Per capita academic performance of an institution	PCP	10%
Total			100%

Table 1. *ShanghaiRanking's ARWU indicators and their weighting*

All ARWU indicators depend on **external, publicly available sources for their data**, including the official site of the Nobel Prize, the International Mathematical Union for Fields Medals, the Clarivate Highly Cited Researchers™ list and several Clarivate Analytics websites for citations and publications. This is why, as has been demonstrated by D. Docampo, **ARWU rankings are reproducible by outside experts**[20].

[19] http://www.shanghairanking.com/methodology/arwu/2022

[20] Docampo, D. (2013). *Reproducibility of the Shanghai academic ranking of world universities results*. Scientometrics 93:567. In practice, the individual indicators are not all perfectly reproducible because the precise bibliometric queries made by the ARWU team are unknown.

Gaming practices of the Highly Cited Researchers Indicator

In 2014 the ShanghaiRanking's ARWU **decided to stop including secondary affiliations in their HiCi indicator**[21] and **only assign the HiCi indicator scores** to institutions that appear in the **primary affiliation.**

This methodological shift is, amongst others due to controversial gaming practices adopted by a number of universities, including **King Abdulaziz University (KAU)**, that notoriously circulated an email to Highly Cited Researchers worldwide[22] proposing each of them a contract with the university for a salary of $72,000 per year. In 2014, more than 120 Highly Cited Researchers accepted this job contract from King Abdulaziz University as part-time researchers and added it as a secondary affiliation on their HCR profiles. This generated a **massive restructuring of the HCR map**:

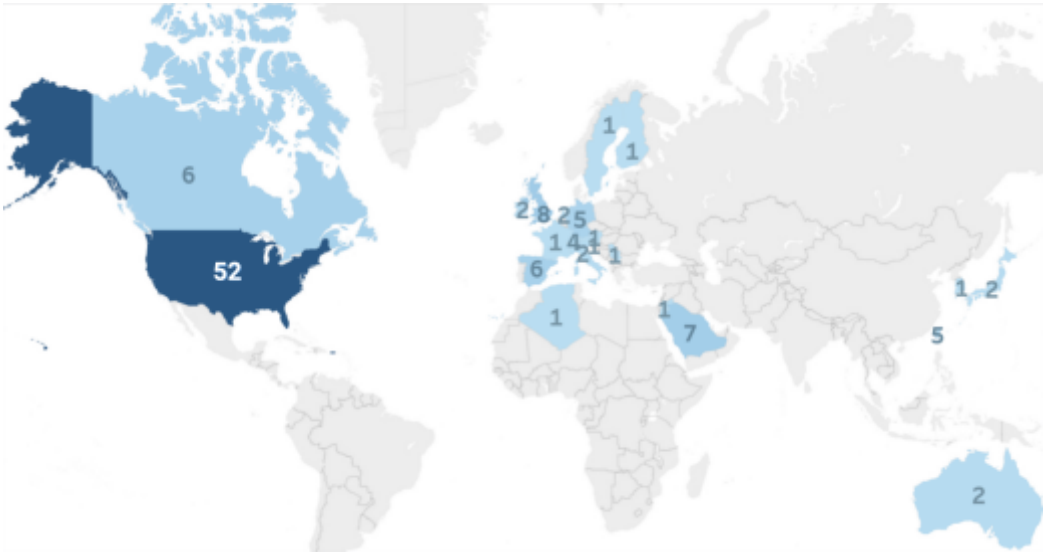

Fig. 1. *Secondary affiliations to King Abdulaziz University among Highly Cited Researchers per country - 2014 (elaboration SIRIS Academic, data source: https://hcr.clarivate.com)*

[21] ARWU 2014 and ARWU 2015 were years of transition in this respect, as also the methodology of the HCR list changed in 2014. In ARWU 2016 the HiCi indicator was finally fully dependent on primary affiliations. For details how it was handled in 2014-2015, please find the methodology here: https://www.lebde.org/ARWU-Methodology-2014.html

[22] Yudhijit Bhattacharjee, Saudi Universities Offer Cash in Exchange for Academic Prestige.Science334,1344-1345(2011).DOI:10.1126/science.334.6061.1344
Megan Messerly, Citations for Sale, The Daily Californian (2014)

The methodological shift (stop taking a secondary affiliation into account) led to a second phase of gaming[23], whereby **some researchers chose to switch their primary and secondary affiliations**[24]. The latest developments of those gaming practices were commented in April 2023 in EL PAÍS[25].

An issue of Research Integrity

Deep down, this controversy is thus about research integrity, in a context where institutional competition makes it tempting for some institutions and individuals to cut corners to optimise their visibility and prestige. Indeed, the very attention given to rankings is itself a part of the issue, and feeds unhealthy gaming practices.

In line with the More than Our Rank initiative[26], SIRIS Academic considers that the current use of Rankings in Higher Education and Research is highly problematic. It tends to unduly conflate scientific quality with visibility, to simplify complex phenomena, underplay the fundamentally collective nature of the scientific process, and conflate very diverse practice for the sake of building ordinal lists. This is particularly true of rankings based on aggregated indicators and even more so of those that rely on reputation surveys and self-submitted data such as Times Higher Education and QS[27].

This report is about the **institutional affiliation practices of individual authors in the**

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[23] KAU changed their policy to make it more attractive for HCR to resign from their current positions and accept a primary affiliation to KAU, whilst decreasing the size of their offer to scholars who took a secondary affiliation. The result is clearly visible: in 2015, some scholars switched to KAU as their primary affiliation, some retained their KAU secondary affiliation and half stopped referring to KAU. See Bornmann, Lutz, and Johann Bauer. 2015. *Which of the World's Institutions Employ the Most Highly Cited Researchers? An Analysis of the Data from Highlycited.com*. Journal of the Association for Information Science and Technology. https://doi.org/10.1002/asi.23396; and Bhattacharjee, Yudhijit. 2011. *Saudi Universities Offer Cash in Exchange for Academic Prestige*. Science 334 (6061): 1344–45.

[24] Presumably in order to secure personal advantages seeing that it seems unlikely that they would not have been aware of the negative consequences that this action would have on their home institution.

[25] M.Ansede (18/04/2023), Saudi Arabia pays Spanish scientists to pump up global university rankings. *EL PAÍS*. https://english.elpais.com/science-tech/2023-04-18/saudi-arabia-pays-spanish-scientists-to-pump-up-global-university-rankings.html

M.Ansede (20/04/2023), Un catedrático capta con su empresa tapadera a científicos españoles para que mientan y digan que trabajan en una universidad saudí. EL PAÍS. https://elpais.com/ciencia/2023-04-20/un-catedratico-capta-con-su-empresa-tapadera-a-cientificos-espanoles-para-que-mientan-y-digan-que-trabajan-en-una-universidad-saudi.html

[26] https://inorms.net/more-than-our-rank/

[27] For a detailed review and recommendations on how universities can use individual indicators to better understand their strengths and weaknesses, see Stride, S., Beldengrün, Y., Cortini, R., Donnarumma, A., Duran, N., Gimenez, X., Heuser, M., Massucci, F., Plaud, S., Rull, G., & Veiga, S. (2021). "Chapter 35: Football lessons for universities or how to go beyond ranking". In *Research Handbook on University Rankings*. Cheltenham, UK: Edward Elgar Publishing. Retrieved Apr 29, 2023, from https://doi.org/10.4337/9781788974981.00048. Many of the other articles in this volume are directly relevant to the debate.

Highly Cited Researchers™ list from Clarivate™. The fact that **ShanghaiRanking** uses this database to build one of the key indicators of their Academic Ranking of World Universities (ARWU) and that it is the indicator which is easiest for a university to influence is **presumably not unrelated to the issues of malpractice** which are detailed in this report.

The point is that such **gaming practices and misleading affiliations feed suspicions about the reliability of science**, and undermine the remarkable work done by most scientists the world over. Correct affiliation practices are one small bit of a general effort to **maintain scientific integrity and earn trust in science** from both decision makers and the general public.

The impact on individual researchers as well as on institutions is important and touches delicate topics related to scientific integrity and ethical practices. **The need to correct malpractice is key but the risk of falling prey to witch-hunts is real, hence the importance of getting the facts right.**

With this report we thus aim to look at the wider picture, by analysing global cases between 2014-2022, focusing on Saudi Arabia affiliations in general and the ones of Highly Cited Researchers from the 8 countries[28], which appear most often in secondary affiliations of Saudi Arabian HCRs. Finally, it is important to underline that our study does not question Saudi Arabian higher education and research policy but specific institutions and individual practices[29].

[28] China, Spain, USA, Turkey, UK, Italy, India, Germany

[29] The vast majority of cases are related to just two Saudi Arabian universities. Most other Saudi Arabian universities are either not concerned or concerned to a very minor extent.

Insights into Highly Cited Researchers affiliated to Saudi Arabia (2014-2022)

Methodological note to our report

The source of the data is the Highly Cited Researchers™ list from Clarivate™ [30] itself, but data were treated and analysed by SIRIS Academic in April 2023. Numbers might be lower from the ones indicated by Clarivate or our previous report on this topic, as in this report we do not count double or triple entries of HCRs in multiple research fields (see introduction).

For this report we proceed to predict changes in ARWU 2023[31] for cases, in which an affiliation switch for a HCRs could have a significant impact on the original university.

Our study is merely about identifying institutional practices. We therefore chose to remove individual names, which, for those interested, are openly available through the Clarivate webpage.

We want to emphasise that we have no way of knowing whether an individual's affiliation practice is legitimate or not - that might depend on highly contextual circumstances - and we do not have the legitimacy to raise that question, which should be tackled by institutions themselves.

[30] https://clarivate.com/highly-cited-researchers/
[31] Simulations were carried out in collaboration with Domingo Docampo.

Saudi Arabian Universities - the Mecca for Highly Cited Researchers?

Table 2. shows that **Saudi Arabia with their 109 Highly Cited Researchers had in 2022,** in proportion to their total number of researchers, **a disproportionately high share of HCRs, namely 0.44%, compared to 0.07% in Spain, 0.06% in China, 0.08% in Germany, 0.09% in Italy and France 0.04% (data not shown). Some of the countries, which get a bit closer to Saudi Arabia's ratio, but still half of it, are Switzerland with a share of 0.25% (data not shown) Netherlands (0.22%, data not shown), the UK (0.19%) or the USA (0.18%).** Clarivate states that "of the world's population of scientists and social scientists, Highly Cited Researchers are 1 in 1,000", thus 0.1%. In total, between 2014-2022.

	Number of researchers in FTE (2018)[32]	Number of HCRs (2022)	Share of HCRs amongst all researchers	HCRs with foreign 2nd affiliation country (2022)	% of HCRs with foreign 2nd affiliation country (2022)	Number of HCRs (2014-22)	HCRs with foreign 2nd affiliation country (2014-22)	% of HCRs with foreign 2nd affiliation country (2014-22)
USA	1,434,415	2,636	0.18%	64	2%	18,501	498	3%
China	1,866,109	1,116	0.06%	55	5%	4,426	348	8%
UK	309,074	577	0.19%	47	8%	3,820	250	7%
Germany	433,234	365	0.08%	34	9%	2,310	179	8%
Saudi Arabia	24,808[33]	109	0.44%	82	75%	274*	210*	77%
Italy	139,853	105	0.08%	8	8%	635	40	6%
Spain	140,120	97	0.07%	13	13%	704	108	15%
India	341,818	38	0.01%	5	13%	157	19	12%
Turkey	111,893	6	0.005%	0	0%	56	8	14%

Table 2 . *Per country; total number of researchers, number of Highly Cited Researchers primarily affiliated to each country in 2022 and share amongst those who have a second foreign affiliation. HCR numbers of 2014-2022 represent the sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times. * For Saudi Arabia the total number of different HCRs between 2014-22 does not take multiple counts into account, thus if HCRs appeared several for several years in the HCR list, they are only counted once.*

Between 2014-2022 274 different HCRs were primarily affiliated to Saudi Arabian institutions, and 210 out of them had a second foreign affiliation, which makes up 77%; significantly higher than for the other countries we looked at, where foreign secondary affiliations accounted for 0-13% in 2022 (the share was 75% for Saudi Arabia in 2022). As we will show below, not all Saudi Arabian insititons have the same

[32] 2018 data from the 2021 UNESCO Science Report, Statistical Annex: https://www.unesco.org/reports/science/2021/en/statistics

[33] 2021 data from the General Authority for Statistics, Kingdom of Saudi Arabia: https://www.stats.gov.sa/en/news/454

share of foreign second affiliations. **There are thus only 64 HCRs in the past 9 years, who have indicated solely Saudi Arabian institutions in their affiliations.**

Following Figure shows the evolution between 2014-2022 of the number of Highly Cited Researchers primary and secondary affiliated to Saudi Arabian institutions.

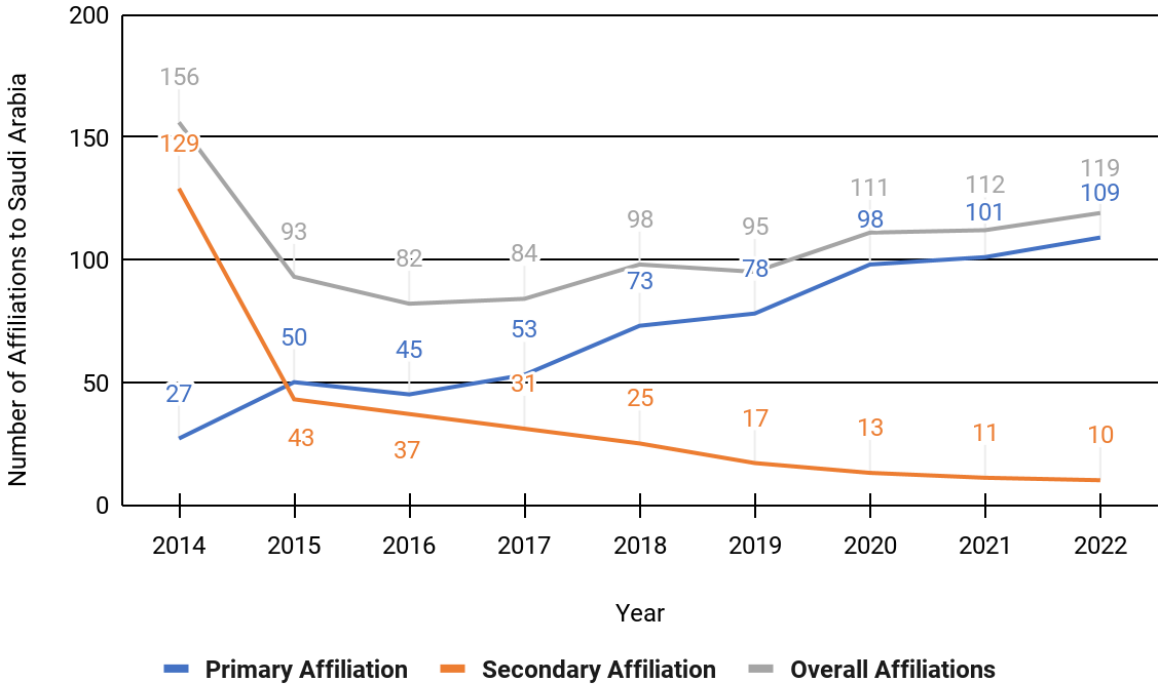


Fig. 2 . *Number of Highly Cited Researchers affiliated to Saudi Arabia between 2014-2022. Overall affiliations (grey), primary (blue) and secondary affiliations (orange) are distinguished.*

Between 2014 and 2022 there was a clear **drop of HCRs indicating Saudi Arabian institutions as secondary affiliation** (from 129 HCRs in 2014 to 10 HCRs in 2022), while the number of **primary affiliated HCRs increased** from 27 in 2014 to 109 in 2022.

As underlined in the introduction due to controversial gaming practices adopted by a number of universities, including **King Abdulaziz University (KAU)**, **ShanghaiRanking's ARWU decided in 2014 to stop including secondary affiliations in their HCR indicator**[34] and **only assign the HCR indicator scores** to institutions that appear in the **primary affiliation.** This led to **some researchers choosing to switch their primary and secondary affiliations**[35]. It is also likely that American universities,

[34] KAU changed their policy to make it more attractive for HCR to resign from their current positions and accept a primary affiliation to KAU, whilst decreasing the size of their offer to scholars who took a secondary affiliation. The result is clearly visible: in 2015, some scholars switched to KAU as their primary affiliation, some retained their KAU secondary affiliation and half stopped referring to KAU. See Bornmann, Lutz, and Johann Bauer. 2015. *Which of the World's Institutions Employ the Most Highly Cited Researchers? An Analysis of the Data from Highlycited.com*. Journal of the Association for Information Science and Technology. https://doi.org/10.1002/asi.23396; and Bhattacharjee, Yudhijit. 2011. *Saudi Universities Offer Cash in Exchange for Academic Prestige*. Science 334 (6061): 1344–45.

[35] Presumably in order to secure personal advantages seeing that it seems unlikely that they

where the majority of cases (52) were concentrated in 2014, contacted their individual researchers to request them to correct their affiliation, following the publication of blogposts and articles on the topic.

The distribution of secondary affiliated HCRs amongst Saudi Arabian institutions is the following:

	Secondary Affiliations									
	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total Number of different HCRs (2014-22)
King Abdulaziz University	125	43	30	27	20	11	8	6	4	**140**
King Saud University	1		4	1	3	3	1	2	2	**12**
King Fahd University of Petroleum & Minerals	4		1							**5**
King Abdullah University of Science & Technology						2	1	2	3	**4**
Prince Sultan University			1	1		1	1	1		**2**
Dammam University			1	1	1					**1**
Imam Abdulrahman Bin Faisal Univ				1	1					**1**
Alfaisal University							1			**1**
Taibah University							1			**1**
Qassim University									1	**1**

Table 3 . *Number of Highly Cited Researchers indicating secondary affiliations to Saudi Arabian institutions between 2014-2022. The total number of different HCRs between 2014-22 does not take multiple counts into account, thus if HCRs appeared several for several years in the HCR list, they are only counted once.*

As can be seen, **King Abdulaziz University is the main university which had in the past numerous HCRs indicating this university as secondary affiliation**, over 125 in 2014, while for the other institutions the yearly number of secondarily affiliated HCRs was never higher than 4 HCRs. In 2022 finally only 4 HCRs indicated King Abdulaziz University as secondary affiliation,while far more indicated it, and other Saudi Arabian universities as primary affiliation, as can be seen in the next table.

would not have been aware of the negative consequences that this action would have on their home institution.

	Primary Affiliations																				
	2014		2015		2016		2017		2018		2019		2020		2021		2022		Total Number of different HCRs (2014-22)		
	Overall	Foreign 2nd affil.	Overall	Foreign 2nd affil.	Overall	Foreign 2nd affil.	Overall	Foreign 2nd affil.	Overall	Foreign 2nd affil.	Overall	Foreign 2nd affil.	Overall	Foreign 2nd affil.	Overall	Foreign 2nd affil.	Overall	Foreign 2nd affil.	Overall	Foreign 2nd affil.	% Foreign 2nd affil.
King Abdulaziz University	7	4	21	16	19	16	18	14	36	26	35	28	37	30	35	29	31	27	127	103	81%
King Saud University	13	7	18	12	16	10	21	13	19	14	22	18	34	26	38	30	39	34	93	76	82%
King Abdullah University of Science & Technology	4	3	7	5	7	5	8	5	9	6	14	4	18	4	16	6	15	4	27	11	41%
King Fahd University of Petroleum & Minerals	3	1	4	1	3	1	6	5	8	6	6	4	5	4	6	3	5	2	14	10	71%
Taif University													3	2	4	3	10	9	12	11	92%
Princess Nourah bint Abdulrahman University																	7	5	7	5	71%
Ministry of Health - Saudi Arabia															2	1	1	1	2	1	50%
Alfaisal University									1	0	1	0							1	0	0%
King Abdullah International Medical Research Center																	1	0	1	0	0%
King Saud Medical City (KSMC)													1	0					1	0	0%

Table 4. *Number of Highly Cited Researchers indicating primary affiliations to Saudi Arabian institutions between 2014-2022 (in grey columns). For each institution also the number of HCRs indicating a foreign, non-Saudi, institution as secondary affiliation is shown. The total number of different HCRs between 2014-22 does not take multiple counts into account, thus if HCRs appeared several for several years in the HCR list, they are only counted once.*

King Saud University (39 HCRs), King Abdulaziz University (31 HCRs) and King Abdullah University of Science & Technology (17 HCRs) are the universities which have the most HCRs affiliated in 2022. Overall, for 2014-22 it is King Abdulaziz University which had most HCRs affiliated to its university. Also remarkable is that **Princess Nourah bint Abdulrahman University enters for the first time in 2022 the HCR list**, and this directly with 7 HCRs. Regarding the **share of foreign second affiliations it depends on the institution**: it is especially high for King Abdulaziz University (81%) and King Saud University (82%), while it is only half as high for the King Abdullah University of Science & Technology (41%). Most Saudi Arabian universities are not concerned by this phenomenon.

The large number of HCRs overalls and amongst them, the large percentage of foreign secondary affiliated HCRs, also raised suspicion at Clarivate: With their number of HCRs (109 HCRs in 2022), Saudi Arabia would appear in 10th position, among the countries with most Highly Cited Researchers. **Clarivate does however not consider Saudi Arabia in its ranking of the top countries in terms of the number of Highly Cited Researchers (Fig. 3).** They comment that their **figures *do not include the few cases in which a Highly Cited Researcher opted to list a primary affiliation that represented a Research Fellowship rather than a permanent home base.*** [36]

Highly Cited Researchers by country or region

Rank	Country/Region	Number of HCRs 2022	World Share (%)
1	United States	2,764	38.3
2	China, Mainland	1,169	16.2
3	United Kingdom	579	8
4	Germany	369	5.1
5	Australia	337	4.7
6	Canada	226	3.1
7	The Netherlands	210	2.9
8	France	134	1.9
9	Switzerland	112	1.6
10	Singapore	106	1.5

Fig. 3 *Screenshot from the Clarivate HCR Analysis webpage, analysing the countries with the highest amount of HCRs*

[36] https://clarivate.com/highly-cited-researchers/analysis/

Saudi Arabia is the main country, besides Taiwan which has 2 cases in 2022, which was **marked with an asterisk, meaning that they are associated with the institution not through main employment, but through a research fellowshi**p. Table 5. shows how many of the 109 Highly Cited Researchers affiliated to Saudi Arabian institutions in 2022 (accounting for ShanghaiRanking's ARWU 2023) and 101 HCRs in 2021 (accounting for ShanghaiRanking's ARWU 2022) have been marked with an asterisk by Clarivate. **It seems that Clarivate started identifying far more such cases in 2022 (44), compared to 2021, when it just marked 9 HCRs with an asterisk[37].** Concretely this means that in 2022 over half of the Highly Cited Researchers of King Saud and King Abdulaziz University are reported not to be mainly employed by those Saudi Arabian universities - and this is probably only the surface of the iceberg.

Primary Affiliation Institution (Saudi Arabia)	2022		2021	
	Number of HCRs	HCRs with an Asterisk (affiliation through research fellowship)	Number of HCRs	HCRs with an Asterisk (affiliation through research fellowship)
King Saud University	39	21	38	4
King Abdulaziz University	31	19	35	5
King Abdullah University of Science & Technology	15	0	16	0
Taif University	10	0	4	0
Princess Nourah bint Abdulrahman University	7	4	0	0
King Fahd University of Petroleum & Minerals	5	0	6	0
Ministry of Health - Saudi Arabia	1	0	2	0
King Abdullah International Medical Research Center (KAIMRC)	1	0	0	0
Overall	**109**	**44**	**101**	**9**

Table 5. *Distribution of 2022 and 2021 HCRs[38] amongst Saudi Arabian institutions and share of them being labelled by Clarivate with an asterisk, i.e. having an affiliation through a research fellowship to their primary affiliation.*

The question is if this type of affiliations were taken into account in **ShanghaiRanking's ARWU.** Table 6 shows the detailed indicator scores for the ranked Saudi Arabian universities. **It can be seen that they are ranked amongst the worldwide best universities in ShanghaiRanking's ARWU 2022**, largely thanks to their extremely high number of Highly Cited Researchers (from the 2021 list). In a recent article, including the case of King Saud University as an example, it was shown that the redirection of an Highly Cited Researcher affiliation is particularly potent when there are only a few

[37] In 2022 Clarivate decided to extend the list of researchers tagged with asterisk to those identifying as affiliated or guest researchers.
[38] https://recognition.webofscience.com/wos-op/awards/highly-cited/2021/

HCRs in an institution, potentially leading to a change of more than 100 places in the rank order[39].

	World Rank	National Rank	ShanghaiRanking's Academic Ranking of World Universities Scores							Number of Highly Cited Researchers (2021 list)
			Total Score	ALU	AWD	HCR	N&S	PUB	PCP	
King Saud University	118-121	1	24.2	0	0	43.2	5.5	58.7	21.4	40
King Abdulaziz University	148-150	2	22.1	0	0	41.6	7.1	50.6	17.7	37
King Abdullah University of Science and Technology	282-284	3	16	0	0	28.2	10.9	30.3	17.8	17
Taif University	408-412	4	12.8	0	0	13.7	0	40	17.6	4
King Fahd University of Petroleum & Minerals	496-499	5	11.4	0	0	16.7	0	28.4	21.3	6
King Khalid University	627-638	6	9.6	0	0	0	1.4	37.5	15.7	0
Prince Sattam Bin Abdulaziz University	812-820	7	7.9	0	0	0	0	32.1	13.4	0

Table 6. *Detailed ranking data, total score and indicator scores for Saudi Arabian universities in ARWU 2022.*

By comparing to other universities with similar numbers of Highly Cited Researchers, we can simulate the HiCi score per number of Highly Cited Researchers and show **that ShanghaiRanking's ARWU 2022 seems to take Highly Cited Researchers into account, even if they are marked with an asterisk in the HCR list**, despite the fact that Clarivate highlights at least since 2019[40] such researchers with an asterisk.

If they had not counted the 4 HCRs associated with a research fellowship to King Saud University in 2021 (see Table 6) in the ShanghaiRanking's ARWU 2022, its score would have been 41.0 (for 36 Highly Cited Researchers)[41], instead of 43.2 points (for 40 Highly Cited Researchers)[42]. The same for King Abdulaziz University: its score for 32 Highly Cited Researchers would have been 38.7[43] instead of 41.6 points for the 37 listed Highly Cited Researchers[44].

[39] Docampo, D., Egret, D. & Cram, L. An anatomy of the academic ranking of world universities (Shanghai ranking). *SN Soc Sci* 2, 146 (2022). https://doi.org/10.1007/s43545-022-00443-3

[40] https://recognition.webofscience.com/wos-op/awards/highly-cited/2019/faq/ - latest available online list (only place where asterisks are visible. They aren't indicated in the archived Excel Sheets of the past HCR lists)

[41] Similar score to the University of Melbourne, University of New South Wales, who all have 36 Highly Cited Researchers

[42] Similar score to the University of Washington, who had 40 Highly Cited Researchers in 2021

[43] Similar score to the National University of Singapore, Mount Sinai School of Medicine, Mayo Medical School, University of Chicago, who all had 32 Highly Cited Researchers in 2021

[44] Similar score to Duke University, who had 37 Highly Cited Researchers in 2021

It shows thus that, unlike Clarivate who exclude primary affiliations with an asterisk from their own ranking of countries and institutions, **ShanghaiRanking assigns points to all institutions with Highly Cited Researchers as their primary affiliation including those marked with an asterisk.** This means that researchers who list, as their primary affiliation, an institution where they had a Research Fellowship or where they are affiliated or guest researchers, have a major negative impact on the ranking of their permanent home institution.

It is unclear how long ShanghaiRankings's ARWU will continue to take into account those HCRs marked with an asterisk. The way the number of Highly Cited Researchers compare to other countries and regions is detailed in more depth in the next chapter.

Understanding the Mercato of Highly Cited Researchers

This chapter aims at looking into more depth into the HCRs, who indicate Saudi Arabian institutions as primary affiliation and understand what countries and incisions are behind their secondary foreign affiliations.

As can seen above in Table 2, **amongst those Highly Cited Researchers indicating Saudi Arabia as a primary affiliation, there are over 70% who indicate a secondary affiliation** located in another country. The following table shows the **secondary affiliation countries of those HCRs, who indicate Saudi Arabia as their primary affiliation** in the Highly Cited Researchers™ list.

Primary Affiliation Saudi Arabia			Secondary Affiliation Saudi Arabia		
Secondary Affiliation Country	Number of Highly Cited Researchers (2022)	Number of Highly Cited Researchers (2014-2022)	Primary Affiliation Country	Number of Highly Cited Researchers (2022)	Number of Highly Cited Researchers (2014-2022)
China	12	44	United States	1	61
Spain	11	19	China	2	28
United States	3	16	United Kingdom	1	11
Turkey	4	14	Taiwan	0	10
India	5	13	Spain	1	9
United Kingdom	6	13	Canada	0	7
Germany	5	12	Germany	1	7
Italy	6	12	Australia	0	5
Pakistan	4	9	Switzerland	0	5
Greece	2	6	Italy	0	3
Algeria	1	5	Austria	1	2
Australia	1	4	Finland	0	2
Egypt	3	4	Ireland	0	2
Estonia	0	4	Japan	0	2
Malaysia	1	4	Jordan	0	2
South Africa	0	4	Netherlands	0	2
Jordan	0	3	Algeria	0	1
Netherlands	2	3	Belgium	0	1
Norway	1	3	France	0	1
Bangladesh	1	2	Hong Kong	1	1
Belgium	0	2	India	0	1
Brazil	2	2	Korea,Republic of	0	1
Chile	1	2	Pakistan	0	1
Denmark	2	2	Saudi Arabia	0	1

Russia	2	2	**Serbia**	0	1
Serbia	0	2	**Slovenia**	0	1
Switzerland	2	2	**South Korea**	0	1
Vietnam	1	2	**Sweden**	0	1
Czech Republic	0	1	**Tunisia**	1	1
Ecuador	0	1	**United Arab Emirates**	1	1
France	0	1			
Mauritius	1	1			
Palestinian Territories	0	1			
Poland	0	1			
Romania	0	1			
Saudi Arabia	0	1			
Scotland	0	1			
Slovakia	1	1			
South Korea	0	1			
Taiwan	0	1			
Thailand	0	1			
No second affiliation	27	64			
TOTAL	**109**	**274**	**TOTAL**	**10**	**167**

Table 7 . *Distribution of Highly Cited Researchers per country of secondary affiliation for researchers who have listed as primary affiliation a Saudi Arabian institution (left) and of countries appearing in the primary affiliation, for those HCRs indicating Saudi Arabia as secondary affiliation. (right).*

We will look first at the cases of Saudi Arabian incision appearing in secondary affiliation. **HCRs from 30 countries indicated Saudi Arabian institution as secondary affiliation.** The principal countries in this list are the United States (61 HCRs), China (28 HCRs), United Kingdom (11 HCRs) and Taiwan (10 HCRs) and Spain (9 HCRs). Most of those cases happened in the years close to 2014, as shown above in Fig. 2.

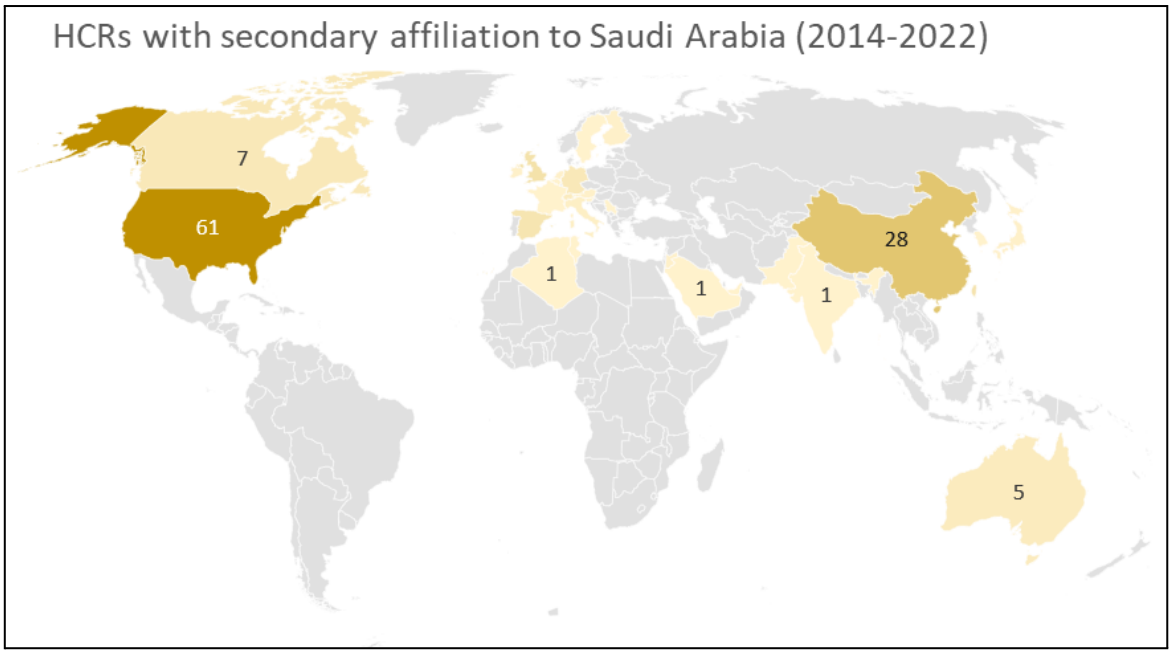


Fig. 4 *Distribution of Highly Cited Researchers per country of primary affiliation for researchers who have listed as secondary affiliation a Saudi Arabian institution*

On the other hand, **a total number of 41 countries have appeared in secondary affiliations for HCRs primarily affiliated to Saudi Arabian institutions**. Fig. 4 summarises them again in a map.

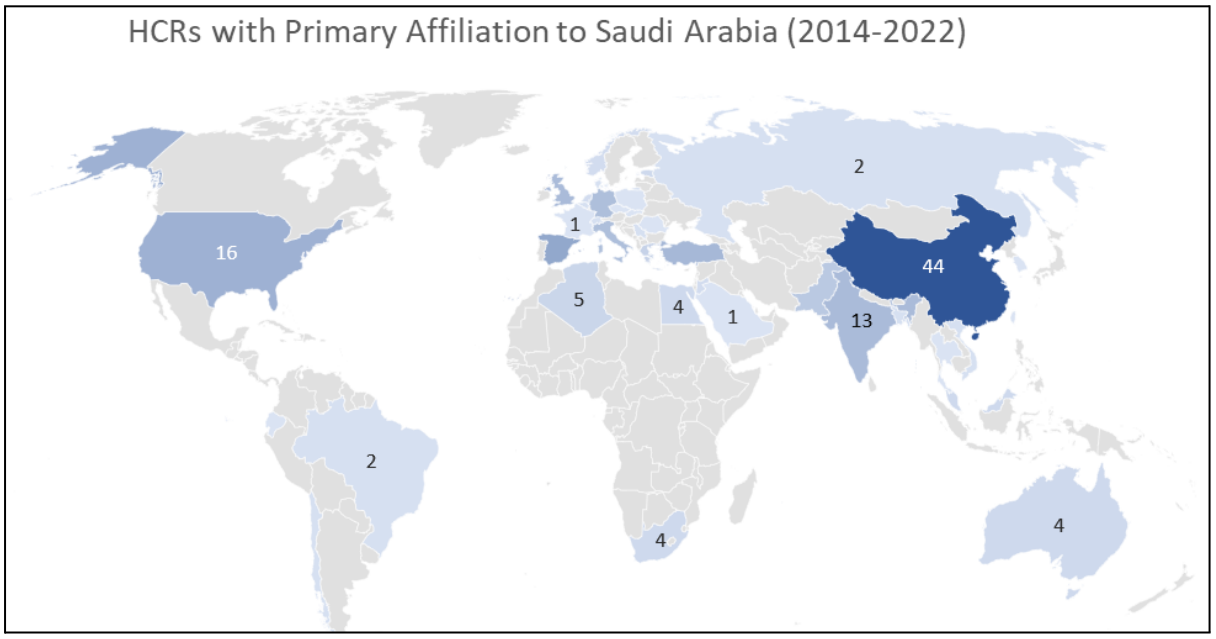


Fig. 5 *Distribution of Highly Cited Researchers per country of secondary affiliation for researchers who have listed as primary affiliation a Saudi Arabian institution*

As we will see below, for most countries the primary secondary affiliation country is the own country, due to double affiliations between a university and a research centre or hospital for example. Saudi Arabia had however just one such case, a HCR in 2020, indicating the affiliations of King Saud Medical City (KSMC) and Alfaisal University.

Countries with more than 10 HCRs, indicating the country's institutions as secondary institutions, while being primarily affiliated to a Saudi Arabian institution are China, Spain, United States, Turkey, United Kingdom, India, Italy and Germany (Table 8.).

Those HCRs of the 8 countries make up 139 of the total 210 different HCRs who have indicated Saudi Arabia as their primary affiliation and a foreign institution as a secondary affiliation, between 2014-2022.

Primary Affiliation Saudi Arabia										
Secondary Affiliation	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**Total Number of different HCRs (2014-22)**
China	3	10	9	11	14	10	10	8	12	**44**
Spain	2	0	0	2	1	3	10	8	11	**19**
United States	4	5	4	4	6	6	6	3	3	**16**
Turkey	0	4	4	3	3	3	4	4	4	**14**
United Kingdom	3	4	3	3	3	6	3	5	6	**13**
India	1	0	0	0	0	3	5	6	5	**13**
Italy	2	2	3	2	2	1	2	5	6	**12**
Germany	3	3	4	5	3	6	9	6	5	**12**
Total non-Saudi Arabian secondary affiliation	15	34	32	37	52	54	66	72	82	**210**

Table 8 . *Number of Highly Cited Researchers per year and second affiliation country, for HCRs indicating Saudi Arabia as primary affiliation. The total number of different HCRs indicates the sum of different HCRs who had those kinds of affiliations between 2014-22.*

It is important to remember that the Highly Cited Researchers are not equally distributed in the world, with 50% of them primarily affiliated to the USA (2636 HCRs) or China (1116 HCRs) in 2022. Amongst those 8 listed countries, the UK (577 HCRs) and Germany (365 HCRs) are also in the top 4, in terms of number of Highly Cited Researchers. It is thus more probable for those countries to appear in the top 8 of countries sharing affiliations with Saudi Arabia. Meanwhile, Spain (101 HCRs), Turkey (6 HCRs), India (38 HCRs) and Italy (HCRs) don't belong to the Top 10, in terms of number of Highly Cited Researchers in 2022, but still have proportionally many HCRs from Saudi Arabia indicating them as secondary affiliations.

Presuming that those HCRs are actually employed at the secondary affiliation, which consequently should be the primary affiliation, enables us to calculate the presumed share of HCRs of those 8 countries indicating a Saudi Arabian institutions as primary affiliation, instead of the institution of their own country:

	Number of HCRs adding the country in secondary affiliation and Saudi Arabia in primary affiliation (2022)	Number of primarily affiliated HCRs (2022)	Presumed percentage of HCRs indicating a Saudi primary affiliation rather than that of their country
Turkey	4	6	40.0%
India	5	38	11.6%
Spain	11	97	10.2%
Italy	6	105	5.4%
Germany	5	365	1.4%
China	12	1,116	1.1%
United Kingdom	6	577	1.0%
United States	3	2,636	0.1%

Table 9 . *Percentage of HCRs indicating a Saudi primary affiliation instead of the one of their own country, presuming that the HCRs indicate a Saudi primary affiliation rather than that of their country.*

This shows that a quite large proportion of the potential overall set of HCRs from Turkey (40%), India (12%) and Spain (10%) indicate Saudi Arabian primary affiliations, instead of the one of their country in 2022. It is important to underline that this presumes that those HCRs do indeed not work primarily in Saudi Arabia, as was shown in the case of Spain by the articles published by El Pais.

This chapter **focuses on those 8 countries, by identifying the affiliation history of each of those Highly Cited Researchers** and briefly contextualising them.
The aim was to see if they have always been primarily affiliated to Saudi Arabian universities or if there was a specific moment in which this switch happened. As explained in the introduction **we merely aim at identifying institutional practices and we therefore chose to remove individual names, which, for those interested, can easily be found through openly available data on the Clarivate webpage.**

Focus on China

China had 1,116 primarily affiliated HCRs in 2022, and 4,426 accumulated HCRs between 2014-2022. Most secondary affiliated institutions are thereby located in China, followed by the USA, Saudi Arabia and Australia[45].

Primary Affiliation China		
Secondary Affiliation Country	**Number of Highly Cited Researchers (2022)**	**Number of Highly Cited Researchers (2014-2022)**
China	89	413
United States	15	91
Saudi Arabia	2	65 (28*)
Australia	11	37
Hong Kong	4	24
Turkey	3	14
Canada	3	14
Singapore	2	13
TOTAL	**1,116**	**4,426**

Table 10 . *Countries indicated most often as secondary affiliation for Highly Cited Researchers indicating a Chinese institution as primary affiliation. HCR numbers of 2014-2022 represent the sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times. *Only for Saudi Arabia the number of different HCRs, without multiple counting, was assessed and is indicated in brackets.*

Summing all HCRs between 2014-22, **Saudi Arabia appears, together with the US, as the first non-Chinese country of primary affiliation for HCRs who indicate a Chinese institution as secondary affiliation**; this occurred 83 times out of 782.

In 2022 China had 1116 HCRs affiliated to its country and 12 HCR indicated a Saudi Arabian university as a primary affiliation and a Chinese institution as secondary affiliation. **In case those would have been actually Chinese primary affiliations, instead of Saudi ones, China could have 1% more HCRs affiliated to its country.**

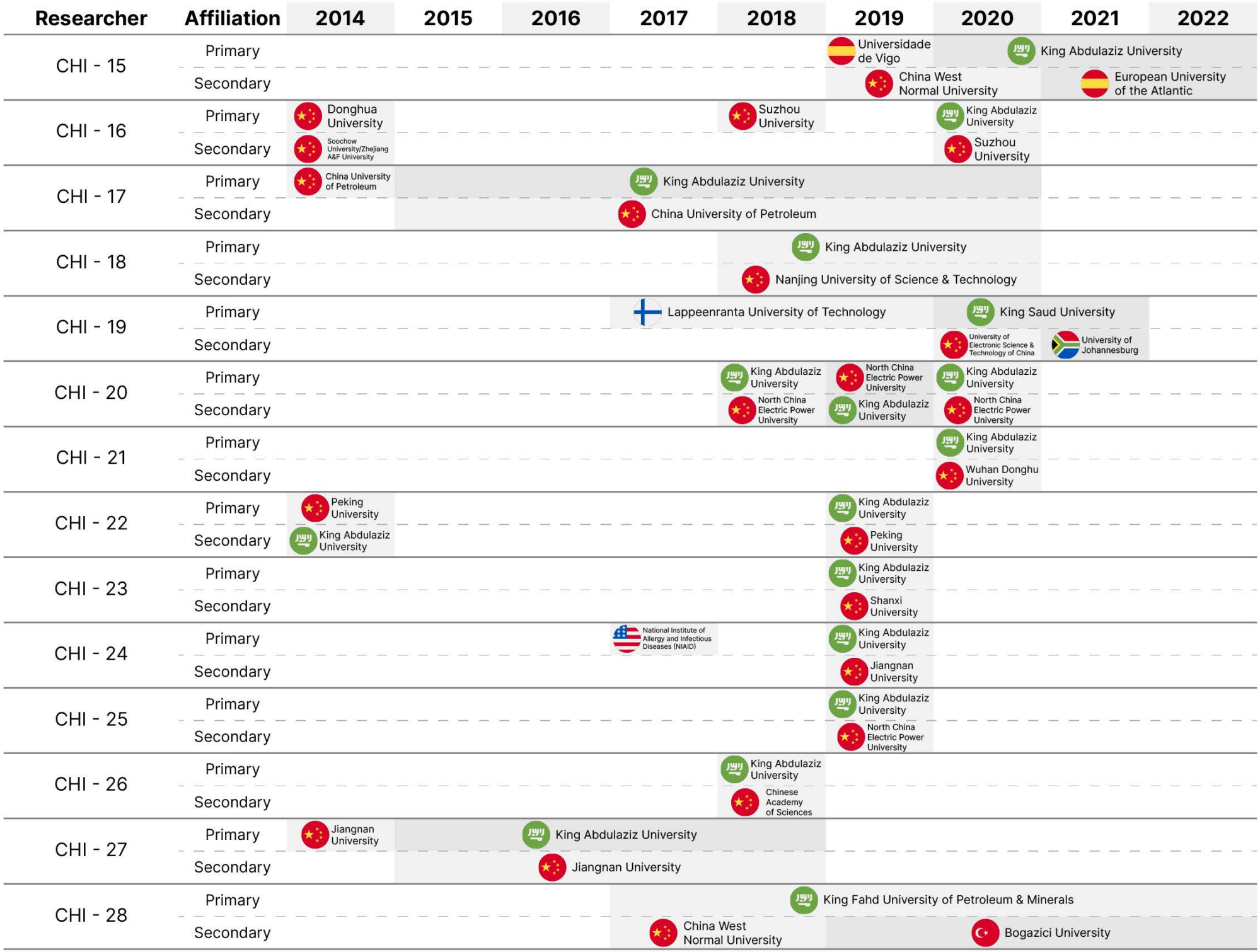
[45] It is important to note that the numbers corresponding to both "Hong Kong" and "China" have to be read carefully, as some HCRs based in Hong Kong identify "China" as their "main country", without making a technical distinction between "Mainland China" and "Hong Kong, China". The same is true for Macau.

Secondary Affiliation China		
Primary Affiliation Country	**Number of Highly Cited Researchers (2022)**	**Number of Highly Cited Researchers (2014-2022)**
China	89	413
United States	11	83
Saudi Arabia	12	83 (*44)
Australia	6	56
Hong Kong	9	21
United Kingdom	2	19
Macau	2	14
Germany	2	11
TOTAL	**146**	**782**

Table 11 . *Countries indicated most often as primary affiliation for Highly Cited Researchers indicating a Chinese institution as secondary affiliation. HCR numbers of 2014-2022 represent the accumulated sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times. *Only for Saudi Arabia the number of different HCRs, without multiple counting, was assessed and is indicated in brackets.*

The following table shows the **affiliation details of those 44 HCRs with a Saudi primary affiliation and a Chinese secondary affiliation between 2014-20**

Researcher	Affiliation	2014	2015	2016	2017	2018	2019	2020	2021	2022
CHI - 01	Primary		University of Texas at San Antonio			King Saud University			University of Texas at San Antonio	Princess Nourah bint Abdulrahman University
	Secondary	King Abdulaziz University				University of Texas at San Antonio				Fujian Normal University
CHI - 02	Primary					Huazhong University of Science & Technology				King Saud University
	Secondary									Huazhong University of Science & Technology
CHI - 03	Primary						Guangxi Normal University		King Abdulaziz University	
	Secondary						University of Electronic Science & Technology of China		Guangxi Normal University	
CHI - 04	Primary									King Abdulaziz University
	Secondary									Xi'an University of Architecture & Technology
CHI - 05	Primary			Southwestern University of Finance & Economics	King Abdulaziz University				King Abdulaziz University	
	Secondary				Southwestern University of Finance & Economics				Southwestern University of Finance & Economics	
CHI - 06	Primary		Chinese Academy of Sciences				King Saud University			
	Secondary						Chinese Academy of Sciences			
CHI - 07	Primary								King Abdulaziz University	
	Secondary								China West Normal University	
CHI - 08	Primary								King Abdulaziz University	
	Secondary								Shandong University of Science & Technology	
CHI - 09	Primary									Taif University
	Secondary									Jiangsu University
CHI - 10	Primary									King Abdulaziz University
	Secondary									Zhejiang Normal University
CHI - 11	Primary						China University of Mining & Technology		King Abdulaziz University	
	Secondary								China University of Mining & Technology	
CHI - 12	Primary								Zhejiang Normal University	King Abdulaziz University
	Secondary									Zhejiang Normal University
CHI - 13	Primary						King Abdulaziz University		King Abdulaziz University	
	Secondary						Shanxi University		Shanxi University	
CHI - 14	Primary								King Abdulaziz University	University of Electronic Science & Technology of China
	Secondary								Zhongnan University of Economics & Law	King Abdulaziz University


Researcher
Affiliation
2014
2015
2016
2017
2018
2019
2020
2021
2022
CHI - 15
Primary
Universidade de Vigo
King Abdulaziz University
Secondary
China West Normal University
European University of the Atlantic
CHI - 16
Primary
Donghua University
Suzhou University
King Abdulaziz University
Secondary
Soochow University/Zhejiang A&F University
Suzhou University
CHI - 17
Primary
China University of Petroleum
King Abdulaziz University
Secondary
China University of Petroleum
CHI - 18
Primary
King Abdulaziz University
Secondary
Nanjing University of Science & Technology
CHI - 19
Primary
Lappeenranta University of Technology
King Saud University
Secondary
University of Electronic Science & Technology of China
University of Johannesburg
CHI - 20
Primary
King Abdulaziz University
North China Electric Power University
King Abdulaziz University
Secondary
North China Electric Power University
King Abdulaziz University
North China Electric Power University
CHI - 21
Primary
King Abdulaziz University
Secondary
Wuhan Donghu University
CHI - 22
Primary
Peking University
King Abdulaziz University
Secondary
King Abdulaziz University
Peking University
CHI - 23
Primary
King Abdulaziz University
Secondary
Shanxi University
CHI - 24
Primary
National Institute of Allergy and Infectious Diseases (NIAID)
King Abdulaziz University
Secondary
Jiangnan University
CHI - 25
Primary
King Abdulaziz University
Secondary
North China Electric Power University
CHI - 26
Primary
King Abdulaziz University
Secondary
Chinese Academy of Sciences
CHI - 27
Primary
Jiangnan University
King Abdulaziz University
Secondary
Jiangnan University
CHI - 28
Primary
King Fahd University of Petroleum & Minerals
Secondary
China West Normal University
Bogazici University

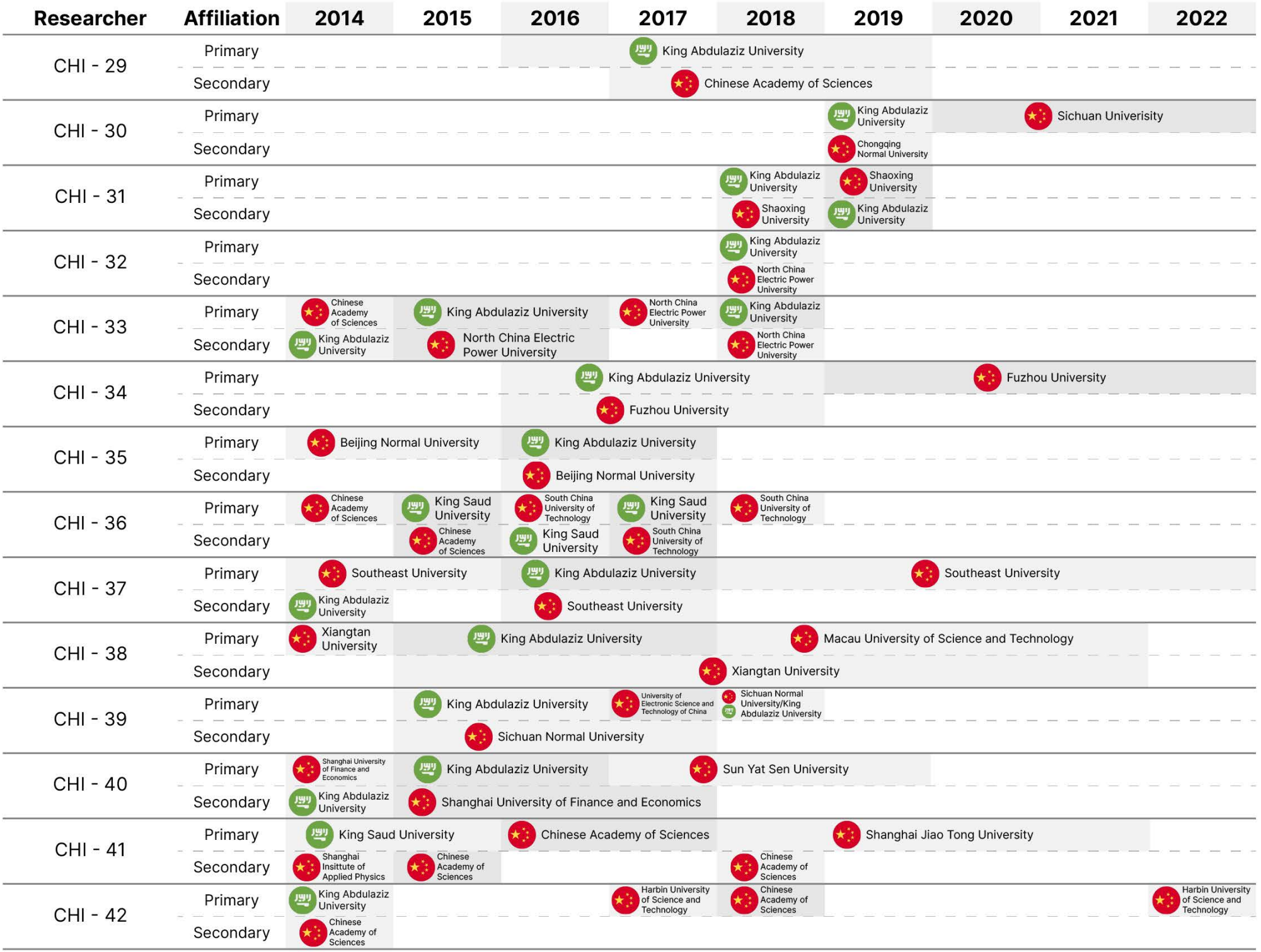

Researcher
Affiliation
2014
2015
2016
2017
2018
2019
2020
2021
2022
CHI - 29
Primary
King Abdulaziz University
Secondary
Chinese Academy of Sciences
CHI - 30
Primary
King Abdulaziz University
Sichuan Univerisity
Secondary
Chongqing Normal University
CHI - 31
Primary
King Abdulaziz University
Shaoxing University
Secondary
Shaoxing University
King Abdulaziz University
CHI - 32
Primary
King Abdulaziz University
Secondary
North China Electric Power University
CHI - 33
Primary
Chinese Academy of Sciences
King Abdulaziz University
North China Electric Power University
King Abdulaziz University
Secondary
King Abdulaziz University
North China Electric Power University
North China Electric Power University
CHI - 34
Primary
King Abdulaziz University
Fuzhou University
Secondary
Fuzhou University
CHI - 35
Primary
Beijing Normal University
King Abdulaziz University
Secondary
Beijing Normal University
CHI - 36
Primary
Chinese Academy of Sciences
King Saud University
South China University of Technology
King Saud University
South China University of Technology
Secondary
Chinese Academy of Sciences
King Saud University
South China University of Technology
CHI - 37
Primary
Southeast University
King Abdulaziz University
Southeast University
Secondary
King Abdulaziz University
Southeast University
CHI - 38
Primary
Xiangtan University
King Abdulaziz University
Macau University of Science and Technology
Secondary
Xiangtan University
CHI - 39
Primary
King Abdulaziz University
University of Electronic Science and Technology of China
Sichuan Normal University/King Abdulaziz University
Secondary
Sichuan Normal University
CHI - 40
Primary
Shanghai University of Finance and Economics
King Abdulaziz University
Sun Yat Sen University
Secondary
King Abdulaziz University
Shanghai University of Finance and Economics
CHI - 41
Primary
King Saud University
Chinese Academy of Sciences
Shanghai Jiao Tong University
Secondary
Shanghai Insittute of Applied Physics
Chinese Academy of Sciences
Chinese Academy of Sciences
CHI - 42
Primary
King Abdulaziz University
Harbin University of Science and Technology
Chinese Academy of Sciences
Harbin University of Science and Technology
Secondary
Chinese Academy of Sciences

Fig 6. *Affiliation history (2014-22) for Highly Cited Researchers, which indicate at some point a Saudi Arabian institution as primary affiliation and a Chinese institution as secondary affiliation.*

Focus on Spain

97 HCRs had a Spanish institution as primary affiliation in 2022, and 704 HCRs (accumulated number) between 2014 and 2022. Their most common secondary affiliation outside Spain has been Saudi Arabia (32 in 2014-2022), followed by the USA and UK.

Primary Affiliation Spain		
Secondary Affiliation Country	**Number of Highly Cited Researchers (2022)**	**Number of Highly Cited Researchers (2014-2022)**
Spain	36	210
Saudi Arabia	0	32 (*9)
United States	3	22
United Kingdom	3	20
China	1	8
Portugal	0	7
Italy	0	5
Australia	2	5
Total	**97**	**704**

Table 12 . *Countries indicated most often as secondary affiliation for Highly Cited Researchers indicating a Spanish institution as primary affiliation. HCR numbers of 2014-2022 represent the sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times. *Only for Saudi Arabia the number of different HCRs, without multiple counting, was assessed and is indicated in brackets.*

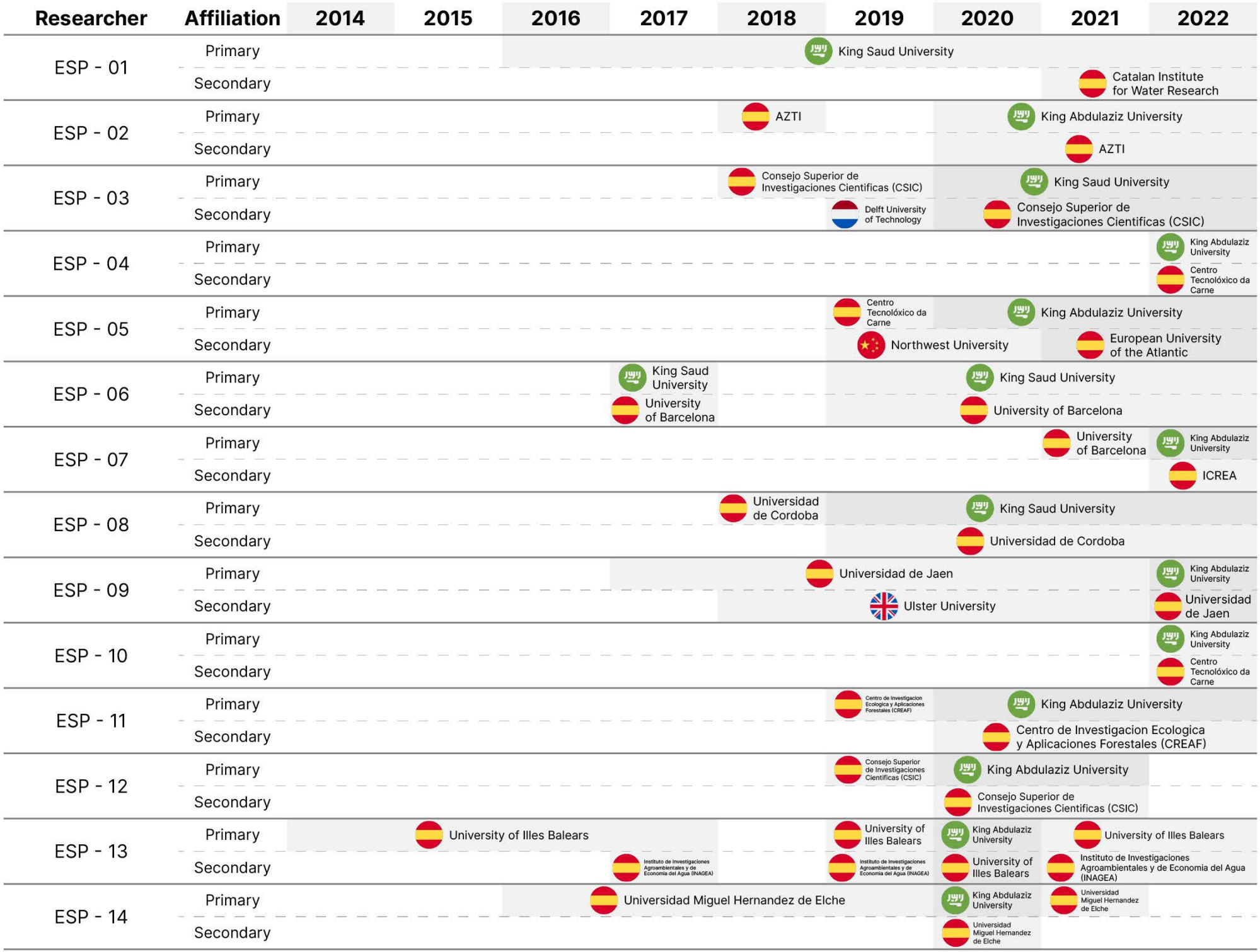
Summing all HCRs between 2014-22, **Saudi Arabia appears as the first non-Spanish country of primary affiliation for HCRs who indicate a Spanish institution as secondary affiliation**. For the remaining Highly Cited Researchers, US, Germany and UK stand out as countries, where most often Spanish institutions appear as secondary affiliation.

In 2022 Spain had 97 HCRs affiliated to its country and 11 HCRs indicated a Saudi Arabian university as a primary affiliation and a Spanish institution as secondary affiliation. **In case those would have been actually Spanish primary affiliations, instead of Saudi ones, Spain would have 11% more HCRs affiliated to its country.**

Secondary Affiliation Spain		
Primary Affiliation Country	**Number of Highly Cited Researchers (2022)**	**Number of Highly Cited Researchers (2014-2022)**
Spain	36	210
Saudi Arabia	11	36 (19*)
United States	3	7
Germany	1	7
United Kingdom	1	5
Italy	0	4
Australia	1	4
Canada	1	3
Total	**55**	**280**

Table 13 . *Countries indicated most often as primary affiliation for Highly Cited Researchers indicating a Spanish institution as secondary affiliation. HCR numbers of 2014-2022 represent the accumulated sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times. *Only for Saudi Arabia the number of different HCRs, without multiple counting, was assessed and is indicated in brackets.*

The following table shows the **affiliation details of those 19 HCRs with a Saudi primary affiliation and a Spanish secondary affiliation between 2014-2022**.


Researcher
Affiliation
2014
2015
2016
2017
2018
2019
2020
2021
2022
ESP - 01
Primary
King Saud University
Secondary
Catalan Institute for Water Research
ESP - 02
Primary
AZTI
King Abdulaziz University
Secondary
AZTI
ESP - 03
Primary
Consejo Superior de Investigaciones Cientificas (CSIC)
King Saud University
Secondary
Delft University of Technology
Consejo Superior de Investigaciones Cientificas (CSIC)
ESP - 04
Primary
King Abdulaziz University
Secondary
Centro Tecnolóxico da Carne
ESP - 05
Primary
Centro Tecnolóxico da Carne
King Abdulaziz University
Secondary
Northwest University
European University of the Atlantic
ESP - 06
Primary
King Saud University
King Saud University
Secondary
University of Barcelona
University of Barcelona
ESP - 07
Primary
University of Barcelona
King Abdulaziz University
Secondary
ICREA
ESP - 08
Primary
Universidad de Cordoba
King Saud University
Secondary
Universidad de Cordoba
ESP - 09
Primary
Universidad de Jaen
King Abdulaziz University
Secondary
Ulster University
Universidad de Jaen
ESP - 10
Primary
King Abdulaziz University
Secondary
Centro Tecnolóxico da Carne
ESP - 11
Primary
Centro de Investigacion Ecologica y Aplicaciones Forestales (CREAF)
King Abdulaziz University
Secondary
Centro de Investigacion Ecologica y Aplicaciones Forestales (CREAF)
ESP - 12
Primary
Consejo Superior de Investigaciones Cientificas (CSIC)
King Abdulaziz University
Secondary
Consejo Superior de Investigaciones Cientificas (CSIC)
ESP - 13
Primary
University of Illes Balears
University of Illes Balears
King Abdulaziz University
University of Illes Balears
Secondary
Instituto de Investigaciones Agroambientales y de Economia del Agua (INAGEA)
Instituto de Investigaciones Agroambientales y de Economia del Agua (INAGEA)
University of Illes Balears
Instituto de Investigaciones Agroambientales y de Economia del Agua (INAGEA)
ESP - 14
Primary
Universidad Miguel Hernandez de Elche
King Abdulaziz University
Universidad Miguel Hernandez de Elche
Secondary
Universidad Miguel Hernandez de Elche

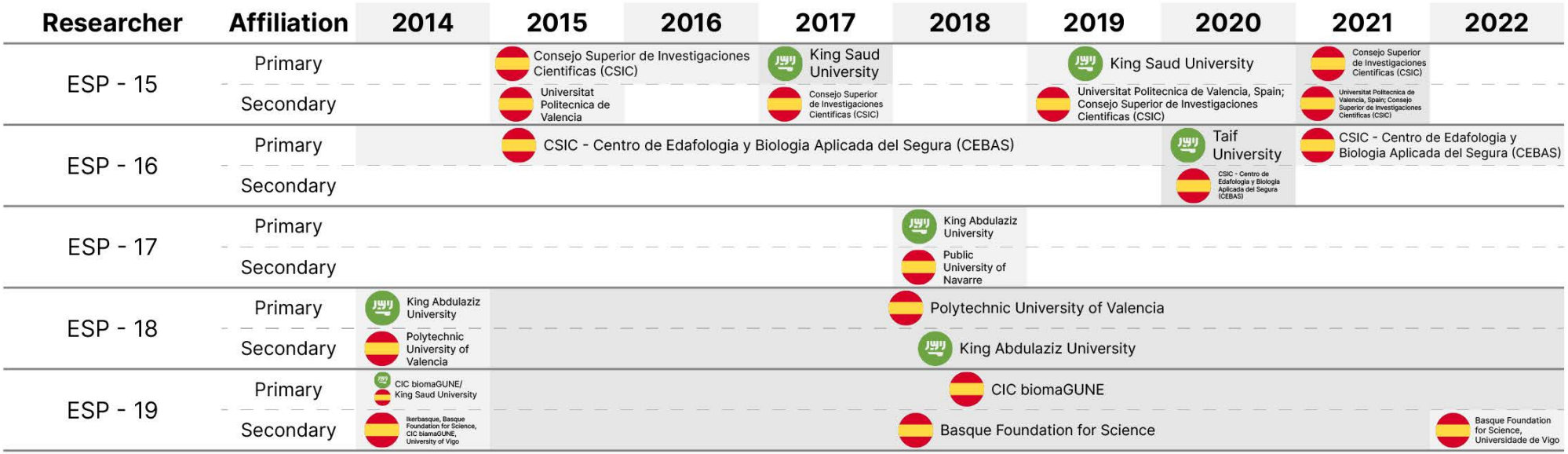


Fig 7. *Affiliation history (2014-22) for Highly Cited Researchers, which indicate at some point a Saudi Arabian institution as primary affiliation and a Spanish institution as secondary affiliation.*

Focus on the USA

In 2022 2,636 HCRs were primarily affiliated to the USA and the country appeared 18,501 as primary affiliation in the HCR list between 2014-2022. The main foreign countries to which US HCRs have been secondarily affiliated to are Saudi Arabia, China, UK and Japan.

Primary Affiliation USA		
Secondary Affiliation Country	**Number of Highly Cited Researchers (2022)**	**Number of Highly Cited Researchers (2014-2022)**
United States	394	2,906
Saudi Arabia	1	92 (*61)
China	11	81
United Kingdom	12	78
Japan	22	42
Switzerland	1	41
Australia	6	36
Canada	5	30
TOTAL	**2,636**	**18,501**

Table 14 . *Countries indicated most often as secondary affiliation for Highly Cited Researchers indicating a US institution as primary affiliation. HCR numbers of 2014-2022 represent the sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times. *Only for Saudi Arabia the number of different HCRs, without multiple counting, was assessed and is indicated in brackets.*

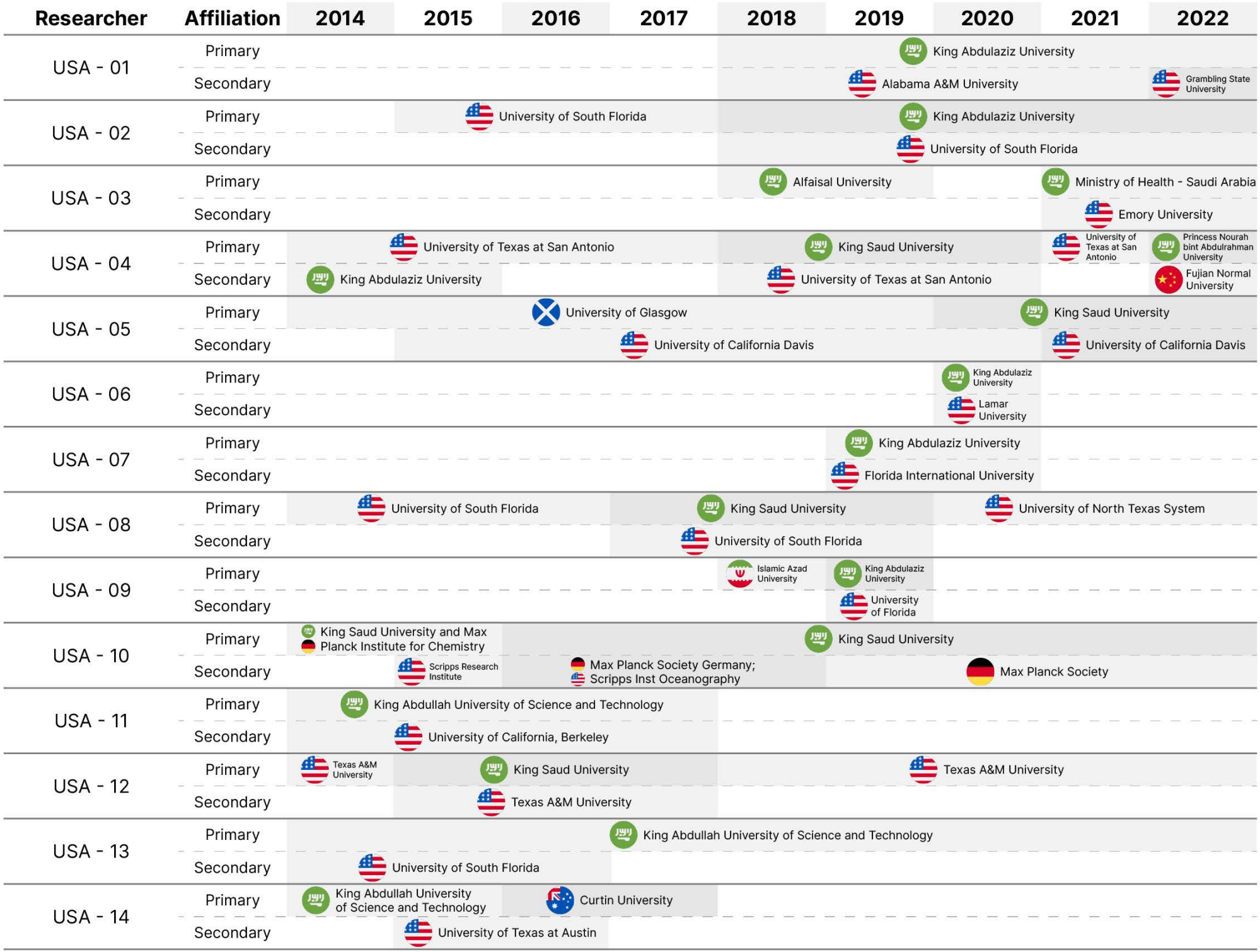
472 HCRs indicated a US institution as a secondary affiliation in 2022, and this happened 3,389 times between 2014-2022. The principal countries, outside the US, to which those HCRs were affiliated were China, Germany, Australia and the UK. Just after those countries followed Saudi Arabia.

In 2022 the US had 2,636 HCRs affiliated to its country and 3 HCR indicated a Saudi Arabian university as a primary affiliation and a US institution as secondary affiliation. In case those would have been actually US primary affiliations, instead of Saudi ones, the US would have 0.1% more HCRs affiliated to its country.

Secondary Affiliation USA		
Primary Affiliation Country	**Number of Highly Cited Researchers (2022)**	**Number of Highly Cited Researchers (2014-2022)**
United States	396	2,908
China	15	90
Germany	9	51
Australia	8	46
United Kingdom	8	45
Saudi Arabia	3	41 (*16)
Switzerland	5	35
Canada	5	27
TOTAL	**472**	**3,389**

Table 15 . *Countries indicated most often as primary affiliation for Highly Cited Researchers indicating a US institution as secondary affiliation. HCR numbers of 2014-2022 represent the accumulated sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times. *Only for Saudi Arabia the number of different HCRs, without multiple counting, was assessed and is indicated in brackets.*

The following table shows the **affiliation details of those 16 HCRs with a Saudi primary affiliation and a US secondary affiliation between 2014-2022**.


Researcher
Affiliation
2014
2015
2016
2017
2018
2019
2020
2021
2022
USA - 01
Primary
King Abdulaziz University
Secondary
Alabama A&M University
Grambling State University
USA - 02
Primary
University of South Florida
King Abdulaziz University
Secondary
University of South Florida
USA - 03
Primary
Alfaisal University
Ministry of Health - Saudi Arabia
Secondary
Emory University
USA - 04
Primary
University of Texas at San Antonio
King Saud University
University of Texas at San Antonio
Princess Nourah bint Abdulrahman University
Secondary
King Abdulaziz University
University of Texas at San Antonio
Fujian Normal University
USA - 05
Primary
University of Glasgow
King Saud University
Secondary
University of California Davis
University of California Davis
USA - 06
Primary
King Abdulaziz University
Secondary
Lamar University
USA - 07
Primary
King Abdulaziz University
Secondary
Florida International University
USA - 08
Primary
University of South Florida
King Saud University
University of North Texas System
Secondary
University of South Florida
USA - 09
Primary
Islamic Azad University
King Abdulaziz University
Secondary
University of Florida
USA - 10
Primary
King Saud University and Max Planck Institute for Chemistry
King Saud University
Secondary
Scripps Research Institute
Max Planck Society Germany; Scripps Inst Oceanography
Max Planck Society
USA - 11
Primary
King Abdullah University of Science and Technology
Secondary
University of California, Berkeley
USA - 12
Primary
Texas A&M University
King Saud University
Texas A&M University
Secondary
Texas A&M University
USA - 13
Primary
King Abdullah University of Science and Technology
Secondary
University of South Florida
USA - 14
Primary
King Abdullah University of Science and Technology
Curtin University
Secondary
University of Texas at Austin

Researcher	Affiliation	2014	2015	2016	2017	2018	2019	2020	2021	2022
USA - 15	Primary	King Abdulaziz University	University of California, Irvine							
	Secondary	University of California, Irvine								
USA - 16	Primary	King Abdullah University of Science & Technology				Georgia Institute of Technology - Georgia Tech				
	Secondary	Georgia Institute of Technology - Georgia Tech				University of Arizona				

Fig 8. *Affiliation history (2014-22) for Highly Cited Researchers, which indicate at some point a Saudi Arabian institution as primary affiliation and a US institution as secondary affiliation.*

Focus on Turkey

In 2022 6 HCRs were primarily affiliated to Turkey and the country appeared 56 as primary affiliation in the HCR list between 2014-2022. The only countries to which Turkish HCRs have been secondarily affiliated to are Romania, Australia, United States and China.

Primary Affiliation Turkey		
Secondary Affiliation Country	**Number of Highly Cited Researchers (2022)**	**Number of Highly Cited Researchers (2014-2022)**
Romania	0	4
Australia	0	2
United States	0	1
China	0	1
Total	6	56

Table 16 . *Countries indicated most often as secondary affiliation for Highly Cited Researchers indicating a Turkish institution as primary affiliation. HCR numbers of 2014-2022 represent the sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times.*

Summing all HCRs between 2014-22, **Saudi Arabia appears as the first non-Turkish country of primary affiliation for HCRs who indicate a Turkish institution as secondary affiliation**. This happened 30 out of 55 times. For the remaining Highly Cited Researchers, Taiwan stands out as country, where most often Turkish institutions appear as secondary affiliation.

In 2022 Turkey had 6 HCRs affiliated to its country and 4 HCRs indicated a Saudi Arabian university as a primary affiliation and a Turkish institution as secondary affiliation. **In case those would have been actually Turkish primary affiliations, instead of Saudi ones, Turkey would have 67% more HCRs affiliated to its country.**

Secondary Affiliation Turkey		
Primary Affiliation Country	**Number of Highly Cited Researchers (2022)**	**Number of Highly Cited Researchers (2014-2022)**
Saudi Arabia	4	30 (*14)
Taiwan	3	16
Canada	1	6
Denmark	1	3
Total	**9**	**55**

Table 17 . *Countries indicated most often as primary affiliation for Highly Cited Researchers indicating a Turkish institution as secondary affiliation. HCR numbers of 2014-2022 represent the accumulated sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times. *Only for Saudi Arabia the number of different HCRs, without multiple counting, was assessed and is indicated in brackets.*

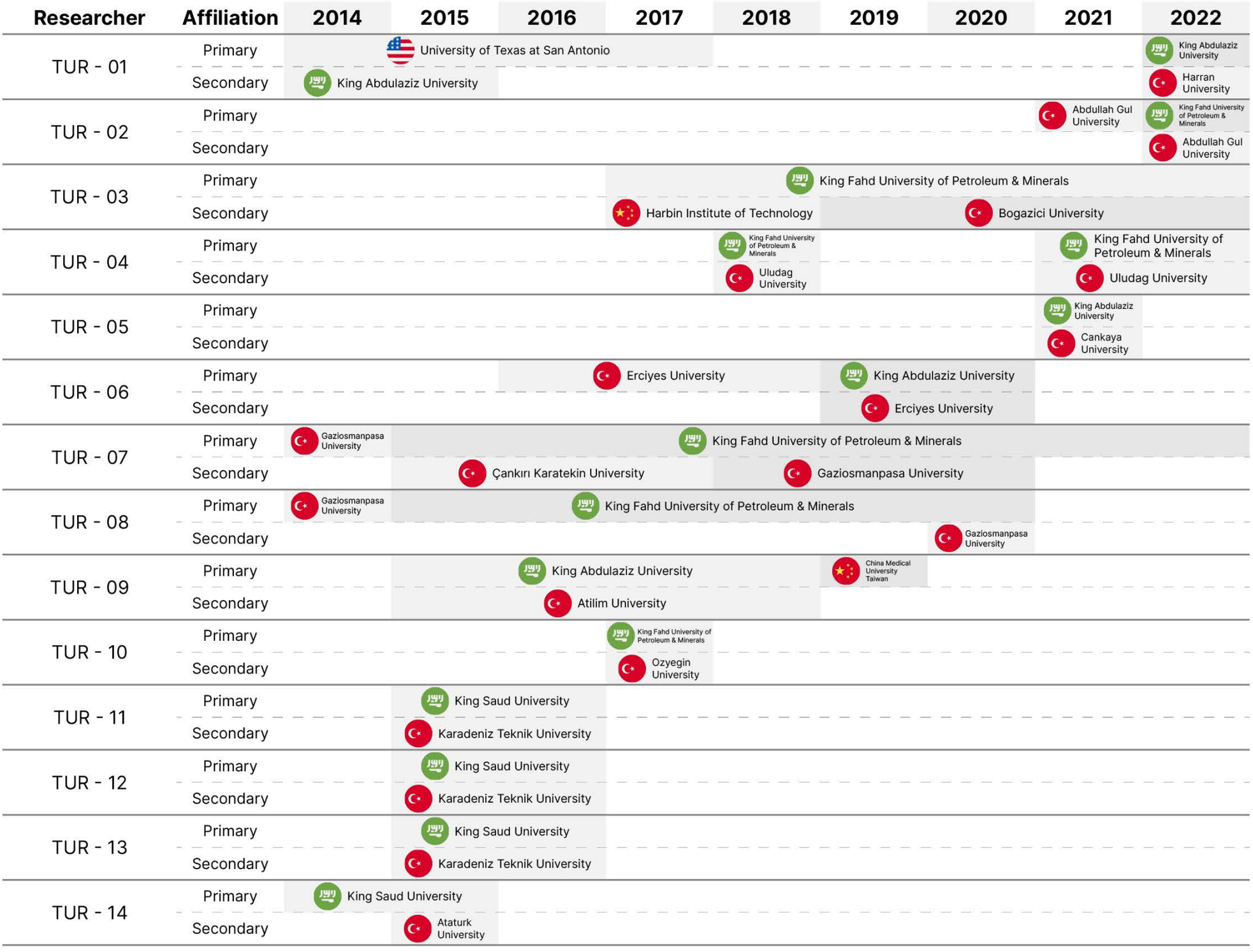


Fig 9. *Affiliation history (2014-22) for Highly Cited Researchers, which indicate at some point a Saudi Arabian institution as primary affiliation and a Turkish institution as secondary affiliation.*

Focus on the UK

In 2022 577 HCRs were primarily affiliated to the UK and the country appeared 3,820 times as primary affiliation in the HCR list between 2014-2022. The main foreign countries to which UK HCRs have been secondarily affiliated to are the US, Australia, Saudi Arabia and China.

Primary Affiliation UK		
Secondary Affiliation Country	**Number of Highly Cited Researchers (2022)**	**Number of Highly Cited Researchers (2014-2022)**
United Kingdom	75	413
United States	8	45
Australia	6	31
Saudi Arabia	1	30 (*11)
China	2	19
Germany	3	18
Switzerand	1	12
Denmark	2	11
Total	**577**	**3,820**

Table 18 . *Countries indicated most often as secondary affiliation for Highly Cited Researchers indicating a UK institution as primary affiliation. HCR numbers of 2014-2022 represent the sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times. *Only for Saudi Arabia the number of different HCRs, without multiple counting, was assessed and is indicated in brackets.*

130 HCRs indicated a UK institution as a secondary affiliation in 2022, and this happened 747 times between 2014-2022. The principal countries to which those HCRs were affiliated were the US, Australia, Netherlands and Saudi Arabia.

In 2022 the UK had 577 HCRs affiliated to its country and 6 HCRs indicated a Saudi Arabian university as a primary affiliation and a UK institution as secondary affiliation. **In case those would have been actually UK primary affiliations, instead of Saudi ones, the UK would have 1% more HCRs affiliated to its country.**

Secondary Affiliation UK		
Primary Affiliation Country	**Number of Highly Cited Researchers (2022)**	**Number of Highly Cited Researchers (2014-2022)**
United Kingdom	74	398
United States	12	78
Australia	10	61
Netherlands	5	32
Saudi Arabia	6	31 (*13)
Spain	3	20
Germany	3	19
Switzerland	4	17
Total	**130**	**747**

Table 19 . *Countries indicated most often as primary affiliation for Highly Cited Researchers indicating a UK institution as secondary affiliation. HCR numbers of 2014-2022 represent the accumulated sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times. *Only for Saudi Arabia the number of different HCRs, without multiple counting, was assessed and is indicated in brackets.*

The following table shows the **affiliation details of those 13 HCRs with a Saudi primary affiliation and a UK secondary affiliation between 2014-2022**.

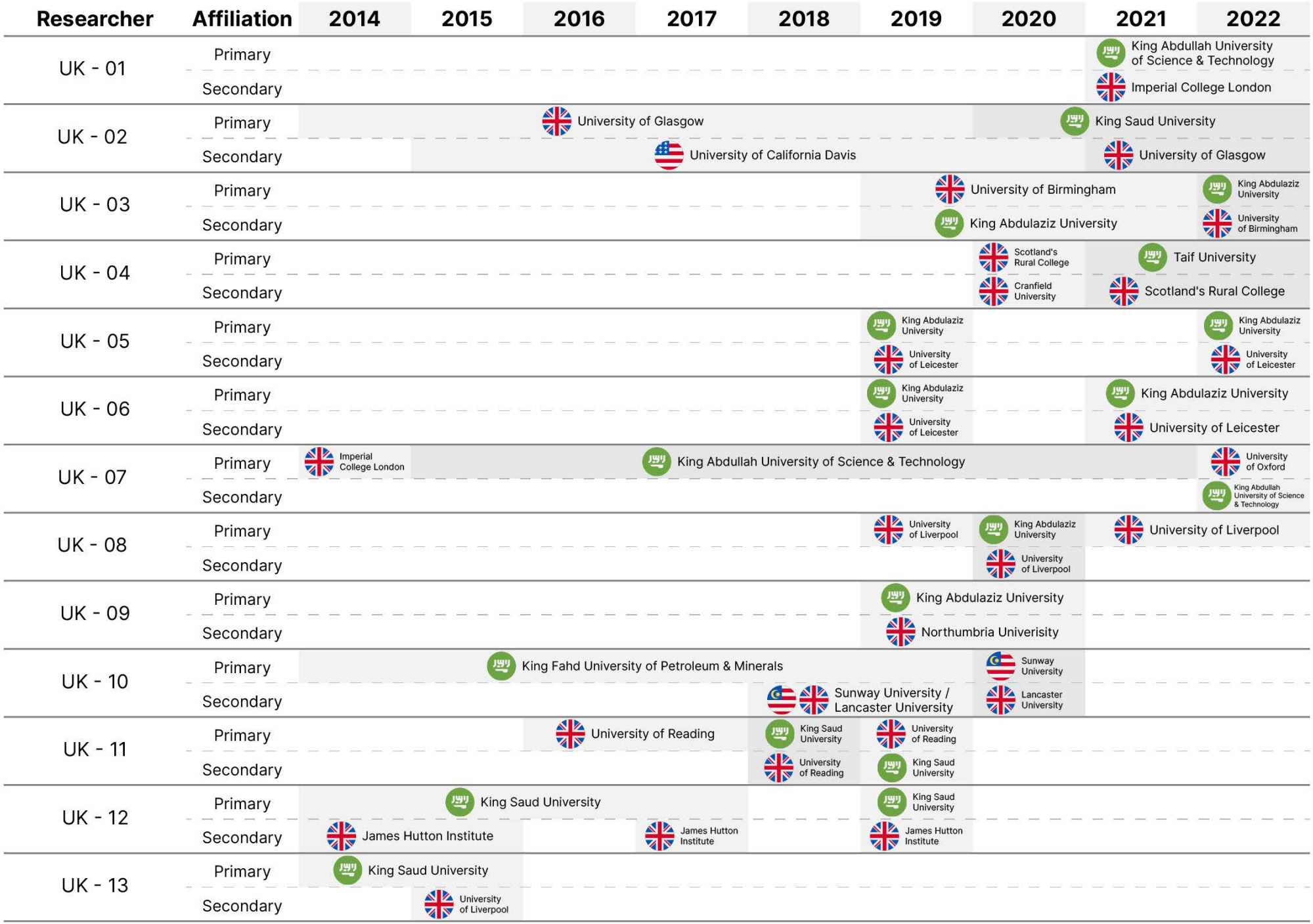


Fig 10. *Affiliation history (2014-22) for Highly Cited Researchers, which indicate at some point a Saudi Arabian institution as primary affiliation and a UK institution as secondary affiliation.*

Focus on India

In 2022 38 HCRs were primarily affiliated to India and the country appeared 157 times as primary affiliation in the HCR list between 2014-2022. The main foreign countries to which Indian HCRs have been secondarily affiliated to are the US, Australia and Austria.

Primary Affiliation India		
Secondary Affiliation Country	**Number of Highly Cited Researchers (2022)**	**Number of Highly Cited Researchers (2014-2022)**
India	2	14
United States	3	14
Australia	0	4
Austria	1	3
United Kingdom	1	2
Canada	0	2
Saudi Arabia	0	1 (*1)
Total	**38**	**157**

Table 20 . *Countries indicated most often as secondary affiliation for Highly Cited Researchers indicating an Indian institution as primary affiliation. HCR numbers of 2014-2022 represent the sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times. *Only for Saudi Arabia the number of different HCRs, without multiple counting, was assessed and is indicated in brackets.*

Summing all HCRs between 2014-22, **Saudi Arabia appears as the first non-Indian country of primary affiliation for HCRs who indicate an Indian institution as secondary affiliation**, this occurred 14 times out of 53. For the remaining Highly Cited Researchers, the US stands out as a country, where most often Indian institutions appear as secondary affiliation.

In 2022 India had 38 HCR affiliated to its country and 5 HCR indicated a Saudi Arabian university as a primary affiliation and the Indian one as secondary affiliation. **In case those would have been actually Indian primary affiliations, instead of Saudi ones, India could have 13% more HCRs affiliated to its country.**

Secondary Affiliation India		
Primary Affiliation Country	**Number of Highly Cited Researchers (2022)**	**Number of Highly Cited Researchers (2014-2022)**
Saudi Arabia	5	20
India	2	14 (*13)
United States	1	8
Australia	0	5
United Kingdom	1	3
Taiwan	1	2
South Africa	0	1
Total	**10**	**53**

Table 21 . *Countries indicated most often as primary affiliation for Highly Cited Researchers indicating an Indian institution as secondary affiliation. HCR numbers of 2014-2022 represent the accumulated sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times. *Only for Saudi Arabia the number of different HCRs, without multiple counting, was assessed and is indicated in brackets.*

The following table shows the **affiliation details of those 13 HCRs with a Saudi primary affiliation and an Indian secondary affiliation between 2014-2022**.

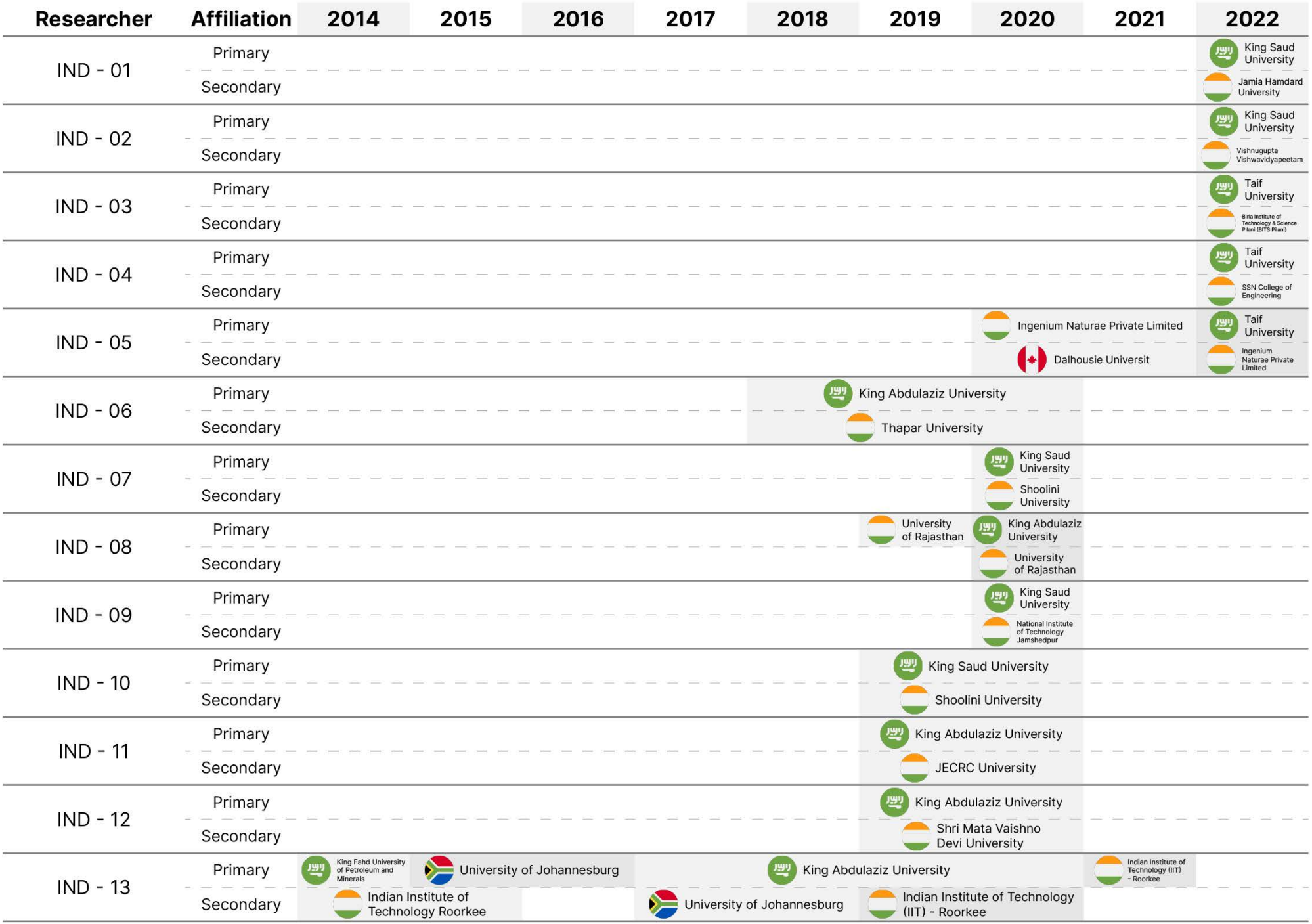


Fig 11. *Affiliation history (2014-22) for Highly Cited Researchers, which indicate at some point a Saudi Arabian institution as primary affiliation and an Indian institution as secondary affiliation.*

Focus on Italy

In 2022 105 HCRs were primarily affiliated to Italy and the country appeared 635 times as primary affiliation in the HCR list between 2014-2022. The main foreign countries to which Italian HCRs have been secondarily affiliated to are the US, China and the UK.

Primary Affiliation Italy		
Secondary Affiliation Country	**Number of Highly Cited Researchers (2022)**	**Number of Highly Cited Researchers (2014-2022)**
Italy	15	92
United States	2	9
China	2	7
United Kingdom	2	5
Germany	0	4
Spain	0	4
Saudi Arabia	0	3 (*3)
Netherlands	0	3
Total	**105**	**635**

Table 22 . *Countries indicated most often as secondary affiliation for Highly Cited Researchers indicating an Italian institution as primary affiliation. HCR numbers of 2014-2022 represent the sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times. *Only for Saudi Arabia the number of different HCRs, without multiple counting, was assessed and is indicated in brackets.*

Summing all HCRs between 2014-22, **Saudi Arabia appears as the first non-Italian country of primary affiliation for HCRs who indicate a Indian institution as secondary affiliation**. This happened 24 out of 159 times. For the remaining Highly Cited Researchers, the United Kingdom and Belgium stand out as countries, where most often Italian institutions appear as secondary affiliation.

In 2022 Italy had 105 HCRs affiliated to its country and 6 HCRs indicated a Saudi Arabian university as a primary affiliation and an Italian institution as secondary affiliation. **In case those would have been actually Italian primary affiliations, instead of Saudi ones, Italy would have 6% more HCRs affiliated to its country.**

Secondary Affiliation Italy		
Primary Affiliation Country	**Number of Highly Cited Researchers (2022)**	**Number of Highly Cited Researchers (2014-2022)**
Italy	15	92
Saudi Arabia	6	24 (*12)
United Kingdom	1	9
Belgium	1	8
Spain	0	5
USA	0	4
Netherlands	0	4
Canada	2	4
Total	**26**	**159**

Table 23 . *Countries indicated most often as primary affiliation for Highly Cited Researchers indicating an Italian institution as secondary affiliation. HCR numbers of 2014-2022 represent the accumulated sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times. *Only for Saudi Arabia the number of different HCRs, without multiple counting, was assessed and is indicated in brackets.*

The following table shows the **affiliation details of those 12 HCRs with a Saudi primary affiliation and an Italian secondary affiliation between 2014-2022**.

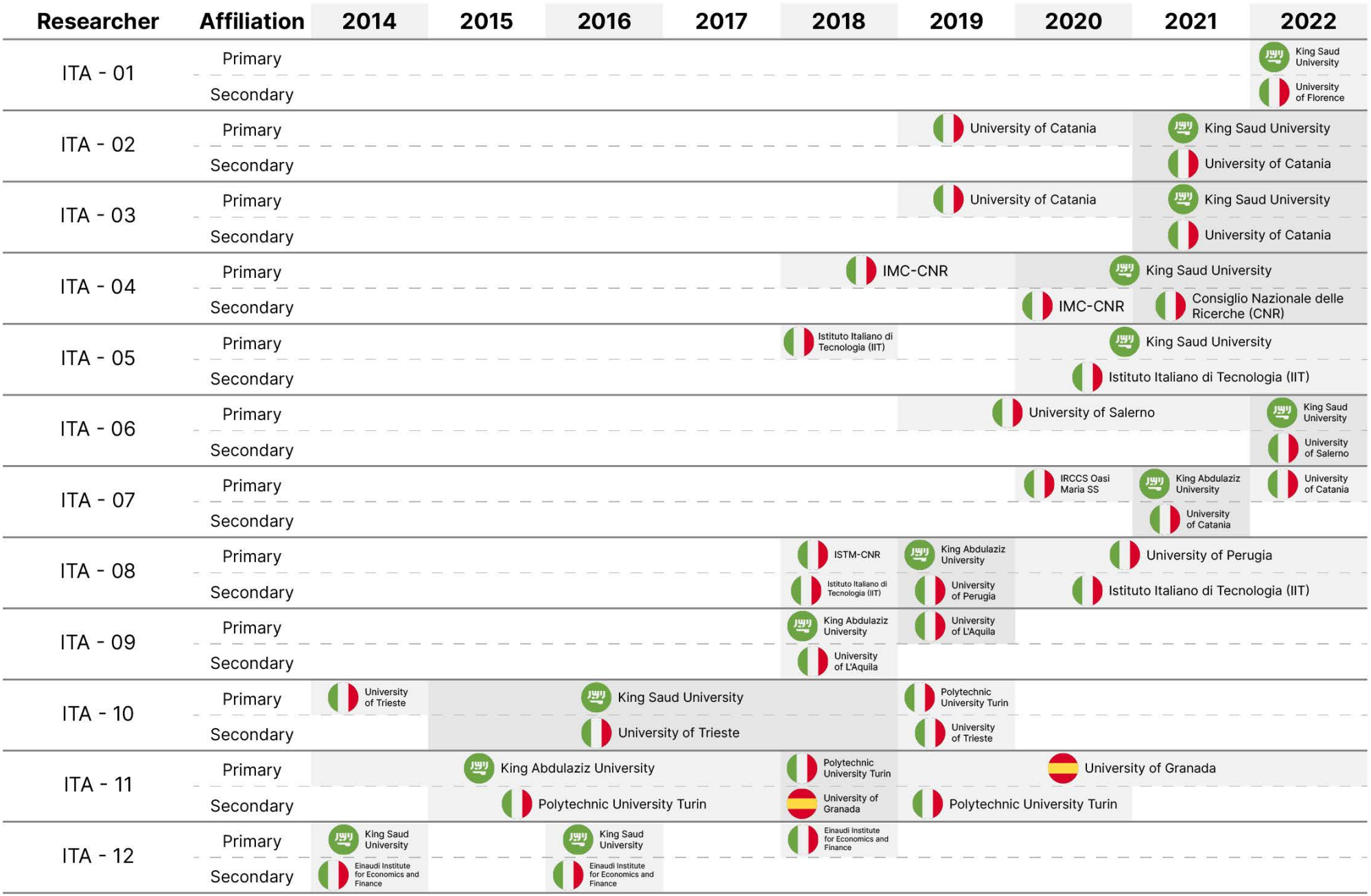


Fig 12. *Affiliation history (2014-22) for Highly Cited Researchers, which indicate at some point a Saudi Arabian institution as primary affiliation and an Italian institution as secondary affiliation*

Focus on Germany

In 2022 365 HCRs were primarily affiliated to Germany and the country appeared 2,310 times as primary affiliation in the HCR list between 2014-2022. Summing all HCRs between 2014-22, Saudi Arabia appears, behind the US, as the second non-German country of secondary affiliation for HCRs who indicate a German institution as primary affiliation; this occurred 21 times.

Primary Affiliation Germany		
Secondary Affiliation Country	**Number of Highly Cited Researchers (2022)**	**Number of Highly Cited Researchers (2014-2022)**
Germany	101	459
United States	9	51
Saudi Arabia	1	21 (*7)
United Kingdom	3	19
Netherlands	3	18
China	2	11
Denmark	1	9
South Korea	3	8
Total	**365**	**2,310**

Table 24 . *Countries indicated most often as secondary affiliation for Highly Cited Researchers indicating a German institution as primary affiliation. HCR numbers of 2014-2022 represent the sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times. *Only for Saudi Arabia the number of different HCRs, without multiple counting, was assessed and is indicated in brackets.*

122 HCRs had a German institution as secondary affiliation in 2022, and 579 HCRs (accumulated number) between 2014-22. Summing all HCRs between 2014-22, **Saudi Arabia appears as the first non-Turkish country of primary affiliation for HCRs who indicate a Turkish institution as secondary affiliation**. This happened 33 out of 579times. For the remaining Highly Cited Researchers, UK and the USA stand out as countries, where most often German institutions appear as secondary affiliation.

In 2022 Germany had 365 HCRs affiliated to its country and 5 HCRs indicated a Saudi Arabian university as a primary affiliation and a German institution as secondary affiliation. **In case those would have been actually German primary affiliations, instead of Saudi ones, Germany would have 1% more HCRs affiliated to its country.**

Secondary Affiliation Germany		
Primary Affiliation Country	**Number of Highly Cited Researchers (2022)**	**Number of Highly Cited Researchers (2014-2022)**
Germany	101	459
Saudi Arabia	5	33 (*12)
United Kingdom	3	18
United States	1	10
Switzerland	0	9
Canada	2	8
China	1	8
Netherlands	2	6
Total	**122**	**579**

Table 25. *Countries indicated most often as primary affiliation for Highly Cited Researchers indicating a German institution as secondary affiliation. HCR numbers of 2014-2022 represent the accumulated sum of all HCRs, thus counting HCRs appearing throughout several years, multiple times. *Only for Saudi Arabia the number of different HCRs, without multiple counting, was assessed and is indicated in brackets.*

The following table shows the **affiliation details of those 12 HCRs with a Saudi primary affiliation and a German secondary affiliation between 2014-2022**.

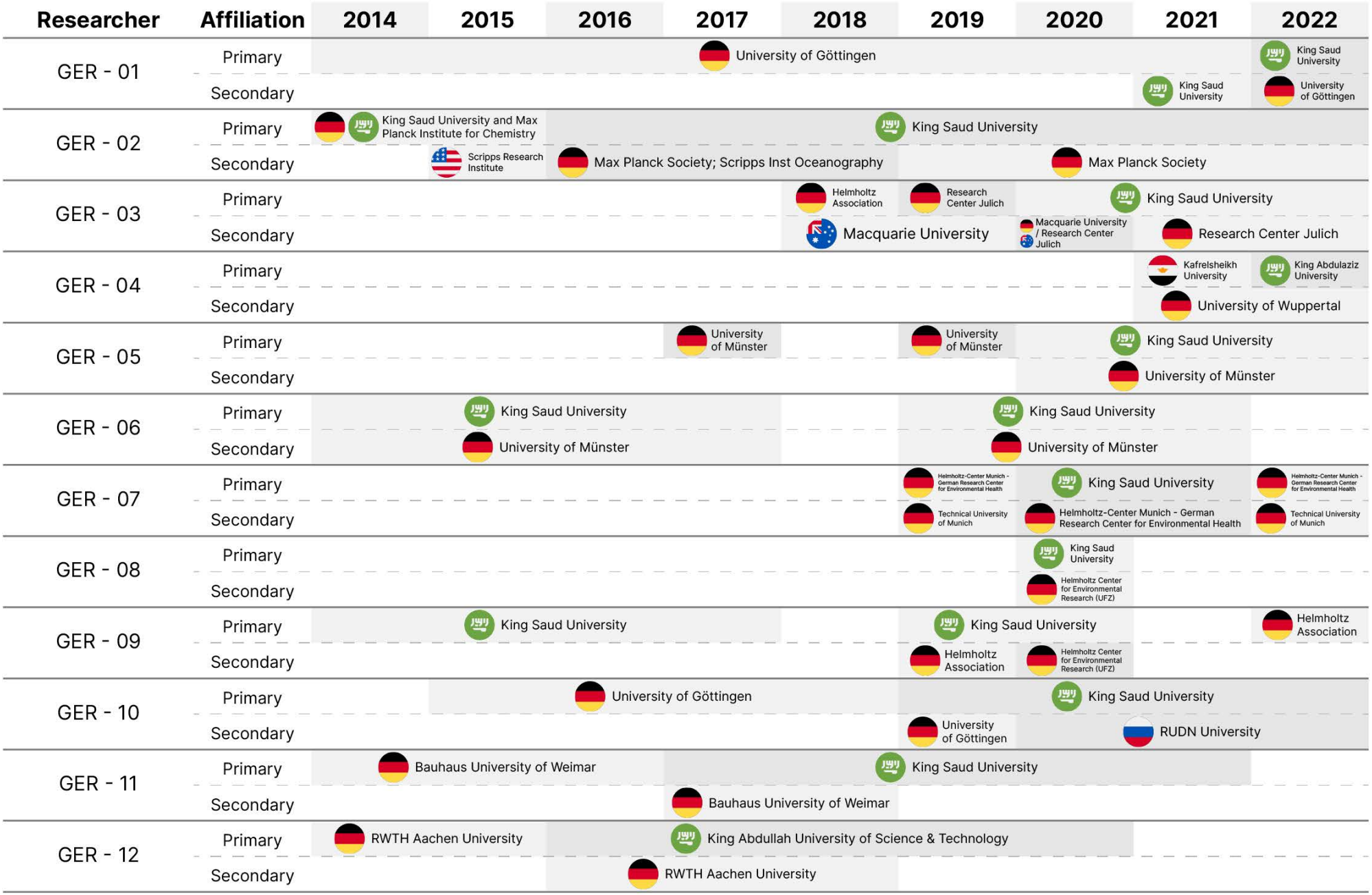


Fig 13. *Affiliation history (2014-22) for Highly Cited Researchers, which indicate at some point a Saudi Arabian institution as primary affiliation and a German institution as secondary affiliation.*

Our Interpretation

Different Models of Affiliation Switches

Analysing the affiliation histories of the 139 HCRs affiliated at some point to Saudi Arabia and simultaneously to one of the 8 focus countries, we identified recurring patterns of affiliation switches. We cluster them into 3 models, with their submodels: The first model is a clear switch to a Saudi Arabian affiliation, the second model are cases of HCRs with affiliation practices with quite strong fluctuations and the last model are cases which seem at first sight legitimate affiliations to Saudi Arabian institutions, but which are probably not in all cases.

Model 1: When primary becomes secondary

		2014	2015	2016	2017	2018	2019	2020	2021	2022
Model 1.1	Primary Affiliation	**Institution A**			**Saudi University**					
	Secondary Affiliation				**Institution A**					
Model 1.2	Primary Affiliation							**Institution A**	**Saudi University**	
	Secondary Affiliation							**Institution B**	**Institution A**	
Model 1.3	Primary Affiliation	**Institution A**						**Saudi University**		
	Secondary Affiliation		**Institution B**						**Institution A**	
Model 1.4	Primary Affiliation						**Institution A**	**Saudi University**	**Institution A**	
	Secondary Affiliation							**Institution A**		
Model 1.5	Primary Affiliation	**Institution A**								**Saudi University**
	Secondary Affiliation								**Saudi University**	**Institution A**

Model 1.1 - The classical switch: After several years of primary affiliation with one institution, the HCR switches his primary affiliation to secondary affiliation, leaving the place to the Saudi university.

Model 1.2 - Giving up your place: Same as model 2.1, but in this case there was originally already another institution listed as secondary affiliation, which has to give up its place to the former primary affiliation, which in turn has to give up its place to the Saudi university.

Model 1.3 - Getting lost on the way
This is supposed to be a model 2.2, except that the HCR forgets to replace their original secondary affiliation with their primary affiliation, while providing the primary affiliation spot to the Saudi university. In this specific case, the mistake was realised one year later, and the original primary affiliation replaced the previous secondary affiliation in the secondary affiliation spot.

Model 1.4 - Admitting the mistake: Similar to model 2.1, except that they remain shortly affiliated to the Saudi university, and soon after have to remove their affiliation to the Saudi university and go back to their original primary affiliation. The most probable case here was that the institution, the researcher him/herself or other stakeholders raised concern about this sudden, probably unjustified switch.

Model 1.5 - Initial confusion: In those cases a HCR starts adding a Saudi university as secondary affiliation. It seems in those cases, they did what made most sense to them - keep their primary employer as primary affiliation and a university with weaker association as secondary affiliation. Such cases were quite common till 2015, when ShanghaiRanking's ARWU stopped taking into account secondary affiliations for their HiCi indicator. In the cases when this happened in recent years, the HCRs did not seem to understand why the Saudi Arabian university wanted to be listed as primary affiliation, and the Saudis had to explain that they were not interested in being listed as a secondary affiliation; this subsequently led in some cases, in the year after, to switching the Saudi affiliation to the primary affiliation, and their original affiliation to secondary one.

Model 2: The rollercoaster careers

		2014	2015	2016	2017	2018	2019	2020	2021	2022
Model 2.1	Primary Affiliation	**Institution A**	**Saudi University**	**Institution B**	**Saudi University**	**Institution B**				
	Secondary Affiliation		**Institution A**	**Saudi University**	**Institution B**					
Model 2.2	Primary Affiliation	**Institution A**				**Saudi University B**			**Institution A**	**Saudi University C**
	Secondary Affiliation	**Saudi University A**				**Institution A**				**Institution B**
Model 2.3	Primary Affiliation	**Saudi University and Institution A**	**Saudi University**							
	Secondary Affiliation		**Institution B**	**Institution A and Institution B**			**Institution A**			

Model 2.1 - The battle for primary affiliation: Those who indicate one year their home institution as primary affiliation, the next year move it to the secondary affiliation, in favour of the Saudi university. The next year they switch again the order of the affiliations, putting the Saudi university in secondary affiliation, which doesn't seem to please the Saudis, thus the next year there is a switch again, which doesn't seem to please the home institution, so the next year they switch again order or finally remove the Saudi university from the affiliation list.

Model 2.2 - The tour of Saudi Arabia: Few cases had more than one Saudi Arabian university affiliated to them, while indicating a foreign secondary affiliation. In one specific case, a researcher was affiliated to 3 different Saudi universities, sometimes in primary, sometimes in secondary, and thereby applying some Model 2 affiliation switches.

Model 2.3 -Making the pie bigger: This is the case for some HCRs, which try to keep their original primary affiliation and list it together with a Saudi university, listing in this way two institutions as primary affiliation. Seems Clarivate tolerated this for some cases. In this case above, it seems the Saudi university wanted to be the sole primary affiliation, which ended up with the HCR putting two secondary affiliations, instead of two primary affiliations.

Model 3: The true Saudi?

		2014	2015	2016	2017	2018	2019	2020	2021	2022
Model 3	Primary Affiliation	**Saudi University**					**Saudi University**			
	Secondary Affiliation	**Institution A**					**Institution A**			

Some HCRs enter the HCR list from the beginning with a Saudi university as primary affiliation and a foreign institution as secondary affiliation; they never make any switches. This is either a fully legitimate case where the main employer is the Saudi Arabian university or a case where the switch was made immediately on publication of the list during the short period when Clarivates accepts corrections for the year (see introduction for how Clarivate determines the affiliations of researchers)[46].

[46] As an example, on Spanish HCR with a Model 3 affiliation history was shown not to work for the Saudi arabian university, according to information shared in a recent article: M.Ansede (20/04/2023), Los científicos de la institución del químico Damià Barceló piden su suspensión cautelar tras su implicación en el escándalo de la trama saudí. *EL PAÍS*. https://elpais.com/ciencia/2023-04-27/los-cientificos-de-la-institucion-del-quimico-damia-barcelo-piden-su-suspension-cautelar-tras-su-implicacion-en-el-escandalo-de-la-trama-saudi.html

Identified Affiliation Switch Patterns

We analysed each of the 138 HCRs from the 8 investigated countries assigned their affiliation history to one or more od the affiliation switch models. The type of switches were quantified per country to understand if some countries have different switch patterns than others. Table 26 summarises the results:

	China	Spain	USA	Turkey	UK	India	Italy	Germany	Grand Total
Model 1.1- The classical switch	10	6	3	4		3	6	6	38
Model 1.2- Giving up your place	2	2			1				5
Model 1.3 - Getting lost on the way	1		2		1			1	5
Model 1.4- Admitting the mistake	6	5	4		3	1	5	1	25
Model 1.5- Initial confusion	3		1		1			1	6
Model 2.1 - The battle for primary affiliation	5								5
Model 2.2 - The tour of Saudi Arabia	1		2			1			4
Model 2.3-Making the pie bigger	1	1	1					3	6
Model 3-The true Saudi?	23	5	7	10	8	9	2	3	67

Table 26. *Distribution of Affiliation switch models per country (some HCRs' affiliation switches fit into several models)*

Overall, most cases (79 times, 49%) are Model 1 switches, amongst which the Model 1.1-classical switch (switching primary affiliation to secondary affiliation) and Model 1.4 admitting the mistake (moving the initial primary affiliation, from secondary affiliation back to primary affiliation) are the most common ones. A large number (67, 42%) of cases enter the HCR list directly with a Saudi Arabian affiliation (Model 3).

- **China:**
  - 44% cases of Model 3, 412 cases Model 1 and 13% cases of Model 2,
  - **Particularity:** The only country where there are cases of Model 2.1 (battle for primary affiliation)
- **Spain:**
  - 68% cases of Model 1, 23% cases Model 3 and 5% cases of Model 2.
  - **Particularity:** Many cases of Model 1.4 (admitting the mistake) switches
- **USA:**
  - 50% cases of Model 1, 35% cases Model 3 and 15% cases of Model 2.
  - **Particularity:** Many cases of Model 1.4 (admitting the mistake) switches
- **Turkey:**
  - 71% cases of Model 3, 29% cases Model 1.1
  - **Particularity:** A very big majority of cases entered directly the HCR list with a Saudi affiliation. 6 out of 14 cases are affiliated with the King Fahd University of Petroleum & Minerals. This is more than 50% of King Fahd's University of Petroleum & Minerals foreign second affiliated HCRs (10 in total, see Table 4.)
- **UK:**
  - 57% cases of Model 3, 43% cases Model 1
  - **Particularity:** A majority of cases entered directly the HCR list with a Saudi affiliation, while for around half of those who switched their primary affiliation to a Saudi one, switched it back after some time (Model 1.4).
- **India:**
  - 64% cases of Model 3, 29% cases Model 1, 7% of Model 2
  - **Particularity:** A very big majority of cases entered directly the HCR list with a Saudi affiliation. 11 out of 13 affiliation switches started only in 2020.
- **Italy:**
  - 85% cases of Model 1, 15% cases of Model 3
  - **Particularity:** A very big majority of cases were Model 1 switches, while half of those cases switched their primary affiliation to a Saudi one, switching it back after some time (Model 1.4).
  -
- **Germany:**
  - 60% cases of Model 1, 20% cases Model 3 and 20% cases of Model 2
  - **Particularity:** All cases are with King Saud, except one with KAUST and one King Abdulaziz University in secondary affiliation.

The impact of such affiliation practices

The direct impact on the main institution of employment is two-fold: First, **investigating these cases is important for ethical, and possibly legal, reasons**: indicating an affiliation that is not that of your main employer in a database or a scientific publication is questionable if not downright unacceptable. **Switching affiliations** would be valid if the researchers in question were renouncing their current position and permanently moving to, in this case, a Saudi Arabian university. It is however more debatable while the researchers are maintaining a full time position in their home institution and even more so if they are public servants and acting without the formal approval of their home institution.

Second, being aware of those cases will hopefully help institutions identify affiliation details that should be corrected and thus ensure that the credit is correctly attributed to the main employer of those Highly Cited Researchers. This is especially relevant for universities, which, whether they want it or not, **are currently partly dependent on the visibility which they gain from rankings**, of which the methodology has been rightly questioned. The number of affiliated Highly Cited Researchers is thus an indicator in the ShanghaiRanking's ARWU and the easiest of the 5 for a university to influence. Adding a single Highly Cited Researcher HCR can result in a university gaining more than 100 places, as shown in a recent study by D. Docampo et al.[47]. The table below shows how the rank of universities appearing in secondary affiliation of Saudi Arabian HCRs in 2022[48] will be affected in a simulated prediction of ARWU 2023[49] for those cases where the affiliation switch happened between 2021 and 2022. For the other cases we simulate what their rank would be in ARWU 2023, in the hypothetical case of the Saudi Arabian HCRs having indicated the university as primary affiliation. As a reminder, the simulation of ARWU 2023 also takes changes in the other indicators into account, and is thus not solely dependent on the change of the number of HCRs.

As can be seen, the **impact can be of up to 150 positions**, for universities in the **lower ranks of the ranking** and those with only 1 or 2 HCRs. For **universities ranked higher**, adding one HCR does not have a strong impact on the rank, as the percentual **change is small**. For the universities, which appeared last in 2021 as primary affiliation of the HCRs indicating a Saudi primary affiliation in 2022, the **predicted impact on the ARWU 2023** can be seen, as e.g. for the case of Kafrelsheikh University[50], University of Salerno, University of Texas at San Antonio or the University of Jaen.

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[47] Docampo, D., Egret, D. & Cram, L. An anatomy of the academic ranking of world universities (Shanghai ranking). *SN Soc Sci* 2, 146 (2022). https://doi.org/10.1007/s43545-022-00443-3

[48] Only universities from the 8 benchmark countries in this report were analysed. More universities from other countries are affected as well.

[49] Simulations were carried out in collaboration with Domingo Docampo.

[50] The reason for including the Egyptian university in the list was, that for GER-04 the switch was a "Model 1.3 - Getting lost on the way" switch, meaning that the German University of Wuppertal was always in secondary affiliation and Kafrelsheikh University was removed from the affiliation list, after King Abdulaziz University entered as primary affiliation.

2022 Highly Cited Researchers with a primary Saudi Arabian affiliation and a secondary affiliation with a foreign university ranked in ARWU								
University	**Last time HCR listed university as 1st affil.**	**Number of HCRs (2021)**	**Number of HCRs (2022)**	**Number of HCRs (2022) - if 1st instead 2nd affil.**	**ARWU 2022**	**ARWU2023 (simulated)**	**ARWU 2023 (if 1st instead of 2nd affil.) (simulated)**	**Ranks lost due to affiliation switch**
Kafrelsheikh University	2021	1	0	1	973	986	832	154
University of Cordoba	2018	0	0	1	837	860	708	152
University of Salerno	2021	1	0	1	608	762	633	129
University of Catania	2020	2	2	4	501	518	456	62
University of Texas at San Antonio	2021	4	1	2	462	626	569	57
Universidad de Jaen	2021	2	1	2	785	867	812	55
China University of Mining & Technology	2020	1	1	2	751	762	708	54
Southwestern University of Finance & Economics	2016	1	1	2	579	574	538	36
Zhejiang University of Technology	2021	2	5	6	462	356	331	25
University of Florence	Never	3	3	4	308	311	289	22
China West Normal University	Never	3	0	1	973	997	978	19
Guangxi Normal University	2020	1	3	4	526	370	353	17
Shandong University of Science & Technology	Never	6	4	5	451	456	439	17
University of Leicester	Never	3	4	6	328	338	322	16
Zhejiang Normal University	Never	5	5	6	558	486	470	16
University of South Florida	2017	3	3	4	293	329	319	10
University of Münster	2019	1	2	3	210	208	201	7
University of Barcelona	Never	8	9	10	185	195	189	6
Jiangsu University	Never	9	8	9	293	256	250	6
University of Birmingham	2021	3	5	6	148	148	143	5
University of Göttingen	2021	5	4	5	171	182	178	4
Huazhong University of Science & Technology	2021	14	14	15	97	82	80	2
Emory University	Never	16	16	17	118	128	126	2
University of Glasgow	2019	11	14	15	142	140	139	1
Imperial College London	Never	25	34	35	23	24	24	0

Table 27. *List of universities listed in ShanghaiRanking's ARWU 2022 and appearing in secondary affiliations of HCRs indicating Saudi Arabian institutions as primary affiliations in 2022. The table shows how their rank would be affected, where the university to be listed in primary affiliation of the HCRs. For the switches that happened between 2021-2022 the predicted impact on the position in the ARWU 2023 ranking can be seen.*

The other institutions, not ranked in ShanghaiRanking's ARWU which were listed as secondary affiliations of HCRs indicating Saudi Arabian institutions as primary affiliations in 2022, can be found in Table 35. Interestingly, many of them actually happen to have zero HCRs primarily affiliated to them.

2022 Highly Cited Researchers with a primary Saudi Arabian affiliation and a secondary affiliation with a foreign institution not ranked in ARWU				
	Last time HCR listed university as 1st affil.	Number of HCRs (2021)	Number of HCRs (2022)	Number of HCRs (2022) - if 1st instead 2nd affil.
Chinese Academy of Sciences	2016	146	177	178
Max Planck Society	2015	70	62	63
Consejo Superior de Investigaciones Científicas (CSIC)	2019	17	15	16
Research Center Julich	2019	1	2	3
Istituto Italiano di Tecnologia (IIT)	2018	2	1	2
Centro de Investigación Ecológica y Aplicaciones Forestales (CREAF)	2019	1	1	2
Abdullah Gul University	2021	1	0	1
Xi'an University of Architecture & Technology	Never	0	0	1
Jamia Hamdard University	Never	0	0	1
Scotland's Rural College	2020	0	0	1
European University of the Atlantic	Never	0	0	1
Harran University	Never	0	0	1
Bogazici University	Never	0	0	1
Uludag University	Never	0	0	1
Grambling State University	Never	0	0	1
Consiglio Nazionale delle Ricerche (CNR)	2019	1	0	1
Vishnugupta Vishwavidyapeetam	Never	0	0	1
Birla Institute of Technology & Science Pilani (BITS Pilani)	Never	0	0	1
SSN College of Engineering	Never	0	0	1
Ingenium Naturae Private Limited	2021	1	0	1
Catalan Institute for Water Research	Never	0	0	1
AZTI	2018	0	0	1
Centro Tecnolóxico da Carne	Never	0	0	2

Table 28. *List of institutions not listed in ShanghaiRanking's ARWU 2022 and appearing in secondary affiliations of HCRs indicating Saudi Arabian institutions as primary affiliations in 2022. Their number of HCRs in 2021, 2022 and their simulated number, in case the institution were listed as primary instead of secondary affiliation, is shown.*

Conclusion

This study provides a **factual analysis of affiliation practices of Highly Cited Researchers indicating Saudi Arabian institutions as primary affiliations and a foreign institution as secondary affiliation, for the time period of 2014-2022**. It shows the extent of such practices, compares the distribution and quantity of Saudi Arabian HCRs with other countries in the world and then looks at the countries and institutions affected by their own researchers switching affiliations to Saudi Arabian ones or directly putting the institution as a secondary affiliation.

The report shows how **Saudi Arabia has a disproportionately high number of HCRs, compared to their overall number of researchers**, well above the share of countries with long-standing research traditions. Their number of HCRs has been growing in the past 9 years and the **majority (over 70%) have a second foreign affiliation**. Setting those numbers into the context of the gaming practices of certain Saudi Arabian universities that have been reported in the press (providing payments in exchange of switching the primary affiliation to the one of the Saudi universities, without changing the main employer) is important, because these **gaming practices have been happening at the cost of other institutions worldwide**.

The second part of the report **helps to understand this impact by identifying the main countries and institutions affected by Saudi Arabian institutions appearing in primary affiliation**, when they are in the second affiliation. For the 8 countries, which had more than 10 HCRs between 2014-2022 with such affiliation practices, we therefore analysed the affiliation history of each individual HCR (for 139 HCRs in total). This helped a.) to understand **patterns of affiliation switches,** which we characterised in 3 different models and b.) **identify the institutions affected by being placed in secondary affiliation alongside a primary, Saudi Arabian affiliation.**

Whilst the questionable affiliation practices by around 1% of researchers within a single list representing 0.1% of all researchers in the world might sound anecdotal, it **opens a major discussion on the impact that affiliations** in such a list, but also in publications, have. It touches upon the heart of a broad range of topics, which are subject to ongoing debate in the field of research: **research integrity, research quality assessment, relevance of rankings or precarity of academic research careers**. And all of this is set within a wider context of **geopolitical influence, use of soft power, competition for talent and corruption**.

Gaming practices and misleading affiliations feed suspicions about the **reliability of science, and undermine the remarkable work done by most scientists the world over. Correct affiliation practices** are one small bit of a general effort to maintain **scientific integrity and earn trust in science** from both decision makers and the general public.

The authors of this report

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Annex: Distribution of Switch models amongst HCRs

The following table shows how we assigned the different switch models to the different HCRs listed in this report. This data was used for the summary in Table 33.

Country	HCR	Switch Model
Italy	ITA-01	3
Italy	ITA-02	1.1
Italy	ITA-03	1.1
Italy	ITA-04	1.1
Italy	ITA-05	1.1
Italy	ITA-06	1.1
Italy	ITA-07	1.4
Italy	ITA-08	1.4
Italy	ITA-09	1.4
Italy	ITA-10	1.1
Italy	ITA-11	1.4/3
Italy	ITA-12	1.4/3
Germany	GER-01	1.5
Germany	GER-02	2.3/1.1
Germany	GER-03	2.3/1.1
Germany	GER-04	1.3
Germany	GER-05	1.1
Germany	GER-06	3
Germany	GER-07	1.4/2.3
Germany	GER-08	3
Germany	GER-09	3
Germany	GER-10	1.1
Germany	GER-11	1.1
Germany	GER-12	1.1
UK	UK-01	3
UK	UK-02	1.3
UK	UK-03	1.5
UK	UK-04	1.2
UK	UK-05	3
UK	UK-06	3
UK	UK-07	3
UK	UK-08	1.4
UK	UK-09	3
UK	UK-10	1.4/3
UK	UK-11	1.4
UK	UK-12	3
UK	UK-13	3
USA	USA-01	3
USA	USA-02	1.1
USA	USA-03	2.2
USA	USA-04	2.2/1.4/1.5/1.3
USA	USA-05	1.3
USA	USA-06	3

USA	USA-07	3
USA	USA-08	1.1
USA	USA-09	3
USA	USA-10	1.1/2.3
USA	USA-11	3
USA	USA-12	1.4
USA	USA-13	3
USA	USA-14	3
USA	USA-15	1.4
USA	USA-16	1.4
Turkey	TUR-01	3
Turkey	TUR-02	1.1
Turkey	TUR-03	3
Turkey	TUR-04	3
Turkey	TUR-05	3
Turkey	TUR-06	1.1
Turkey	TUR-07	1.1
Turkey	TUR-08	1.1
Turkey	TUR-09	3
Turkey	TUR-10	3
Turkey	TUR-11	3
Turkey	TUR-12	3
Turkey	TUR-13	3
Turkey	TUR-14	3
China	CHN-1	2.2/1.4/1.5/1.3
China	CHN-2	1.1
China	CHN-3	1.2
China	CHN-4	3
China	CHN-5	1.1
China	CHN-6	1.1
China	CHN-7	3
China	CHN-8	3
China	CHN-9	3
China	CHN-10	3
China	CHN-11	1.1
China	CHN-12	1.1
China	CHN-13	3
China	CHN-14	3
China	CHN-15	1.2/3
China	CHN-16	1.1
China	CHN-17	1.1
China	CHN-18	3
China	CHN-19	3
China	CHN-20	2.1
China	CHN-21	3
China	CHN-22	1.5
China	CHN-23	3
China	CHN-24	3
China	CHN-25	3
China	CHN-26	3
China	CHN-27	1.1
China	CHN-28	3
China	CHN-29	3
China	CHN-30	3

China	CHN-31	1.4
China	CHN-32	3
China	CHN-33	2.1
China	CHN-34	3/1.4
China	CHN-35	1.1
China	CHN-36	2.1
China	CHN-37	1.5/1.4
China	CHN-38	1.1
China	CHN-39	3/2.3
China	CHN-40	1.5
China	CHN-41	3/1.4
China	CHN-42	3/1.4
China	CHN-43	2.1
China	CHN-44	2.1
India	IND-01	3
India	IND-02	3
India	IND-03	3
India	IND-04	3
India	IND-05	1.1
India	IND-06	
India	IND-07	3
India	IND-08	1.1
India	IND-09	3
India	IND-10	3
India	IND-11	3
India	IND-12	3
India	IND-13	1.1/1.4/2.2
Spain	ESP-01	3
Spain	ESP-02	1.1
Spain	ESP-03	1.1
Spain	ESP-04	3
Spain	ESP-05	1.2/3
Spain	ESP-06	3
Spain	ESP-07	1.1
Spain	ESP-08	1.1
Spain	ESP-09	1.2
Spain	ESP-10	3
Spain	ESP-11	1.1
Spain	ESP-12	1.1
Spain	ESP-13	1.4
Spain	ESP-14	1.4
Spain	ESP-15	1.4
Spain	ESP-16	1.4
Spain	ESP-17	3
Spain	ESP-18	1.4
Spain	ESP-19	2.3

Table A1. *Distribution of affiliation switch models per HCR*