Mapping Croatian Researchers Based Abroad:

Unlocking Transnational Knowledge Networks and Mobility Pathways

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Executive Summary

This study presents the first systematic empirical mapping of Croatian researchers based abroad, addressing a critical data gap in Croatia's research and innovation (R&I) governance. It provides an analytically grounded understanding of mobility patterns, transnational engagement, and return intentions, with the aim of informing evidence-based policy capable of strengthening Croatia's R&I system within the European Research Area (ERA). The analysis is based on an anonymous, self-administered online survey of Croatian researchers abroad, using purposive and snowball sampling. Although the sample is non-representative and reflects self-selection bias, the consistency of observed patterns enables identification of consistent structural patterns.

Profile and Mobility Patterns

The sample of 667 Croatian researchers abroad is predominantly **female (58%)** and concentrated in early- and mid-career cohorts. The largest cohort (**39%**) was born between 1986–1995, with **Millennials accounting for 58%** of respondents. Most were born in Croatia (**78%**) and hold Croatian citizenship (**78%**).

Researchers are globally distributed, with the largest shares in the **United States (17%)**, **Germany (14%)**, and the **United Kingdom (10%)**. Employment is primarily in universities (**60%**), followed by research institutes (**25%**) and private companies (**13%**). **PhD students** represent the largest professional group **(24%)**, followed by **postdoctoral researchers (18%). Academic staff account for smaller shares** (assistant professors 9%, associate professors 8%, full/tenured professors 9%), while **33% of respondents are employed in non-teaching or other roles**. Disciplinary representation is led by natural sciences (**43%**), followed by medical and health sciences (**23%**), engineering (**15%**), and social sciences (**13%**). By career stage, respondents span **R1 (26%), R2 (31%), R3 (29%),** and **R4 (14%)**, with **45% having over 10 years of research experience**.

Academic mobility is closely linked to career formation: **44%** obtained or plan to obtain a PhD within the past 10 years, most frequently in Germany (**14%**), Croatia (**12%**), the United States (**12%**), and the United Kingdom (**10%**). Migration is primarily driven by structural factors, including access to career opportunities, research infrastructure, collaboration opportunities, funding, and salaries.

Despite international mobility, ties to Croatia remain strong: **60%** visit several times per year and **28%** once annually. However, **98%** report receiving no support from Croatian national funding sources.

Transnational Networks and Collaboration

A high proportion of respondents maintain transnational connections:

- **83%** are acquainted with Croatian researchers abroad
- **87%** are acquainted with researchers in Croatia

However, these networks are typically small and path-dependent:

- **62%** maintain networks of 1–5 contacts abroad
- **55%** report 1–5 contacts in Croatia
- **16%** (abroad) and **20%** (with Croatia) remain disconnected

Collaboration remains relatively limited and only modestly institutionalized:

- **66%** report no experience with joint research projects involving researchers in Croatia
- **15%** have participated in one collaboration, and **16%** in several collaborations
- Only **2%** report more intensive collaboration.

Existing ties are primarily based on prior personal or professional relationships rather than formal mechanisms.

While contacts provide moderate professional benefits (collaboration opportunities and system awareness), non-professional benefits (social ties, cultural connection) are more prominent. Information flows rely largely on personal contacts and social media, with a strong preference for direct and targeted engagement.

Return Intentions and Barriers

Return and migration intentions are mixed:

- **27%** express positive intentions
- **32%** are undecided
- **39%** report negative intentions

Time horizons are uncertain: **40%** cannot specify a timeframe, while only **7%** foresee return within two years and **11%** within 2–5 years.

Return motivations are primarily non-professional, driven by family ties and willingness to contribute to Croatia. In contrast, professional incentives, such as funding, infrastructure, and career opportunities, are perceived as weak.

Key barriers include:

- Salary and living-standard disparities
- Limited research funding and infrastructure
- Bureaucratic complexity
- Concerns about research quality

Younger researchers and those at earlier career stages show greater openness to return, though overall associations remain modest.

Diaspora Engagement

A majority (**61%**) recognize the importance of Croatian diaspora organizations, particularly for:

- Facilitating international researcher circulation
- Supporting knowledge exchange
- Promoting scientific achievements

However, engagement remains low:

- **77%** report no interaction with diaspora organizations
- Only **2%** engage frequently

Respondents favor practical, network-based support over formal institutional structures.

Policy Implications

The findings challenge a traditional "brain drain" narrative. Croatian researchers abroad are largely early-career and embedded in international training and employment systems, particularly in leading research countries. Mobility reflects structural asymmetries in global research systems rather than simple outmigration.

The evidence supports a shift toward a **brain circulation/brain linkage** approach. While strong social and professional ties to Croatia exist, they remain underutilized due to weak institutional frameworks. Current patterns indicate the presence of both bonding (national) and bridging (international) social capital, but limited mechanisms to translate these into sustained collaboration or innovation outcomes.

Croatia's R&I system therefore faces a structural challenge: not the loss of human capital, but the **under-institutionalization of transnational knowledge circulation**.

Strategic Policy Directions

The central challenge is not to restrict outward mobility, but to activate transnational scientific potential. Croatia already possesses extensive informal networks of researchers abroad, yet lacks coordinated and continuous mechanisms capable of transforming these connections into sustained collaboration, knowledge transfer, and innovation outcomes. Public policy must therefore move beyond the brain drain paradigm toward structured knowledge circulation, in line with European Research Area priorities on talent mobility and research careers.

These recommendations primarily reflect the characteristics of the study sample, which is largely composed of first-generation migrants and early-career researchers. As such, they are principally designed to address the needs, motivations, and constraints of this group. Croatian descendants of the second and third post-migrant generation may face different barriers, which would require additional, specifically tailored policy approaches beyond the scope of these recommendations.

Policy Recommendations

PILLAR 1: Governance

Objective: Building a coherent and transparent system for engaging scientists abroad

- Establish a National Science Diaspora Strategy with a clear coordinating mandate and defined institutional responsibilities.
- Introduce measurable indicators for collaboration with scientists abroad
  (co-publications, joint grants, mobility flows, reintegration outcomes).
- Integrate diaspora engagement into performance-based funding frameworks.
- Strengthen internationalization, including wider use of English and support for returning families.
- Reduce administrative barriers through transparent recruitment, streamlined recognition procedures, and simplified grant administration.

PILLAR 2: Visibility and Mapping

Objective: Ensuring visibility and accessibility of scientists abroad

- Given that 80% of respondents would welcome direct contact from potential partners in Croatia, develop a National Science Diaspora Registry building on existing initiatives.
- Ensure data quality, regular updates, and institutional ownership.

- Enable thematic search aligned with Smart Specialization priorities.
- Activate the registry through targeted outreach, embassy engagement, and institutional coordination.

PILLAR 3: Collaboration and Circulation

Objective: Transforming connections into measurable collaboration

- Given that 60% of respondents visit Croatia several times per year, introduce a Thematic Scientific Connectivity Program (events, matchmaking, seed funding).
- Establish co-funded research programs involving diaspora scientists and Croatian institutions.
- Complement with visiting positions, short-term fellowships, and remote mentoring/co-supervision.
- Focus on measurable scientific and innovation outputs.

PILLAR 4: Return and Reintegration

Objective: Reducing barriers and enabling sustainable return pathways

- Given that 70% of respondents rely on information and experiences of scientists who have already returned, establish a Returning Scientists Network (mentorship system involving returnees).
- Develop a centralized and regularly updated information system, building on the existing Guide for Returning Scientists.
- Integrate researchers into broader one-stop support services (housing, schooling, taxation, partner employment).
- Reform research careers through transparent tenure-track systems, and competitive funding.
- Enable flexible mobility (dual affiliations, temporary return, circulation).

Concluding Remarks

Croatian scientists abroad represent a strategic resource that remains underutilized. With improved governance, stronger internationalization, more efficient administration, and targeted collaboration instruments, Croatia can transform transnational scientific networks into a key driver of innovation and competitiveness.

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Foreword

This report reflects both scientific inquiry and a strong personal and professional commitment. From the outset, particular attention was devoted to assembling a team of authors with diverse expertise and experience related to the topic, spanning different geographical contexts and institutional settings. The team brings together researchers working in Croatia, Croatian researchers working abroad, and contributors with varied academic and professional backgrounds. This plurality of perspectives has been essential in ensuring both analytical depth and policy relevance.

A similarly inclusive approach guided the construction of the sample. The study encompasses not only first-generation migrants and early-career researchers, but also Croatian descendants from second- and third-generation post-migrant communities, particularly from Latin America and Australia. This diversity was considered essential for capturing the full scope of Croatia's global scientific community, although policy recommendations in the study target primarily researchers born in Croatia, now in doctoral and postdoctoral training within highly developed research systems, in the United States, the United Kingdom and across the EU. This important limitation will be addressed in our future research.

This report is therefore not only an academic contribution, but also a strategic reflection. It is grounded in the conviction that Croatia's researchers abroad should be understood as a strategically valuable resource that needs to be systematically engaged and integrated into the national research and innovation system. Unlocking this potential requires not only recognition, but also the development of appropriate institutional frameworks and policy instruments.

As authors, we are committed to actively informing all relevant stakeholders in Croatia about the key findings of this study and its evidence-based policy recommendations. We see this as part of a broader responsibility to contribute to the development of a more coherent, internationally connected, and forward-looking research and innovation system.

Finally, I would like to express my sincere appreciation to all participants who contributed to this study. It is my personal hope that they will recognize their perspectives in these findings, and that the policy measures that may follow will create tangible opportunities for engagement, collaboration, and, where desired, return.

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We further thank Ms. Caroline Spivak, founder of the Croatian Women's Network, and Ms. Sanja Palić, Chair and Co-founder of the AUS–NZ Croatian Women in Leadership (AUS–NZ CWL), for disseminating information about the study through social media and direct e-mail outreach.

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REPUBLIKA HRVATSKA
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demografije i useljeništva

List of Abbreviations

ACAP	Association of Croatian American Professionals
AUS-NZ CWL	Australia and New Zealand Croatian Women in Leadership
CBS	Croatian Bureau of Statistics
CoARA	Coalition for Advancing Research Assessment
OST	European Cooperation in Science and Technology
CSF	Croatian Science Foundation
EC	European Commission
ERA	European Research Area
ERC	European Research Council
EU	European Union
FORD	Fields of Research and Development
GDP	Gross Domestic Product
GoC	Government of the Republic of Croatia
HR-OOZ	Croatian Open Science Cloud
MSCA	Marie Skłodowska-Curie Actions
MSEY	Ministry of Science, Education and Youth
NGO	Non-governmental Organization
OECD	Organization for Economic Co-operation and Development
RAICEX	Network of Associations of Spanish Researchers and Scientists Abroad
RCP	Research Cooperability Program
R&D	Research and Development
R&I	Research and Innovation
STEM	Science, Technology, Engineering, and Mathematics
STP	Science and Technology Project
UKF	Unity through Knowledge Fund

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1.

Introduction and Context

1.1. Study Motivation and Highly Skilled Migration

The global landscape of scientific mobility has undergone significant transformation in recent decades, prompting a re-evaluation of established theories and national policy approaches concerning the movement of highly skilled professionals (Khan, 2021; Lang, 2021; Chen et al., 2022; Echeverría-King et al., 2022; Ito et al., 2025). These shifts are particularly relevant for countries such as Croatia, a post-socialist European Union member with a fragmented research and innovation (R&I) sector consisting of a large number of public universities and research institutes, many of which face overlapping structural challenges. These include an aging academic workforce (Bjelić Gaćeša, 2021), insufficient doctoral training capacity, inadequate funding mechanisms for early-career researchers (Turk & Ledić, 2016), lagging internationalization and a missing *culture of mobility* (Hornstein Tomić, 2023). Apart from the established pockets of excellence, these conditions constrain the full-scale development of competitive research and large-scale participation in international scientific collaborations, contributing to the continued emigration of research talent and weakening institutional efforts to retain talented researchers or facilitate their reintegration. Therefore, outward migration reflects not only individual research career choices, but also broader systemic constraints embedded in the national R&I environment.

Against this background, the study examines Croatian researchers based abroad. It maps their sociodemographic and professional profiles, analyzes the structural push–pull factors driving emigration, and assesses existing transnational scientific networks, as well as the potential for more intensive collaboration between the scientific diaspora and researchers at home. As an exploratory study, it aims to assess the current level of engagement within networks of Croatian researchers both abroad and in Croatia, and to examine the conditions under which they could contribute to national scientific development through knowledge transfer, collaboration, or return. In doing so, it provides an evidence base for moving beyond a brain-drain narrative toward a more strategic approach to the engagement of Croatian researchers abroad. Thus, it also seeks to move beyond narratives of loss by situating Croatian researchers abroad within broader transnational knowledge systems and innovation networks.

Brain Drain and Push–Pull Migration

Historically, scientific mobility, as well as highly skilled migration, particularly in technological fields, has been conceptualized through the brain drain paradigm. This framework portrays the emigration of educated professionals from peripheral or developing countries to core economies as a unidirectional loss of human capital. Rooted in classical economic models (e.g. Bhagwati and Hamada, 1974), this perspective treated emigration as a direct threat to national development, especially in contexts lacking the institutional capacity to reproduce advanced knowledge domestically. As a result, policy responses in many sending countries were defensive in nature, emphasizing restrictive mobility measures or return incentives based on the assumption that physical return was both necessary and desirable.

To understand the individual and structural dynamics behind highly skilled individuals' migration decisions, migration scholars have long utilized the push-pull framework (Lee, 1966). This heuristic model categorizes factors influencing migration into two groups: push factors, which are negative, repulsive conditions in the place of origin that motivate individuals to leave, and pull factors, which are positive, attractive conditions in potential destinations that draw them in. Although originally formulated for general migration streams, the push-pull model has been effectively adapted to analyze the mobility of scientists and academics (King, 2012). They form a relevant professional group for assessing the nexus between return migration and development in countries of origin (King, 2022; Mueller, 2022).

In the context of scientific mobility from countries such as Croatia, push factors typically encompass systemic deficiencies in the national R&I environment. These include, for example, insufficient R&I funding, limited career prospects, and precarious employment for early-career researchers. The environment has also been criticized for non-transparent recruitment mechanisms, closed circles, bureaucratic challenges, and system inertia (Hornstein Tomić, 2018). Additionally, there is an aging academic workforce with limited renewal, perceived weaker research culture standards, and isolation from global networks. In addition, these factors continue to hamper the return of scientists from the diaspora and to burden their reintegration into home institutions (Hornstein Tomić, 2018). Finally, these factors also limit *home-country receptivity* to knowledge transfer from returning or diaspora scientists (Nevinskaite, 2016), thereby slowing the development of local research capacity and infrastructure.

Conversely, pull factors represent the attractive conditions offered by major science-producing countries, such as abundant and competitive research funding, advanced infrastructure and technology, clear and merit-based career pathways, higher salaries, the prestige of working in top-tier institutions, and immersion in vibrant, international scientific communities with merit-based, transparent recruitment (Franzoni et al., 2012; Scellato et al., 2015).

The push-pull framework is particularly useful for moving beyond the simplistic "loss" narrative of brain drain by illuminating the rationale for mobility. It positions the researcher's decision not as a mere symptom of national failure but as a strategic response

to a comparative assessment of opportunities and constraints across national systems. However, critics note that the model can be overly mechanistic, potentially underestimating the role of personal networks, serendipity, and the increasingly complex, circulatory nature of modern academic careers (Ackers, 2005; Czaika & Reinprecht, 2022). Furthermore, factors can be ambiguous; for instance, the desire for "international experience" can be both a pull from the global market and a push from a system that undervalues locally trained talent.

During the early stages of global skilled migration policy development, particularly throughout the 1980s and 1990s, these assumptions translated into return-oriented strategies that sought to recoup public investments in education and stabilize national development trajectories (Meyer, 2001; Kapur & McHale, 2005; Agrawal et al., 2008). However, such interventions frequently failed to produce sustained effects, largely because they overlooked alternative modes of diaspora engagement, including remote collaboration, transnational networking, and knowledge transfer without permanent return (Mueller, 2022). The limited success of these approaches ultimately contributed to the emergence of new conceptual and policy frameworks that redefined diasporas not as lost assets, but as potential transnational actors embedded in global innovation systems.

Brain Circulation and Brain Linkage

Over the past two decades, a growing body of empirical literature has increasingly challenged the linear and deterministic assumptions of the brain drain model. As Khan (2021) demonstrates in a meta-synthesis of academic mobility in Europe, simplistic frameworks fail to capture the structural, institutional, and individual-level factors shaping contemporary mobility patterns. Highly skilled migration is now widely understood as a multidirectional and often cyclical process, embedded in global research labor markets, digital infrastructures, and transnational scientific communities. Rather than constituting an irreversible loss, highly skilled migration frequently involves temporary stays, circular movement, and sustained professional engagement across borders. It thus resonates with general migratory practices and dynamics between new and old EU-member states as fluid, flexible, and unpredictable, with low levels of integration into host society and low identification with host culture (Engbersen, 2018). Such *liquid* migration patterns entail the possibility of return, continuous mobility, and multiple forms of homeland engagement from the diaspora.

This reconceptualization is supported by comparative studies such as Chen et al. (2022), who show that return migration is both substantial and positively selective across regions. In 90% of the 60 countries analyzed, return migrants were more highly educated than non-migrants, particularly within the 25 to 34 age cohort, suggesting that return flows often inject advanced human capital during peak productive years. These findings position return migration as a component of broader processes of brain circulation, in which temporary or strategic emigration may contribute to long-term national development, especially in countries seeking to strengthen their innovation systems.

At the same time, other strands of literature emphasize the networked and relational dimensions of scientific mobility rather than its physical endpoints. Jonkers and Tijssen (2008), for instance, demonstrate that Chinese life scientists who returned from the United States to mainland China maintained robust international collaboration networks, sustaining high levels of productivity and co-publication. Their findings underscore the importance of viewing mobile scientists as nodes within global knowledge networks, whose contributions are shaped by connectivity and institutional embeddedness rather than geographical presence alone.

The diminishing relevance of physical proximity is further reinforced by Lang (2021), who highlights the role of digital communication and virtual collaboration in reshaping scientific cooperation. Drawing on the German case, Lang shows that even countries experiencing net inflows of talent simultaneously lose significant numbers of their own highly skilled professionals, many of whom remain actively engaged with domestic institutions through advisory or supervisory roles, international projects, and virtual participation. This dual role of countries as both senders and receivers of talent challenges the zero-sum logic underpinning traditional brain drain theory.

Recent work by Ito et al. (2025) further elaborates the intermediary role of mobile scientists by demonstrating how internationally educated PhDs facilitate the internationalization of non-mobile researchers in Colombia. Their analysis shows that co-authorship with mobile scientists significantly increases both the likelihood and intensity of foreign collaboration among previously isolated researchers. However, the study also highlights the fragility of such linkages, noting that sustained benefits often depend on the continued involvement of mobile intermediaries. These findings reinforce the need to conceptualize highly skilled migration not merely as movement, but as a structured set of relationships shaped by institutional contexts and individual agency. This phenomenon has also been highlighted in the Croatian context by Hornstein Tomić (2023) and was further affirmed by participants in this study – *"One of the most beneficial ways the Croatian Science Diaspora can contribute is by establishing joint appointments with Croatian institutions. It is challenging, but being part of the system, at least for a portion of the time, is the way to help. Shown by example. I have a 20 % appointment in Croatia."* (RP74)

Taken together, the literature reflects a paradigmatic shift from brain drain toward concepts such as brain circulation and brain linkage, which more accurately capture the mobility, agency, and connectivity of highly skilled professionals in a globalized and digitalized scientific landscape. For sending countries such as Croatia, this shift carries important policy implications, signaling the need to move beyond loss-avoidance strategies toward institutional support of transnational mobility, proactive diaspora engagement, and the institutionalization of transnational collaboration mechanisms (Hornstein Tomić, 2020). Our research participants also emphasize proactive engagement with the diaspora – *"I think that Croatian science diaspora can help Croatia - just see what other diasporas have done for their home countries."* (RP26).

The framework of brain circulation offers a corrective viewpoint to deterministic perspectives on highly skilled migration by recognizing the potential for mobile scientists to contribute to their countries of origin not only through return, but through transnational collaboration, and sustained cross-border interaction (Saxenian, 2005; Meyer, 2001). Evidently, such contributions are not conditioned by physical return. As Lang (2021) and Echeverría-King et al. (2022) demonstrate, digitalization and virtual collaboration have expanded the modalities through which knowledge transfer and institutional engagement can occur, allowing scientific contribution to be episodic, virtual, or network-based. This reconceptualization is particularly relevant for countries such as Croatia, where structural constraints limit large-scale returns but do not preclude meaningful engagement of researchers from abroad.

Nevertheless, the benefits of brain circulation are neither automatic nor evenly distributed. Evidence from Latin America and the Caribbean shows that effective diaspora engagement requires intentional policy design, institutional coordination, and strategic continuity (Echeverría-King et al., 2022). Without such frameworks, diaspora initiatives often remain fragmented and underutilized. Similar patterns are evident in the Croatian context, where inconsistent institutional support and limited strategic vision have constrained the mobilization of scientific social capital. Some of our research participants have confirmed this in their open answers – "*…if the Croatian Government wants to have back some of the researchers to raise the level of research in Croatia, then this should be done by providing new positions not linked to the current establishment at the universities, less bureaucracy, adequate funds and salaries*." (RP92), "*I would go back to Croatia tomorrow if there were fair and transparent opportunities for researchers in Croatia, policy and strategy. I would be happy to work for less, having a secure salary to live a decent life, and with prosperity to grow and advance in my career.*" (RP94). Those statements echo the findings of a recent study about "Croatia´s (hidden) potential: highly skilled, young remigrants as agents of change", which illuminates the international mobility patterns and return migration trajectories of young Croatian academics and entrepreneurs, based on qualitative interviews and focus group discussion (Hornstein Tomić, Kurilić and Bagić, 2023).

Social Capital and Scientific Diasporas

In this context, social capital theory provides a valuable analytical lens for examining how scientific diasporas and internationally trained scientists function as agents of change. Social capital refers to resources embedded within networks of trust, reciprocity, and social relations that individuals can mobilize to achieve collective or individual goals (Bourdieu, 1986; Coleman, 1988; Lin, 2001). For diaspora scientists, this encompasses both bonding capital, rooted in shared national or cultural ties, and bridging capital, linking domestic institutions to global research infrastructures (Putnam, 2000; Meyer, 2001). By operating at the intersection of these networks, diaspora scientists are uniquely positioned to act as brokers and intermediaries between different epistemic and institutional contexts.

Building on these broader conceptualizations, Lin (2001, p. 20) defines social capital as 'resources embedded in one's social networks, or resources that can be accessed or mobilized through ties in the networks.' These resources, whether tangible, such as funding or equipment, or intangible, such as prestige, enable individuals to achieve their goals. In the scientific context, researchers access and exchange such resources through professional networks, gaining advantages that might otherwise be difficult to obtain. While Lin (2001) conceptualizes social capital primarily at the individual level, participation in larger networks, such as a scientific diaspora, expands this capacity by providing access to resources embedded in the ties of other members.

However, as literature consistently cautions, social capital does not activate itself. Without enabling structures, such as formal collaboration schemes, diaspora registries, or institutional mandates, network resources risk remaining symbolic rather than productive (Meyer, 2001; Jonkers & Tijssen, 2008).

Likewise, the transfer of social remittances, which have been described by Levitt in contrast to financial remittances as the "ideas, behaviors, identities, and social capital flowing from the country of immigration to the country of origin" (Levitt, 1998, p. 927), or of intangible remittances, as identified by Pinkow-Läpple and Möllers (2025) as knowledge, normative structures and practices that migrants have acquired abroad, succeeds when enabling structures in receiving contexts are in place. Furthermore, social, or intangible remittances bear great potential for spurring development and change, when strategic agency is applied by those transferring them (Hornstein Tomić, 2023).

Croatian researchers based abroad frequently express willingness to contribute, yet encounter bureaucratic barriers, unclear points of contact, or a lack of sustained follow-up – "*There is a substantial number of Croatian scientists in bio-medical sciences. My experience is very positive when Croatian scientists choose to collaborate together in preference to collaborating with international scientists of similar skills/scope. Such a process could be improved by having a dedicated international organization to foster links between Croatian scientists, both those who work inside and outside Croatia*." (RP44), "*…one of the key reasons why I do not wish to maintain contact with Croatian organizations is the lack of support and no funding availability even when I was admitted to a PhD program at the University of Cambridge*." (RP51). " Also, language barriers can be an issue- "*I think this may be my most significant one in any attempt to collaborate or move any portion of my career to Croatia since I am an English speaker only and while I work to learn Croatian, I am not optimistic in achieving the fluency needed for academic and professional environments*." (RP96). Such language barriers would not be an issue, if the Croatian academic environment was more internationalized, with English as common language.

Addressing these challenges requires not only recognition of diaspora potential, but its systematic institutionalization within national science and innovation policies.

Viewed through this lens, the scientific diaspora emerges not as a by-product of emigration but as an organized, potentially strategic collective. Diaspora organizations, whether formal associations or informal networks, increasingly serve as intermediaries in scientific collaboration and science diplomacy (Echeverría-King et al., 2022). Comparative cases, such as RAICEX (Red de Asociaciones de Investigadores y Científicos Españoles en el Exterior), the Network of Associations of Spanish Researchers and Scientists Abroad, illustrate how expatriate scientists can act as stakeholders within national innovation systems despite residing abroad (Ortega-Paino & Oliver, 2022). For small countries such as Croatia, these models underscore the importance of shifting from symbolic engagement to structural inclusion.

Ultimately, this study adopts a relational, agent-centered perspective on the Croatian researchers based abroad. Rather than framing highly skilled migration solely in terms of loss or return, it conceptualizes diaspora scientists as embedded actors within global knowledge flows, whose contributions depend on institutional contexts, network structures, policy choices, and agency. Thus, the research lays the groundwork for a policy-relevant, empirically grounded analysis of how Croatia can better engage its global research community as long-term partners in further national development.

1.2. Country Profile

Demographic Decline, Rapid Aging and Emigration

Over the past three decades, Croatia's population has decreased from roughly 4.5 to 3.8 million inhabitants. Between the two most recent population censuses (2011 and 2021), population decline reached almost 10% (~400,000 people).

The Croatian population is also rapidly aging. The average age of the population has increased since 2011 from 41.7 to 44.5 in 2024. Also, the share of population aged 65 and over has risen from 17.7% in 2011 to 23.2% in 2024 (Croatian Bureau of Statistics [CBS], 2025a).

Since joining the European Union in 2013, more than 15% of the working age population (over 250,000 people) have emigrated (World Bank, 2024). A substantial share of these emigrants are professionals in high-demand sectors, including healthcare, engineering, IT and R&I. This pattern of brain drain causes the loss of human capital essential for innovation, productivity growth, and long-term competitiveness. Although some migration was initially intended to be temporary, many emigrants settle abroad permanently, attracted by higher wages, stronger institutional support, and more predictable career trajectories.

The cumulative effects of demographic decline, rapid aging and emigration are profound and long-lasting. A shrinking working-age population has led to labor shortages across key sectors. Simultaneously, population aging places increasing pressure on pension systems, healthcare provision, and public finances. Taken together, these trends indicate that demographic decline constitutes not merely a social concern, but a strategic challenge with far-reaching implications for Croatia's economic development and societal resilience.

Emerging Migration Patterns

In recent years, Croatia has experienced notable shifts in its migration dynamics. To address labor shortages, the country has introduced more flexible regulations for the employment of foreign workers, resulting in increased immigration not only from neighboring countries but, for the first time, also from more distant countries such as Nepal, India, and the Philippines. While these measures have helped to alleviate immediate labor market pressures, their demographic impact remains limited for the time being, as most foreign workers so far do not settle permanently. At the same time, a modest return flow of Croatian emigrants has emerged; however, its scale remains insufficient to offset ongoing population losses or to reverse broader negative demographic trends.

These developments are reflected in the most recent population statistics. According to the mid-

year population estimate of the Croatian Bureau of Statistics for 2024, Croatia had 3,866,233 inhabitants, marking the third consecutive year of population increase (CBS, 2025a). Despite this, natural population change remained negative, with a rate of −4.9 per 1,000 inhabitants (−19 011 persons) (CBS, 2025b). In 2024, a total of 70,391 persons immigrated to Croatia (an increase of 1.4% compared to the previous year), while 38,997 persons emigrated abroad, representing a decrease of 0.6%. As a result, Croatia recorded a positive net migration balance of 31,394 persons with foreign countries (CBS, 2025c).

Return Policies and Diaspora Engagement

According to the Central State Office for Croats Abroad, it is estimated that approximately 3.2 million Croatian emigrants and their descendants reside worldwide, making Croatia one of the countries with the largest diaspora relative to its population size. This substantial diaspora represents a significant demographic, economic, and knowledge potential for Croatia. However, systematic data on educational levels and other socio-economic characteristics of the diaspora remains limited.

In response, Croatia has established a framework for diaspora engagement and return, that includes coordination and programs by various ministries and other institutions (e.g. Ministry of Demography and Immigration, the Ministry of Foreign and European Affairs, the Ministry of Science, Education and Youth, the Ministry of Labor, Pension System, Family, and Social Policy, the Croatian Employment Service, the Central State Office for Croats Abroad).

Existing measures include financial incentives for returnees who establish businesses (the *I Choose Croatia/Biram Hrvatsku initiative*) or purchase property, simplified citizenship procedures for individuals of Croatian origin, a five-year income tax exemption on employment wages, and support for Croatian language learning and social integration.

The *I choose Croatia* measure provides financial incentives of up to €27,000 for returnees starting their own businesses. Since its introduction in 2022, more than 1,500 applications have been approved. Beneficiaries are predominantly male and mostly hold secondary education. Empirical research suggests that such programs primarily function as facilitating instruments rather than decisive drivers of return, as return decisions are more strongly shaped by broader economic improvements and personal motivations (Budimir, Hornstein Tomić, and Pinkow-Läpple 2025).

The *Scientist Return/Znanstvenik povratnik* initiative, launched in 2004 and revised in 2018, represents Croatia's main instrument specifically targeting researchers abroad. Under this measure, universities and public research institutes could propose the hiring of Croatian scientists working abroad, with positions approved and funded by the Ministry of Science, Education and Youth. The number of such positions was capped at 1% of an institution's scientific and teaching staff.

Prior to 2018, eligibility required at least five years of post-PhD work experience abroad, without differentiation based on institutional prestige or research excellence. The 2018 reform introduced a more flexible, merit-based model: the required period abroad was reduced to four years and could be further shortened for candidates from highly ranked universities or those holding prestigious grants, such as those awarded by the European Research Council (ERC).

Between 2015 and 2020, 53 scientists returned through the measure, while between 2020 and September 2025 an additional 52 returned. However, following the introduction of the *performance-based agreements* (*Programski ugovori*) for funding of public higher education institutions and public scientific institutes, the governance structure has shifted. From 2025, the Ministry of Science, Education and Youth no longer directly approves individual return positions. Instead, the possibility of hiring returning scientists must now be incorporated into the institutional Performance Agreements of individual universities and research institutes. The decision-making authority has therefore become more decentralized and contingent on institutional strategic planning and budgetary priorities.

Taken together, these measures indicate that Croatia has established a formal policy basis for return migration, but much less so for sustained and systematic diaspora engagement among those who remain abroad. However, implemented measures do not yet constitute a coherent and strategically integrated institutional framework for attracting, engaging, and retaining highly skilled migrants and researchers. Policies remain dispersed across multiple institutions, administratively complex, and only partially tailored to the specific needs of highly skilled professionals. As a result, while mechanisms for return exist, they lack the coordinated strategic orientation, targeted instruments, and long-term integration measures necessary to effectively attract talent and integrate highly skilled migrants and diaspora researchers.

1.3. Research and Innovation in Croatia

Human Resources

According to the Croatian Bureau of Statistics (2025d), the total research and development (R&D) personnel in 2024 amounted to 27,387. In 2024, total R&D employment amounted to 16,554.1 full-time equivalent (FTE) personnel.

Funding

Based on data from the Croatian Bureau of Statistics (2025d), gross domestic expenditure on R&D as a percentage of GDP (R&D intensity) in Croatia increased substantially between 2017 and 2022, rising from 0.86% to 1.43%. It then decreased slightly to 1.39% in 2023 and 1.35% in 2024 (CBC, 2025e).

Out of the total of 1.2 billion euro spent for R&D in 2024 in Croatia, the largest amount of funding was allocated to the business sector (54.8%), followed by higher education (27.2%), and the government and private non-profit sector (18.0%) (CBS, 2025d).

In comparison to the EU, R&D funding in Croatia is still lagging (European Commission [EC] 2025a). For example, in 2023, R&D intensity (gross domestic expenditure on R&D as a percentage of GDP) in Croatia was 1.39% in comparison to the EU average of 2.24%. Also, in 2023, public expenditure on R&D as a percentage of GDP was 0.63% in comparison to the EU average of 0.72%.

Scientific Quality

Despite improvements in funding, the quality of scientific output remains relatively modest. For example, the share of the country's scientific publications within the top 10% most cited scientific publications worldwide as a percentage of total scientific publications of the country grew between 2012-2021, remaining however below the EU average (in 2021, 4.6% in Croatia vs 9.6% in the EU). Similar trends are also seen in the number of international co-publications, which showed a trend of steady growth between 2012-2023, however again remaining below the EU average (in 2023, 43.2 in Croatia vs 55.9 in the EU). One contributing factor for modest scientific outputs, in the view of the European Commission, is the fragmented public research base consisting of 25 public research institutes and 8 universities with around 110 faculties.

Innovation Indicators

According to the data reported in the European Innovation Scoreboard 2025 (EC 2025b), the number of public-private co-publications as a share of total publications is above the EU average (in 2023, 9.1% vs 7.7%). However, the number of patent applications filed under the Patent Cooperation Treaty per billion of GDP is very low (in 2022, 0.5 in Croatia vs EU average of 2.8). Croatia is a moderate innovator (performing at 71.6% of the EU average in 2025), however the country's innovation performance has grown faster than the EU since 2018 (+19.4 pp for Croatia vs. +12.6 pp for the EU).

Recent Reforms

In recent years, Croatia has undertaken a series of reforms aimed at transforming its fragmented research landscape into a more cohesive, knowledge-based economy. These efforts are guided by key strategic frameworks, including the *National Development Strategy 2030* (Government of the Republic of Croatia [GoC], 2021a), the *Smart Specialization Strategy 2023-2029* (Ministry of Science, Education and Youth [MSEY], 2021) and the *National Recovery and Resilience Plan 2021-2026* (GoC, 2021b). As part of this process, Croatia has adopted new legislative measures, notably the Act on Higher Education and Scientific Activity and the Act on Quality Assurance in Higher Education and Science.

In parallel, Croatia has aligned its national research and innovation (R&I) agenda with the priorities of the European Research Area (ERA), placing emphasis on open science, research assessment reform, talent mobility, gender equality, and knowledge valorization (EC, 2025c). The country has also introduced a new performance-based funding model for research organizations, designed to promote excellence and strengthen public–private collaboration, alongside new programs aimed at enhancing research quality and supporting the creation of proprietary knowledge. In addition, Croatia has made notable progress in digital research infrastructure through the development of the Croatian Scientific and Educational Cloud (HR-ZOO) and has advanced gender equality in STEM fields.

Despite these achievements, challenges related to talent retention and international mobility persist and will require further targeted policy action.

1.4. Objectives of the Study

This study provides the first systematic empirical overview of Croatian researchers working outside Croatia. By identifying patterns of mobility, career stages, destination countries, disciplinary profiles, and forms of transnational engagement, it addresses a significant data gap in Croatia's research and innovation (R&I) governance framework.

The overall objective of the study is to develop a comprehensive and analytically grounded understanding of Croatia's externally based R&I human capital, including mobility patterns, transnational engagement, and return intentions, and to translate these findings into an evidence-based policy framework capable of strengthening Croatia's R&I system within the European Research Area (ERA).

Specific Objectives:

(1) **To analyze Croatian scientific mobility** through contemporary theoretical frameworks that conceptualize mobility as multidirectional, career-embedded, and structurally shaped by asymmetries in global academic labor markets. This includes examining the structural determinants of mobility and career formation by identifying the key factors that influence researchers' decisions to pursue and sustain careers abroad.

(2) **To assess the extent, quality, and institutionalization of ongoing professional and collaborative ties among Croatian researchers abroad and with domestic institutions**, and to determine whether these networks remain informal and path-dependent or are supported by structured institutional mechanisms.

(3) **To examine return intentions and reintegration conditions** by analyzing attitudes toward return, including motivations, deterrents, and projected time horizons associated with potential reintegration into the Croatian R&I system.

(4) **To develop evidence-based policy recommendations grounded in the empirical findings**, aimed at strengthening Croatia's capacity to govern transnational knowledge circulation, enhancing the institutional activation of diaspora networks, aligning national R&I structures with ERA priorities, and addressing systemic barriers affecting collaboration and return.

2.

Methodology

2.1. Survey and Sampling Design

Online Questionnaire

The study employed an online, anonymous, coded, self-administered survey comprising of eight sections.

The first section collected **demographic information**, including gender, year of birth, place and country of birth, citizenship, country of residence. The second section focused on respondents' **professional background**, including year of PhD completion/ expected year of PhD completion, the university and country where the PhD was obtained, academic position, career stage, employing organization, research experience, field of research, and funding from Croatian institutions.

The third section addressed **academic mobility**. It included questions on the highest academic degree or training obtained in the country of birth and abroad, the career stage at which respondents left their country of birth, motivations for moving abroad, and frequency of visits to Croatia. The fourth section examined **family and circumstances and language proficiency,** including relationship status, partner's nationality and Croatian language proficiency, parental status, and children's proficiency in Croatian.

The fifth section explored **networks among Croatian researchers based abroad**. Respondents were asked whether they maintained contact with other Croatian researchers, about the intensity of these interactions, how these contacts were established, perceived benefits of the contacts, and the reasons for the absence of contacts. The sixth section investigated **networks among Croatian researchers based abroad and in Croatia**. This included the presence and intensity of contacts with researchers in Croatia, pathways through which such contacts were formed, associated benefits, factors influencing the decision to initiate or accept collaboration, as well as the reasons for the absence of contacts. This section additionally queried preferred sources for receiving information on research developments in Croatia and preferred modes of communication with Croatian institutions.

The seventh section examined **return and migration intentions**. It focused on attitudes toward returning or relocating to Croatia, anticipated timing of potential return, perceived benefits and challenges, key factors discouraging return or continued careers in Croatia, and preferred sources of guidance for relocating or conducting research in Croatia.

The eighth and final section assessed the **perceived role of diaspora organizations in supporting Croatian researchers abroad** and the frequency of engagement with such organizations.

The questionnaire was informed by a pilot project conducted by the Association Penkala, which mapped and studied the Croatian scientific diaspora in the UK (Pale et al., 2026), as well as by a study of the Polish research diaspora conducted by the Polonium Foundation in 2018 (Czerniawska et al., 2018). Specifically, the sections addressing professional networks, return potential, and the role of diaspora organizations were adopted (with permission) from the Polish survey (Czerniawska et al., 2018). However, compared to the original instrument, we introduced Likert scales to enable more nuanced measurement. Our questionnaire was initially developed in English and subsequently translated into Spanish and Portuguese[1] through a standardized translation process.

The survey instrument commenced with an informed consent statement detailing the study's objectives, the intended use and confidentiality of collected data, potential risks and benefits associated with participation, and participants' rights. Upon completion of the questionnaire, respondents were invited to submit optional open-ended comments, indicate their willingness to participate in subsequent phases of the study, and assist in disseminating the survey to other Croatian researchers based abroad. Participants were also provided with an opportunity to register in the Map of Croatian Scientists[2], a publicly available registry developed and curated by the Association Penkala.

Ethical Approval

The study received ethical clearance from the Ethics Committee of the Institute for Migration Research on 28 February 2025.

Inclusion Criteria

Participants were eligible for inclusion in the study if they met two criteria: 1) they were researchers, as defined by the Frascati Manual (OECD, 2015); and 2) they were either born in Croatia or identified as being of Croatian descent. The latter criterion was intentionally defined broadly and based on self-identification to ensure an inclusive mapping of Croatian researchers based abroad. This inclusive approach corresponds with the definition of who belongs to the Croatian diaspora applied by the Central State Office for Croats Abroad. It further reflects the exploratory and policy-oriented nature of the study, which aims to capture various professional, institutional, cultural and transnational connections relevant to science, innovation and knowledge exchange.

[1] Translation in Spanish and Portuguese were provided to facilitate participation of the researchers who are the descendants of Croatian emigrants in Latin America.

[2] Available at: https://www.mapa-znanstvenika.hr/#/map-page.

Sampling

The survey instrument was administered using the Microsoft Office Forms platform. Data collection commenced on 5 May 2025 and concluded on 15 September 2025.

To maximize the reach and diversity of participants, a combination of purposive sampling, mixed recruitment strategies, and snowball sampling techniques were employed. Recruitment proceeded in three main stages.

First, the initial invitation was distributed via the existing mailing lists of the Institute for Migration Research and the Association Penkala, comprising of approximately 500 email contacts of Croatian researchers residing abroad. Recipients were invited to participate and were explicitly encouraged to further disseminate the survey among their professional networks.

Second, Croatian embassies, consulates, and diaspora organizations were contacted and asked to circulate the survey announcement through their respective networks. Notably, the Association of Croatian American Professionals (ACAP), One Croatia, the Croatian Women's Network, and AUS-NZ Croatian Women in Leadership (AUS-NZ CWL) disseminated flyers and survey links to their members, thereby extending the study's outreach.

Third, the LinkedIn platform was employed as an additional recruitment channel. Using available search filters, researchers of Croatian origin working abroad were identified and contacted with personalized connection requests. Each message included a brief description of the study, a link to the questionnaire, and a request to further share the survey within their professional circles. The platform was also used to post general announcements about the study and reminders concerning the survey closing date.

Follow-up reminders were sent both via email (to individuals who had not responded to initial invitations) and via LinkedIn (to individuals who had not replied to connection requests).

A total of 667 completed questionnaires were received: 608 in English, 38 in Spanish, and 21 in Portuguese.

2.2. Statistical Analysis

All statistical analyses were conducted using IBM SPSS Statistics version 31.0.

Descriptive statistics were used to provide an overview of the sample and to describe the main characteristics of the sample. Categorical variables were summarized using frequencies and percentages to show how respondents are distributed across key groups, such as gender, country of residence, academic position, field of research, and institutional affiliation. Numerical and ordinal variables, including age, year of PhD completion, and years of research experience, were summarized using basic measures of central tendency to indicate typical values within the sample.

Several constructs were assessed using multi-item sections consisting of statements rated on a 0–5 scale. In these sections, respondents rated each item on a five-point Likert type scale ranging from 0 (not true at all) to 5 (completely true). A top-category approach was used, focusing on responses at the highest end of the scale - only those who selected the highest rating (5) were discussed in the Results section. The reported percentages therefore reflect the proportion of respondents who perceived each factor as highly important.

Internal consistency was examined separately for each multi-item section using Cronbach's alpha.

Associations between categorical variables and intention to return were examined using chi-square tests with Cramér's V as a measure of association strength, while associations involving ordinal or numerical variables were examined using Spearman's rank-order correlations. Statistical significance was assessed using standard thresholds ($p < .05$ and $p < .01$).

2.3. Definitions

In this study we use several definitions.

Researcher

The term "researcher" is used in the study in accordance with the definition from the Frascati manual (OECD, 2015). It encompasses "professionals engaged in the conception or creation of new knowledge, conducting research and improving or developing concepts, theories, models, techniques, instrumentation, software or operational methods", who work in academia or/and industry, including doctoral students.

Croatian Researchers Based Abroad

The phrase "Croatian researchers based abroad" (and "Croatian researchers abroad") is used as an umbrella term encompassing both Croatia-born researchers currently residing abroad and researchers of Croatian descent who have not previously lived in Croatia (individuals who are descendants of Croatian emigrants from different emigration waves). This formulation also acknowledges that researchers' professional trajectories are often characterized by repeated, multi-directional, or long-term mobility across countries, although such dynamics were not explicitly analyzed in this study.

Career Stage

We adopted a model of career stages from the European Commission (2011). It focuses on individual competences and leadership, and it is sector-neutral (applicable to companies, NGO's, research institutes, research universities or universities of applied sciences).

The four career stages are:

R1: First Stage Researcher (up to the point of PhD),
R2: Recognized Researcher (PhD holders or equivalent
who are not yet fully independent);
R3: Established Researcher (researchers who have developed a level of independence);
R4: Leading Researcher (researchers leading their research area or field).

Fields of Science

Fields of science are defined according to the Fields of Research and Development (FORD) classification proposed by the OECD in the 2015 Frascati Manual:

Field 1: Natural Sciences
Field 2: Engineering and Technology
Field 3: Medical and Health Sciences
Field 4: Agricultural and Veterinary Sciences
Field 5: Social Sciences
Field 6: Humanities and the Arts

3.

Results

3.1. Characteristics of Croatian Researchers Based Abroad

Chapter Summary

The chapter provides a snapshot overview of Croatian researchers based abroad. Although the studied sample is not representative and is subject to selection bias, the study nevertheless offers valuable insights into a population that has not previously been examined in comparable scope. As a mapping and exploratory exercise, it constitutes a first systematic attempt to address gaps in the official statistics by providing key socio-demographic characteristics of the Croatian researchers abroad. These include their demographic profile, selected aspects of family life and Croatian language proficiency, professional profile and academic mobility trajectories.

The study is based on survey data collected from 667 researchers across all career stages and research fields. Most respondents were born in Croatia, with smaller shares born in Bosnia and Herzegovina, Brazil, Argentina, and the United States. With regard to family circumstances, most respondents are married/cohabiting or in a relationship, and slightly more than one-third have children. Data on the Croatian language proficiency of partners and children point to potential needs for support mechanisms facilitating Croatian language acquisition within researchers' families.

At the time of the survey, respondents were predominantly residing in the United States, Germany and the United Kingdom, and were primarily employed at universities and research institutes. The majority obtained their PhD degree within the past ten years, most frequently in Germany. PhD students and postdoctoral researchers constitute the largest groups in the sample. Notably, an overwhelming majority of respondents reported that they are not currently receiving any form of national funding support for research or mobility.

In terms of academic mobility trajectories, approximately half of the respondents obtained their master's degree in their country of birth prior to relocating abroad, while the most commonly obtained degree abroad was the doctorate, followed by postdoctoral training. Analysis of motivations for relocation abroad indicates that migration decisions are driven primarily by structural differences in research systems between origin and destination countries, rather than by lifestyle or personal factors. However, data about the frequency of visits indicate a relatively strong physical presence occurring through regular visits.

Demographic profile

Demographic profile of Croatian researchers abroad is shown in Table 1 and Box 1.

Sex and Age Group

A total of 667 Croatian researchers based abroad participated in the survey (Table 1). The sample is skewed towards women, who account for 58% of respondents. The age distribution further indicates a concentration in younger and mid-career cohorts. In particular, the largest share of researchers (39%) was born between 1986 and 1995. When grouped by generation, Millennials (Generation Y) clearly dominate the sample, representing 58% of all respondents.

Birth Place

The majority of surveyed researchers were born in Croatia (78%). Among those born in Croatia, most originate from large urban centres, primarily Zagreb (36%), followed by Split (10%) and Rijeka (7%).

Citizenship

The share of Croatian citizens mirrors the share of respondents born in Croatia, with 78% holding Croatian citizenship. At the same time, 67% of surveyed researchers do not hold dual citizenship.

Country of Residence

Surveyed researchers are geographically dispersed across the globe; however, the largest share currently resides in the United States (17%). Within Europe, the most common countries of residence are Germany (14%) and the United Kingdom (10%).

Table 1. **Demographic characteristics of the surveyed respondents (n = 667)**

Variable	Category	%
Sex	Male	41.83
	Female	57.87
	Other	0.30
Age Group	≤ 1945	0.60
	1946–1955	1.65
	1956–1965	4.65
	1966–1975	12.89
	1976–1985	21.89
	1986–1995	38.83
	≥ 1996	19.49
Generation	Quiet Generation	0.60
	Baby Boomers	5.70
	Generation X	22.94
	Generation Y	57.87
	Generation Z	12.89
Country of Birth	Croatia	78.41
	Bosnia and Herzegovina	4.50
	Brazil	3.00
	Argentina	3.00
	United States	3.00
City of Birth (Croatia)	Zagreb	36.38
	Split	10.3
	Rijeka	6.64
	Osijek	3.49
	Zadar	3.32
Country of Citizenship	Croatia	78.41
	United States of America	6.00
	Brazil	3.15
	Argentina	2.70
	Australia	1.95
Dual Citizenship	No	67.17
	Yes	32.83
Country of Residence	USA	17.24
	Germany	13.64
	UK	10.19
	Switzerland	7.65
	Austria	5.25

Family Life and Language Proficiency

Family life and language proficiency of Croatian researchers abroad are shown in Table 1 and Box 2.

Marital Status and Parenthood

The majority of surveyed researchers are either married or cohabiting (51%) or currently in a relationship (22%). Approximately one-quarter of respondents are single (23%), while smaller proportions (3%) are divorced or widowed (1%). Also, 62% of surveyed researchers reported not having children (Box 2).

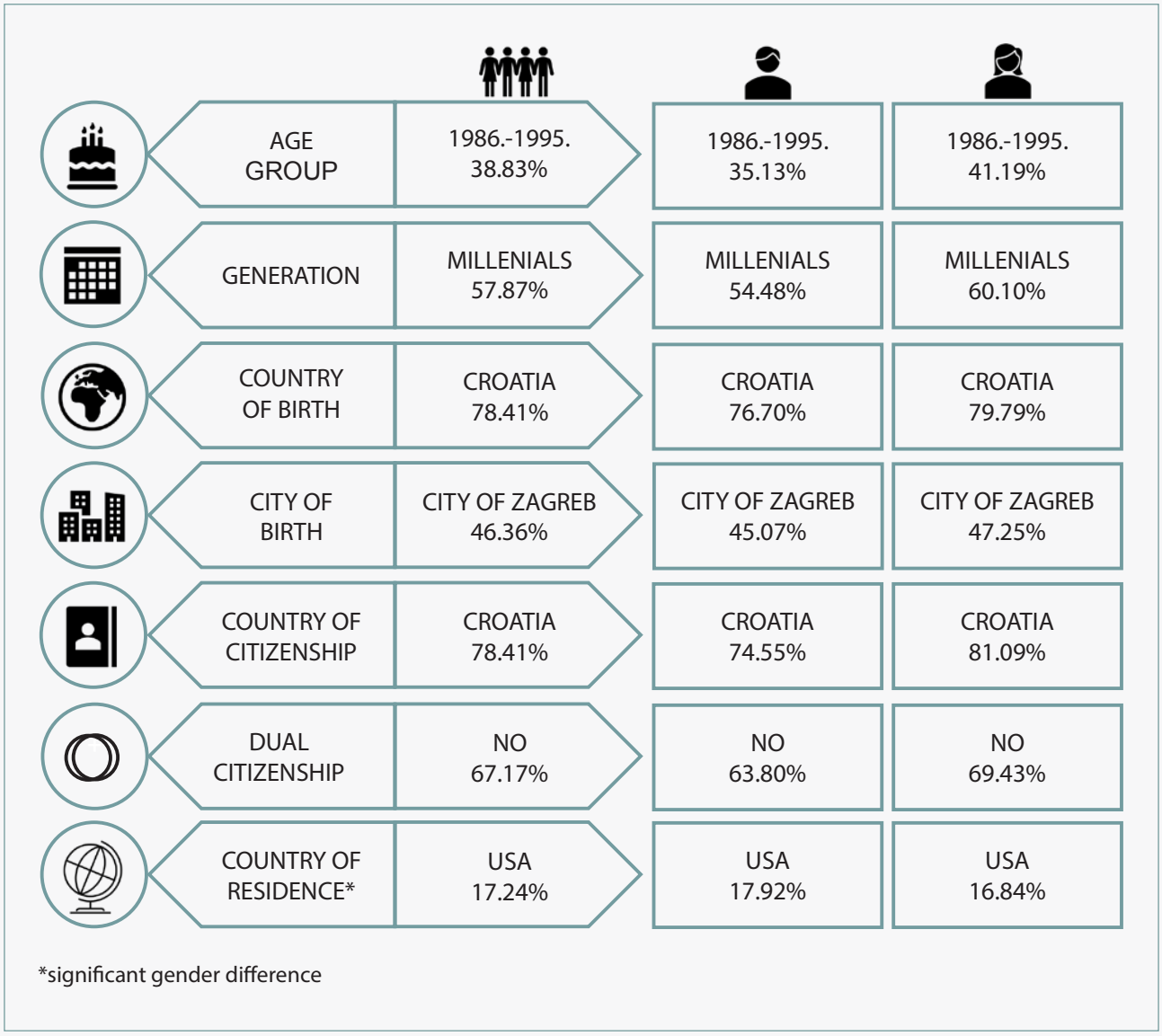
Table 2. **Family life and language proficiency of the surveyed respondents (n = 667)**

Variable	Category	%
Marital Status	Married or cohabiting	51.27
	Single	22.79
	In a relationship	21.74
	Divorced	3.15
	Widowed	1.05
Parenthood	No	61.62
	Yes	38.38
Language proficiency†	Fluent	85.59
	Advanced	2.40
	Intermediate	3.30
	Basic	4.65
	Does not speak Croatian	4.05
Partner's nationality††	Yes	35.09
	No	64.91
Partner's language proficiency†	Fluent	37.58
	Advanced	2.63
	Intermediate	3.64
	Basic	17.98
	Does not speak Croatian	38.18
Child's language proficiency – most proficient†	Fluent	31.47
	Advanced	11.64
	Intermediate	12.93
	Basic	24.14
	Does not speak Croatian	19.83
Child's language proficiency – least proficient†	Fluent	19.37
	Advanced	9.95
	Intermediate	15.71
	Basic	20.94
	Does not speak Croatian	34.03

Notes: †Language proficiency in Croatian; †† partner's Croatian nationality

Box 1: Overview of Key Statistics

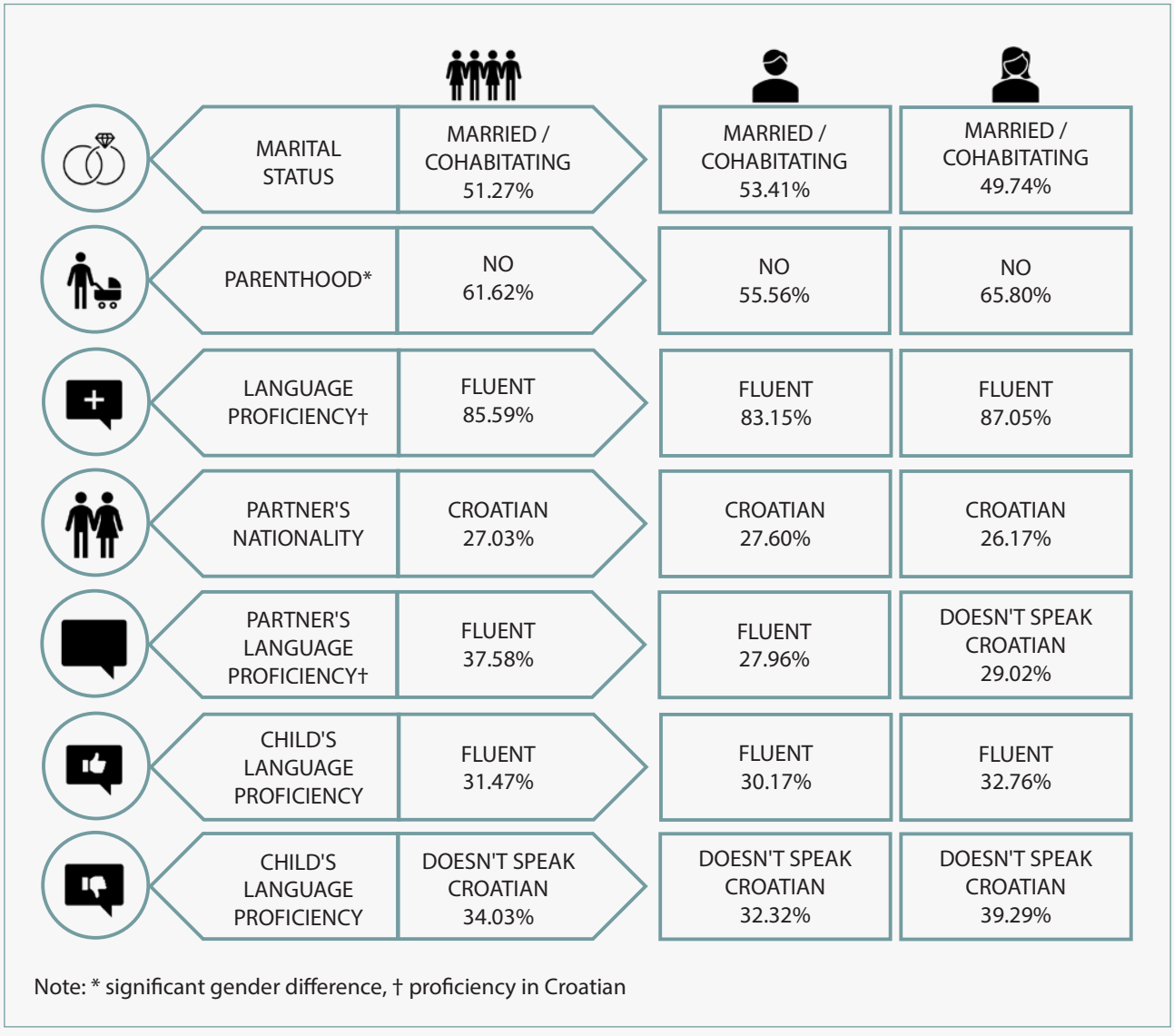
Demographic Profile of Croatian Researchers Based Abroad



*significant gender difference

Box 2: Overview of Key Statistics

Family and Language Proficiency of Croatian Researchers Based Abroad



Note: * significant gender difference, † proficiency in Croatian

Proficiency in Croatian

The vast majority of respondents reported a high proficiency in the Croatian language. Most participants (86%) identified as fluent, and only 4% indicated that they do not speak Croatian at all.

Nationality of Partners and Proficiency in Croatian

More than half of the respondents (65%) reported having a non-Croatian spouse or partner. In terms of language proficiency, 38% of respondents' spouses or partners were reported to be fluent in Croatian, while an equal share (38%) did not speak Croatian at all.

Language Proficiency among Researchers' Children

To assess Croatian language proficiency among researchers' children, respondents were first asked to identify the child with the highest level of proficiency and to evaluate their ability to speak Croatian. Among these, 31% of children were reported to be fluent and 20% did not speak Croatian.

Subsequently, respondents were asked to identify the child with the lowest level of proficiency in Croatian. Within this group, 19% were described as fluent and 34% as not speaking Croatian.

Professional Profile

Professional profile of Croatian researchers abroad is shown in Table 3 and Box 3.

Year of PhD

As many as 44% of surveyed researchers obtained (or planned to obtain) their PhD degree in the last ten years.

University and Country of PhD

The most frequently cited institution where Croatian researchers abroad obtained or plan to obtain their PhD degree is the University of Zagreb (6%). With respect to the country of PhD attainment, Germany (14%) is most frequently mentioned, followed by Croatia (12%), the United States (12%), and the United Kingdom (10%). A statistically significant gender difference was also found with regard to the country in which the PhD was obtained - a significantly higher proportion of men completed their PhD degrees in Germany compared to women.

Academic Position

PhD students constitute the largest group of surveyed researchers (24%), followed by postdoctoral researchers (18%). Assistant professors account for 9% of respondents, while associate professors and full or tenured professors each represent 8% and 9% of the sample, respectively. In addition, a substantial share of respondents (33%) reported holding non-teaching or other professional positions.

Research Career Stage and Years of Research Experience

In terms of research career stage, R1 "First Stage Researchers" comprise 26% of the sample, R2 "Recognized Researchers" 31%, R3 "Established Researchers" 29%, and R4 "Leading Researchers" 14%. With regard to research experience, the largest proportion of respondents (45%) reported having more than ten years of research experience.

Employing Organization

The majority of respondents are currently employed at universities (60%), followed by research institutes (25%) and private companies (13%). An additional 11% work in government or public research agencies, NGOs, or are self-employed as consultants, entrepreneurs, or in similar roles.

Field of Research

Most respondents are active in the natural sciences (43%), followed by medical and health sciences (23%), engineering and technology (15%), and the social sciences (13%). The humanities and arts (6%) and agricultural and veterinary sciences (1%) represent the smallest disciplinary groups. A statistically significant gender difference was identified for the field of research, with a significantly higher proportion of women working in the natural sciences compared to men.

Research Funding from Croatia

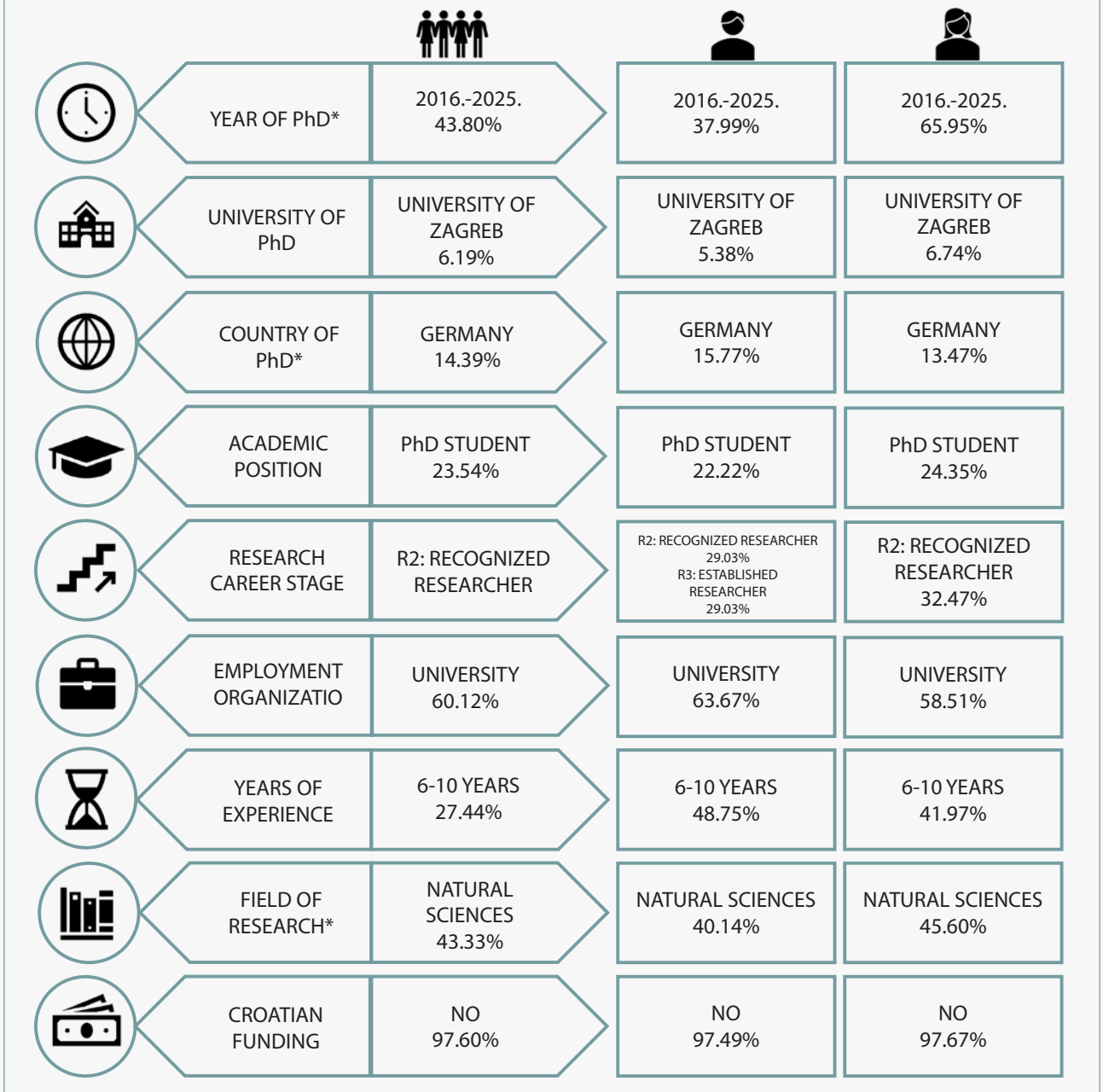
An overwhelming majority (98%) of respondents reported not receiving currently any form of support (e.g., scholarship or grant) from Croatian national funding sources.

Table 3. **Professional profile of the surveyed respondents (n = 667)**

Variable	Category	%
Year of PhD	1976-1985	1.50
	1986-1995	2.80
	1996-2005	9.10
	2006-2015	21.60
	2016-2025	43.80
	2026-2035	21.10
University of PhD	University of Zagreb	6.19
	University of Oxford	1.96
	University of São Paulo	1.81
	University of Cambridge	1.66
	ETH Zurich	1.51
Country of PhD	Germany	14.39
	Croatia	12.29
	United States of America	11.54
	United Kingdom	10.04
	Austria	5.85
Academic position	PhD student	23.54
	Postdoctoral researcher	17.99
	Assistant professor	8.55
	Associate professor	7.5
	Full professor/tenured professor	9.3
	Researcher or scientist (non-teaching role)	17.39
	Professor Emeritus	0.15
	Other	15.59
Research career stage	R1: First Stage Researcher	25.64
	R2: Recognized Researcher	31.26
	R3: Established Researcher	29.29
	R4: Leading Researcher	13.81
Employment organization	University	60.12
	Research Institute	24.74
	Government or public research agency	4.20
	NGO or nonprofit organization	2.70
	Private company	13.49
	Self-employed	4.20
Years of experience	Less than 1 year	1.80
	1-5 years	26.09
	6-10 years	27.44
	More than 10 years	44.68
Field of research	Natural Sciences	43.33
	Engineering and Technology	14.99
	Medical and Health Sciences	22.64
	Agricultural and Veterinary Sciences	1.05
	Social Sciences (with Economics)	12.99
	Humanities and the Arts	5.70
Funding from Croatia	Yes	2.40
	No	97.60

Box 3: Overview of Key Statistics

Professional Profile of Croatian Researchers Based Abroad



Note: *significant gender difference

Academic Mobility Trajectories

Academic mobility trajectories of Croatian researchers abroad are shown in Table 4 and Box 4.

Highest academic degree obtained in the country of birth/ abroad

Half of the respondents obtained their master's degree in their country of birth before relocating abroad. Conversely, the most frequently obtained academic degree abroad is doctorate (34%), closely followed by post-doctoral training (31%).

Academic Career Stage when Moved Abroad

The majority of researchers (57%) relocated during postgraduate studies (Master's or PhD).

Motivations for Moving Abroad and Visits to Croatia

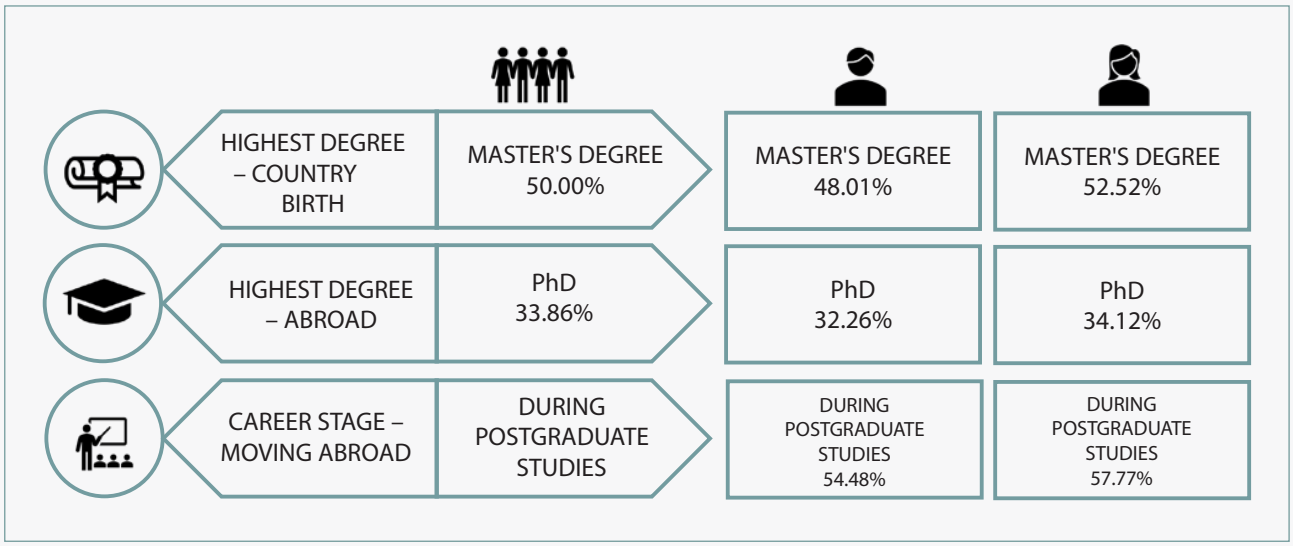
To obtain a better insight into factors that drive international migration of surveyed researchers, respondents were asked to evaluate their key

Table 4. **Academic mobility trajectories of the surveyed respondents (n = 667)**

Variable	Category	%
Highest academic degree obtained in the country of birth	Bachelor's degree	19.40
	Master's degree	50.00
	PhD	15.77
	Post-doctoral research	5.05
	None	9.78
Highest academic degree obtained abroad	Bachelor's degree	1.26
	Master's degree	15.59
	PhD	33.86
	Post-doctoral research	30.87
	None	18.43
Academic career stage when moved abroad	During undergraduate studies	7.24
	During postgraduate studies (Master's or PhD)	56.86
	After completing PhD	5.58
	During postdoctoral research	5.58
	After starting a professional academic career	2.71

Box 4: Overview of Key Statistics

Academic Mobility Trajectories of Croatian Researchers Based Abroad



motivations for moving abroad from their country of birth (Figure 1).

The results show that career-related factors and factors related to research eco-systems are the primary drivers of relocation abroad. The most prominent motivation is the availability of better career opportunities, identified as important by 73% of respondents. Closely following are the pursuit of higher education or postdoctoral training abroad and the access to advanced research infrastructure, as mentioned by 68% and 63% respondents, respectively.

Motivations related to the quality of research, funding, and international collaboration also feature prominently. International collaboration and access to global professional networks were considered important by 50% of respondents, while an equal share (50%) emphasized better funding opportunities for research.

In addition, higher salaries and improved financial prospects were cited as an important motivation by 47% of respondents, as well as the access to higher-quality research expertise or mentorship that were identified as important by 45% of respondents.

In contrast, lifestyle and personal considerations were less dominant. General quality of life was identified as an important factor by 36% of respondents, while only 29% viewed the opportunity to experience a new or different culture as influential. Personal factors, such as family or relationship considerations, played a comparatively minor role, with only 18% indicating

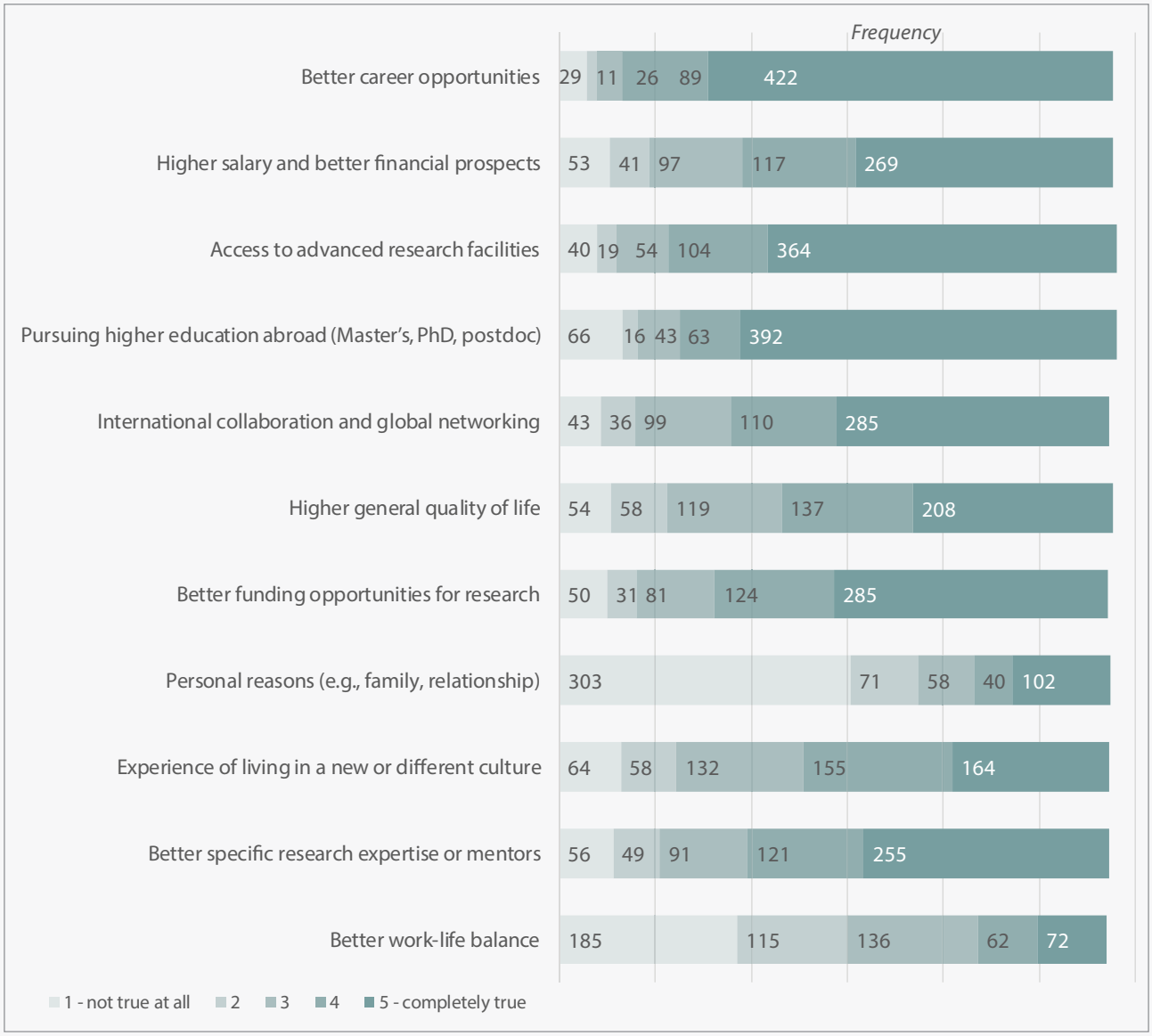


Figure 1. **Key motivations for relocating from the country of birth.** Based on the survey question: If you moved abroad from the country of your birth, what motivated you? Respondents had the opportunity to select all that applies (1 means "not true at all", 5 means "completely true").

their importance. Work-life balance emerged as the least influential factor, with just 13% of respondents regarding it as an important motivation.

Overall, these findings suggest that respondents' motivations for moving abroad are perceived to be driven primarily by structural differences in research systems, rather than by lifestyle or personal considerations. This reinforces the importance of differences between national research systems in terms of career pathways, funding mechanisms, infrastructure availability, institutional governance, and international integration.

Frequency of Visits to Croatia

Finally, to evaluate the degree of physical presence and ongoing connectivity with Croatia, respondents were also asked to report the frequency of visits to Croatia for personal and professional reasons (Figure 2). A majority visits the country regularly, 60% respondents reported visiting several times and 28% indicated that they visit once a year. A smaller proportion of respondents (12%) visits less than once a year or never. These results imply a relatively high level of physical presence that occurs through visits.

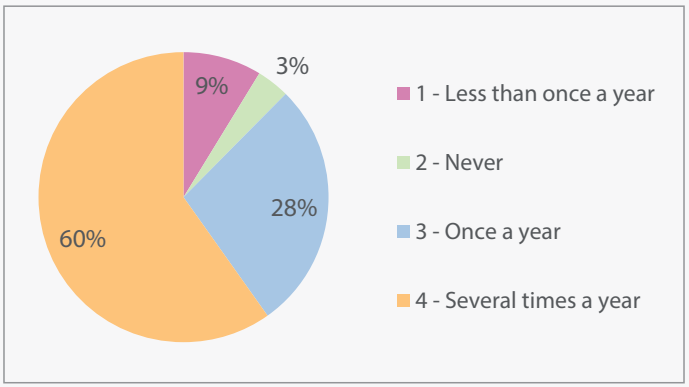


Figure 2. **Frequency of visits to Croatia.** Based on the survey question: If you don't live in Croatia, how often do you visit Croatia? (both personal and professional reasons). Sample size, n = 652.

3.2. Networks among Croatian Researchers Based Abroad

Chapter Summary

In this chapter we explore the scientific social networks among Croatian researchers based abroad. The results show that most surveyed researchers (83%) are acquainted with fellow Croatian researchers abroad and usually maintain contact with a small network (1-5 contacts), while a notable minority remains entirely disconnected (16%). Social and professional ties formed prior to emigration, as well as contacts established through professional settings, represent the primary modes of acquaintance, whereas formal networking structures play a relatively limited role. More than half of the respondents report benefits from these contacts, predominantly of a social and emotional nature, alongside more limited professional collaboration. The absence of contact is generally not due to deliberate avoidance or negative perceptions. Based on the obtained responses, it is not evident whether missing opportunities for interaction constitute a key constraint for more active networking of Croatian researchers abroad.

Number of Contacts

First, we asked respondents to report if they are acquainted with other Croatian researchers abroad, and subsequently we asked them to specify the number of individuals they are in contact with (Figure 3).

A large majority of surveyed researchers (83%) reported that they are acquainted with other Croatian researchers working abroad and most respondents (62%) reported maintaining contact with between one and five fellow researchers abroad. However, as many as 17% of respondents are disconnected from other Croatian researchers abroad and currently are without any contacts.

Modes of Acquaintance

We also examined the modes of acquaintance among Croatian researchers abroad (Figure 4). Notably, the most frequently reported mode of acquaintance was through pre-existing ties and the professional sphere. Old acquaintances from the period when researchers lived in Croatia (56%) represent a major resource for meeting and networking. Professional settings also represent an important source of contact: past collaboration in the workplace (40%) and meeting at conferences (39%). Friends of friends (34%) and chance encounters (29%) further contribute to interpersonal linkages among surveyed researchers. More organized forms of association, such as networking meetings or organizations connecting Croatians abroad (17%), appear less common.

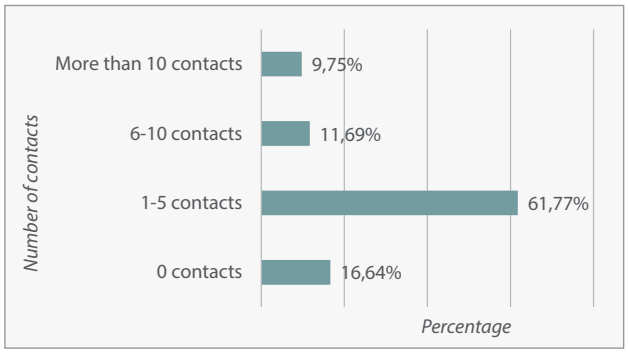


Figure 3. **Number of contacts among Croatian researchers abroad.** Based on the survey question: With how many Croatians working as researchers outside of Croatia are you in contact with? Sample size, n = 666.

Professional and Non-professional Benefits

We were also interested to examine if respondents considered that contacts among Croatian researchers abroad are beneficial in professional or non-professional ways. Indeed, more than half of the surveyed respondents (56%) reported experiencing these types of benefits.

Furthermore, when asked to specify the types of benefits derived from these interactions (Figure 5), a majority of respondents reported benefits of a social and emotional nature. Specifically, 54% indicated social benefits and enjoyment of shared leisure activities, while 52% emphasized a sense of mutual understanding linked to their shared position as Croatian researchers working abroad. In addition, 30% of respondents reported benefits associated with shared interests in contemporary Croatian affairs. Lastly, 30% identified professional benefits related to research collaboration.

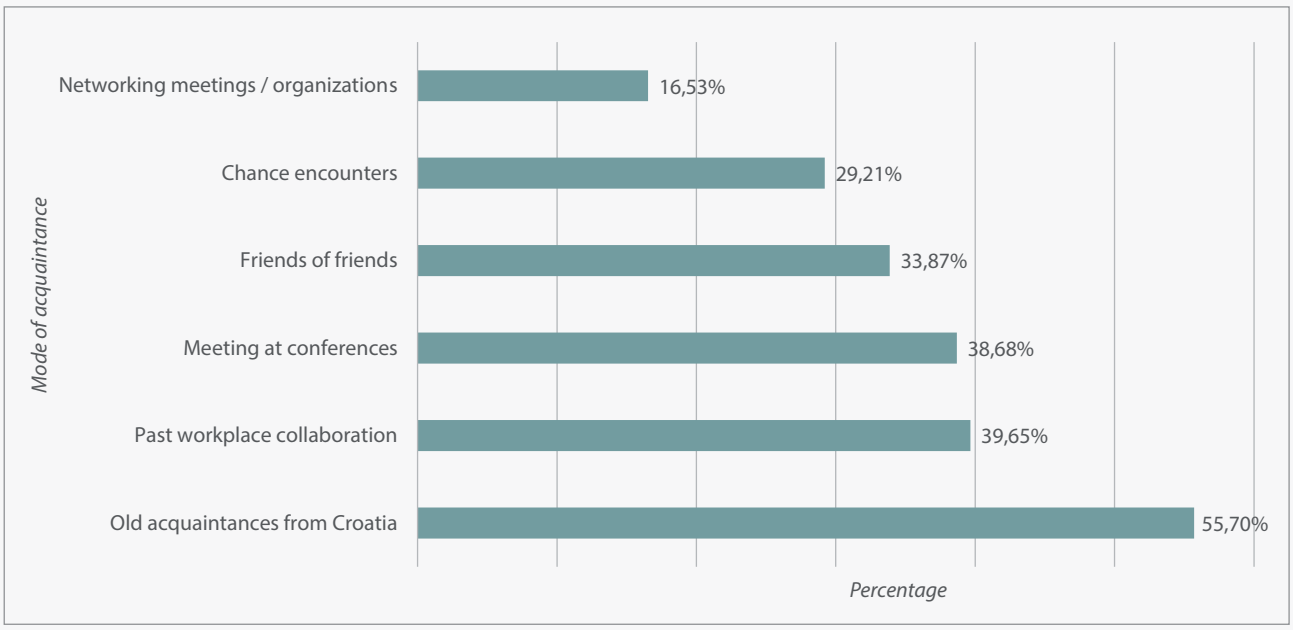


Figure 4. **Mode of acquaintance in networks of Croatian researchers abroad.** Based on the survey question: How did you meet Croatians working as researchers outside of Croatia? Respondents had the opportunity to select all the answers that apply. Sample size, n = 623.

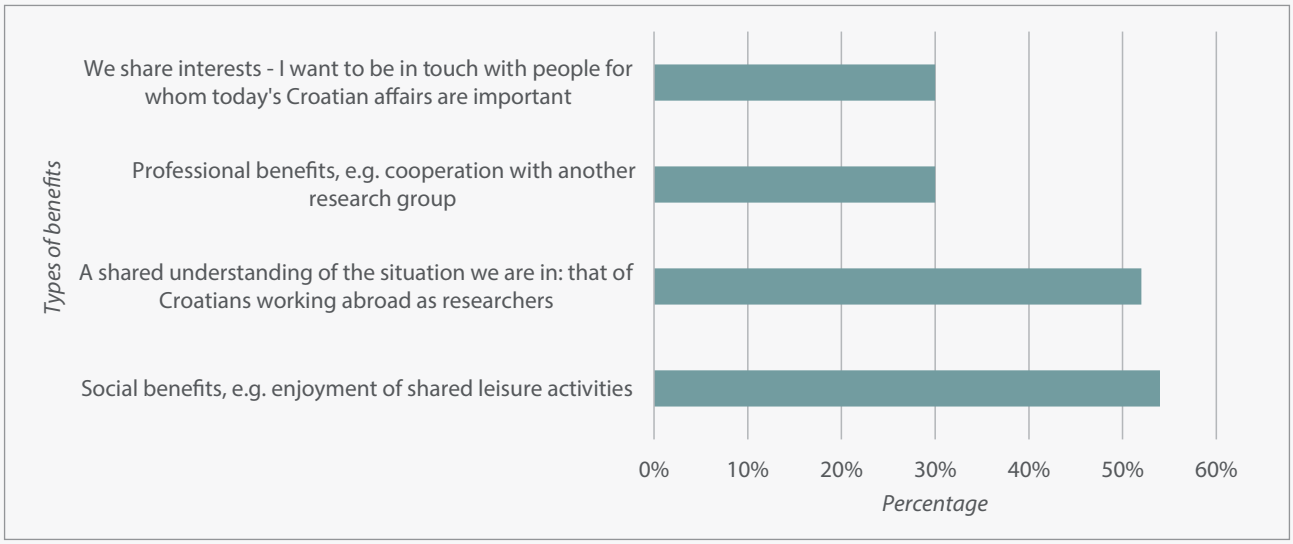
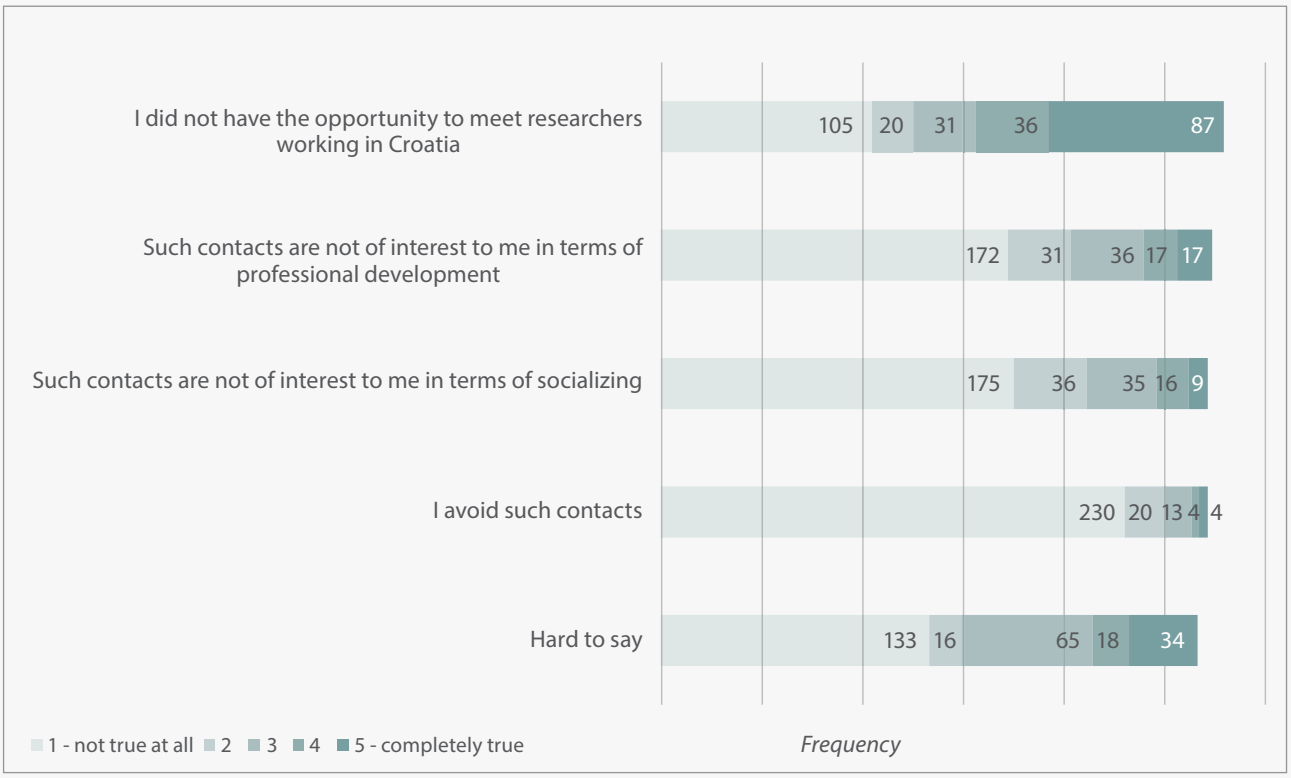


Figure 5. **Types of benefits from networks of Croatian researchers abroad.** Based on the survey question: What are the benefits for you from having contact with Croatians working as researchers outside of Croatia? Respondents had the opportunity to select all the answers that apply. Sample size, n = 650.

Lack of Contact

Lastly, we examined obstacles for contact among Croatian researchers abroad (Figure 6). An overwhelming majority of respondents (81%) reported that they did not intentionally avoid contact with other Croatian researchers abroad. Consistent with this finding, more than half of the respondents did not perceive such contacts as socially uninteresting (58%) or professionally irrelevant (52%). In addition, 44% of researchers indicated that they were able to articulate the reasons why such contacts do not occur. For one third (33%) of researchers the lack of opportunities to meet compatriot researchers represented a key barrier to establishing contacts, whereas a comparable proportion (30%) did not consider the (non-) availability of opportunities to be a limiting factor.

In summary, these findings indicate that the lack of contact among expatriate Croatian researchers is not driven by intentional avoidance or negative social or professional perceptions. Although the views on the role of opportunities for interaction are divided among respondents, this finding is potentially significant both for further research and policy consideration.



Note: Mandatory question. It reflects respondent's attitudes to the lack of contact in general.

Figure 6. **Views regarding lack of contact among Croatian researchers abroad.** Based on the survey question: If you don't have contact with Croatians working as researchers outside of Croatia, what is the reason? Respondents had the opportunity to select all that applies (1 means "not true at all", 5 means "completely true").

3.3. Networks Between Croatian Researchers Based Abroad and Researchers in Croatia

Chapter Summary

In this chapter we explore the scientific social networks between Croatian researchers based abroad and researchers in Croatia. A large majority of respondents (87%) reported being acquainted with researchers in Croatia. Over half of respondents reported contact with one to five researchers, while approximately one quarter maintained more extensive networks involving six or more contacts. Nevertheless, 20% of respondents remained disconnected, highlighting gaps in engagement between researchers abroad and at home.

Existing connections are predominantly rooted in prior personal and professional ties. Most respondents met researchers based in Croatia through earlier acquaintances formed while living in Croatia, followed by past workplace collaboration, conferences, and informal social networks. Active networking efforts and chance encounters played a comparatively minor role, suggesting that collaboration networks are largely path-dependent rather than strategically initiated.

Contacts with researchers in Croatia were perceived to offer moderate professional benefits, primarily in terms of facilitating research collaboration, enhancing awareness of the Croatian research landscape, and supporting potential return/migration or future mobility. More instrumental benefits, such as access to funding, infrastructure, or income opportunities, were less frequently reported. Limitations to professional benefits were mainly attributed to competing career priorities and field-specific constraints, rather than negative perceptions or deliberate disengagement.

Both accepting and initiating collaboration were driven by similar motivations. Shared research interests, opportunities for international collaboration, and collaboration with specific researchers emerged as the strongest incentives, followed by prospects for joint funding and spending time in Croatia. Institutional incentives, such as lecturing opportunities or access to equipment, were less influential, and resistance to collaboration was minimal.

Non-professional benefits were reported even more frequently than professional ones. A substantial majority of respondents experienced personal and social gains, including maintaining family ties and friendships, staying connected to Croatian culture, gaining insight into the national research system, and deriving satisfaction from contributing to Croatia's scientific community.

Information about developments in Croatian science is primarily obtained through direct professional contacts and social media, while conferences and formal publications play a secondary role. Preferences for engagement strongly favour direct, personalized communication and targeted invitations to scientific events.

Finally, most respondents (66%) reported no prior experience with joint research projects involving researchers in Croatia. While a small share had participated in one (15%) or a few collaborations (16%), sustained or intensive collaboration was rare (2%).

Number of Contacts

Similarly to the obtained results regarding contacts among Croatian researchers abroad, the majority of surveyed researchers (87%) reported that they are acquainted with other researchers working in Croatia.

Over half of the respondents (55%) reported being in contact with 1 to 5 researchers, making this the most common category (Figure 7). An additional 14% indicated contact with 6 to 10 researchers, and 11% reported contact with more than 10 researchers, suggesting that approximately one quarter of the sample (25%) sustains relatively extensive professional connections with colleagues in Croatia. Conversely, 20% of respondents reported having no contact with researchers working in Croatia. This subgroup represents a noteworthy minority that remains professionally disconnected from the domestic research community.

Modes of Acquaintance

The most frequently reported mode of meeting researchers working in Croatia (Figure 8) was through old acquaintances from the period when they lived in Croatia (69%). Past collaboration in the workplace (37%), meeting at conferences (29%) and meeting through friends of friends (28%) also accounted for a substantial portion of connections. Chance encounters (14%) and active looking for contacts in networking meetings (11%) were the least common modes of acquaintance. These findings suggest that contacts between

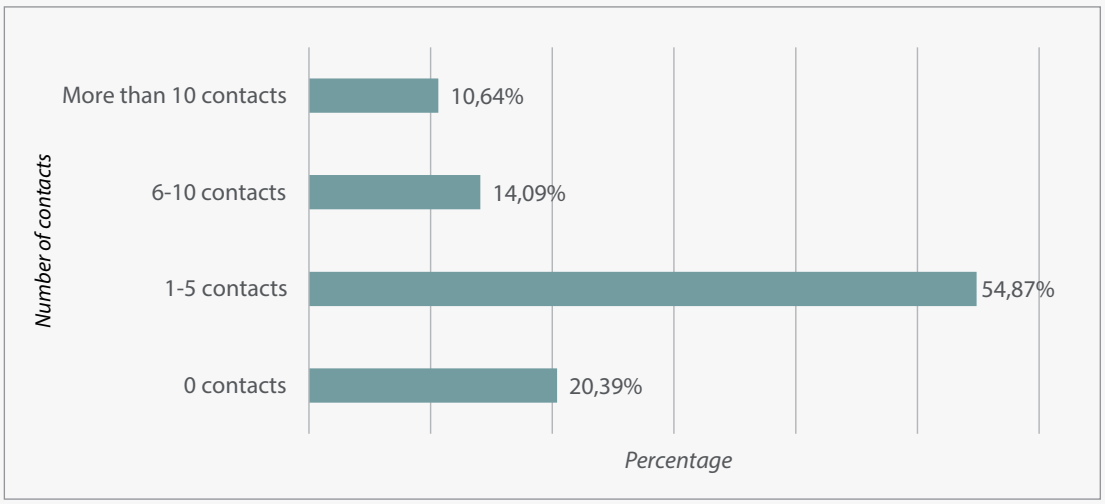


Figure 7. **Number of contacts between Croatian researchers abroad and researchers working in Croatia.** Based on the survey question: With how many researchers working in Croatia are you in contact? Sample size, n = 667.

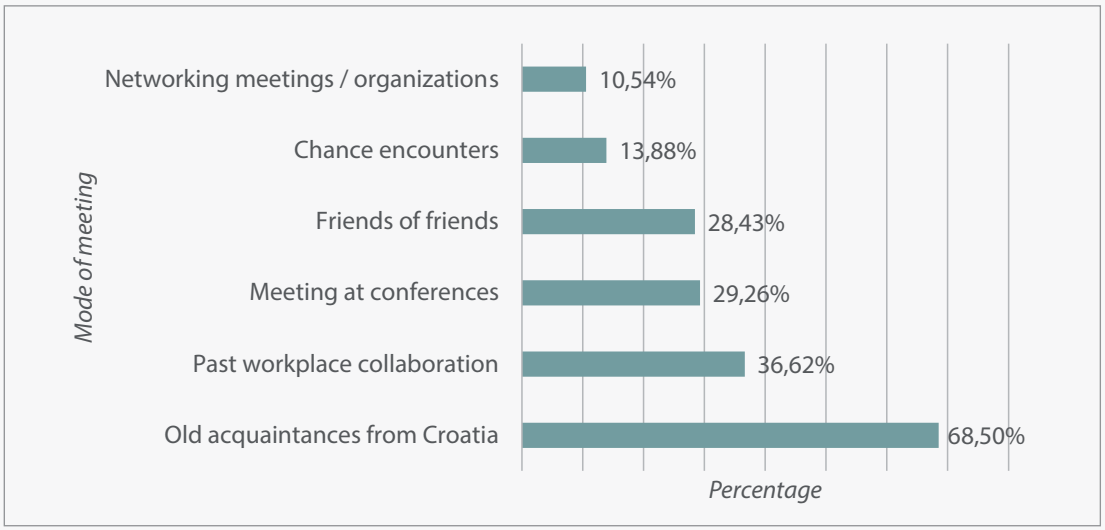


Figure 8. **Mode of acquaintance between Croatian researchers abroad and researchers working in Croatia.** Based on the survey question: How did you meet Croatians working as researchers outside of Croatia? Respondents had the opportunity to select all the answers that apply. Sample size, n = 598.

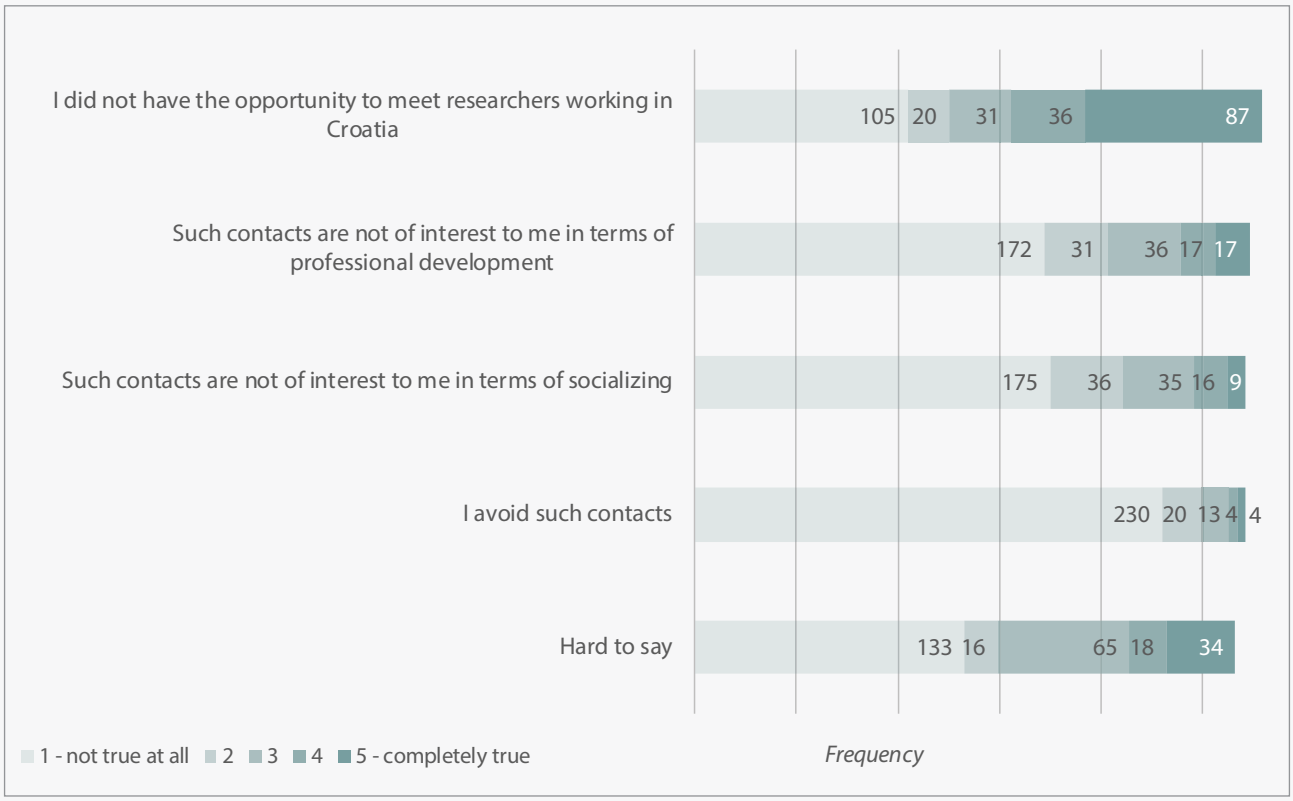
researchers abroad and researchers based in Croatia are more dependent on individual career pathways than on organized modes of networking.

Lack of Contact

In comparison to the results regarding the lack of contact among Croatian researchers abroad, respondents expressed very similar views regarding the reasons they do not maintain contact with researchers working in Croatia (Figure 9.).

An overwhelming majority of respondents (85%) reported not to intentionally avoid contacts with researchers in Croatia. Furthermore, for a clear majority of respondents, contacts with researchers in Croatia were socially interesting (65%) and professionally relevant (63%). When asked whether it was difficult to explain why contact does not occur, half of the respondents (50%) reported that it was not hard to articulate the reasons. Lastly, for 38% of respondents limited opportunities to meet researchers in Croatia represented an important barrier to establishing such contact.

Consistent with the findings on the lack of contact among Croatian researchers abroad, the results indicate that limited interaction between researchers abroad and researchers in Croatia is not primarily driven by intentional avoidance or negative social or professional perceptions. While respondents hold differing views



Note: Mandatory question. It reflects respondent's attitudes to the lack of contact in general.

Figure 9. **Views regarding the lack of contact with researchers working in Croatia.** Based on the survey question: If you don't have contact with Croatians working as researchers outside of Croatia, what is the reason? Respondents had the opportunity to select all the answers that apply (1 means "not true at all", 5 means "completely true").

on the role of opportunities for interaction, this issue remains a salient consideration for subsequent research and policy discussions.

Professional Benefits

We examined the professional benefits of contacts between researchers abroad and researchers in Croatia. Respondents were split in their views, one half of them reported to have professional benefits from these contacts, whereas the other half did not report such benefits.

Furthermore, respondents were asked to assess the perceived professional benefits of maintaining contacts with researchers working in Croatia (Figure 10). Approximately one third of respondents (32%) indicated that such contacts provide meaningful opportunities for collaboration with specific researchers or research groups. Slightly fewer respondents reported that contacts with researchers in Croatia facilitate the establishment of international collaborations (29%) or enhance their understanding of ongoing research activities in Croatia (28%). In addition, 26% of respondents considered these contacts to be potentially relevant for easing a future return or migration to Croatia.

Less frequently reported benefits include opportunities to lecture at Croatian universities (16%) and access to financial support for international collaboration (13%). By contrast, only a small proportion of respondents perceived contacts with researchers in Croatia as facilitating access to scientific instruments or equipment (6%) or providing opportunities for additional income (5%).

Overall, these findings indicate that contacts with researchers in Croatia are perceived to provide moderate professional benefits, primarily related to research collaboration, improved awareness of the Croatian research landscape and facilitating return or future migration. More instrumental or resource-based advantages, including access to funding, infrastructure, or additional income, are reported less frequently, suggesting that the value of these ties seems mainly relational and informational, not resource-sensitive.

Lack of Professional Benefits

Furthermore, respondents were asked to rate perceived reasons for the lack of professional benefit from the contact with researchers working in Croatia (Figure 11).

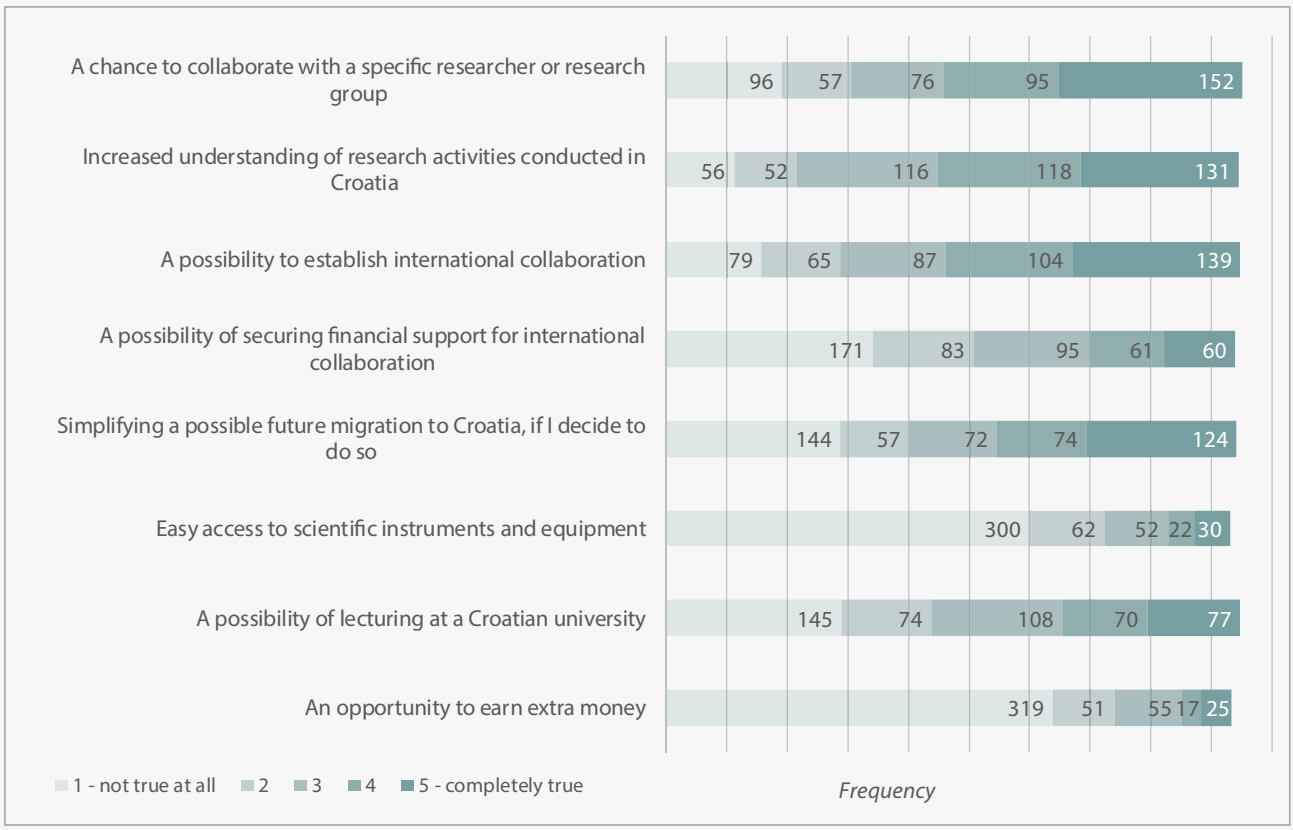


Figure 10. **Perceived professional benefits from contacts with researchers in Croatia.** Based on the survey question: If you have contact with researchers working in Croatia, what are the professional benefits? Respondents had the opportunity to select all the answers that apply (1 means "not true at all", 5 means "completely true").

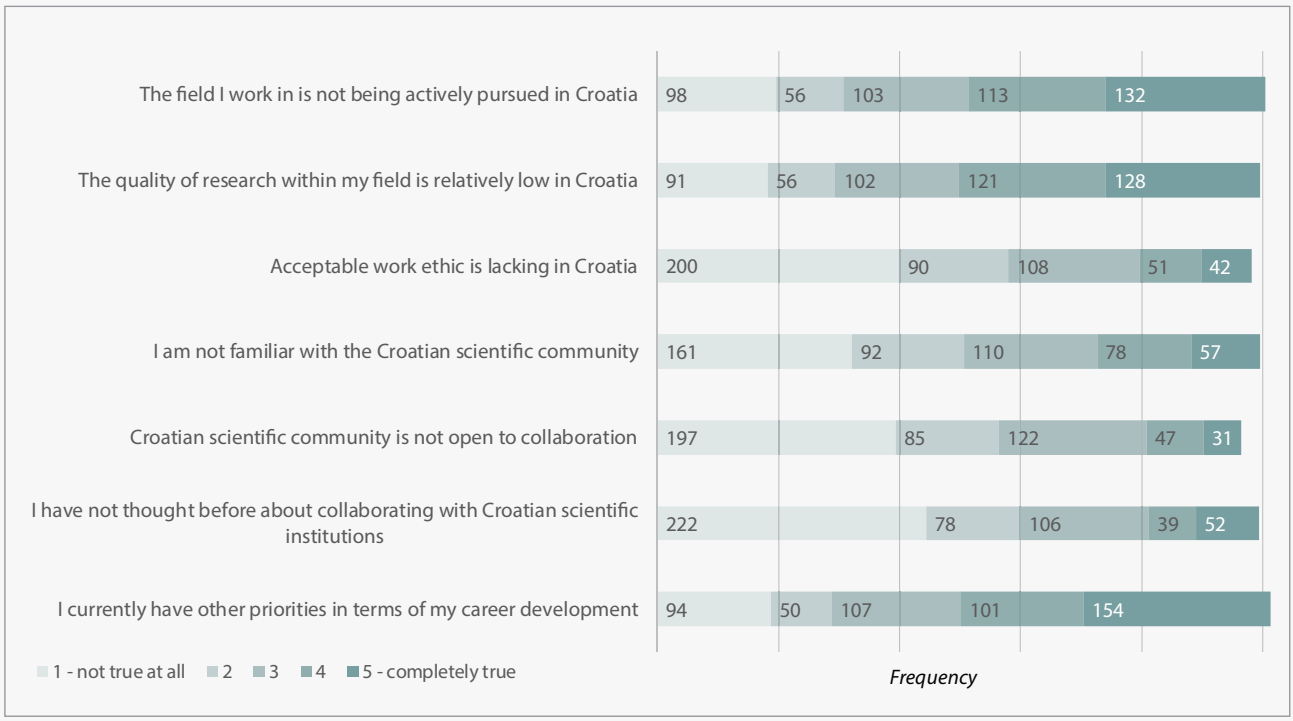


Figure 11. **Perceived reasons for the lack of professional benefit from the contact with researchers working in Croatia.** Based on the survey question: What is the reason for the lack of professional benefit from the contact with researchers working in Croatia? Respondents had the opportunity to select all the answers that apply (1 means "not true at all", 5 means "completely true").

A range of moderately important factors were identified. For 30% of respondents the presence of other, more pressing career priorities limited engagement. In addition, 26% attributed the lack of benefit to the absence of active research in their specific field in Croatia, while an equal share pointed to a perceived lower quality of research in their field. Less frequently mentioned factors include limited familiarity with the Croatian scientific community (11%) and the fact that collaboration with Croatian institutions had not previously been considered (10%). A smaller proportion of respondents associated the lack of professional benefit with concerns related to work ethic (9%) or a perceived lack of openness to collaboration within the Croatian scientific community (6%).

Overall, respondents identified competing career priorities and field-specific or quality-related constraints as moderately important factors limiting the professional benefits of engagement. Factors such as limited familiarity, lack of prior consideration of collaboration, and negative perceptions of work practices or openness to collaboration were mentioned less frequently.

Accepting Collaboration

Next, we were interested to explore factors that would lead researchers based abroad to accept collaboration with researchers based in Croatia (Figure 12).

The most prominent motivating factor for accepting collaboration was thematic alignment and shared research interests, identified as strong incentive by 67% of respondents. Slightly over half of respondents indicated that the opportunity to establish an international collaboration (53%) and to work with a specific researcher or research group (51%) would strongly motivate their engagement. Nearly half of respondents reported that the prospect of securing joint funding would be highly influential (46%), while 44% noted that the opportunity to spend time in Croatia would positively affect their willingness to collaborate. Less frequently cited motivations include the possibility of lecturing at a Croatian university, identified by 33% of respondents, and access to research equipment, identified by 21% of respondents. Finally, only a very small minority of respondents (2%) indicated that they saw no reasons to engage in collaboration.

In conclusion, strong motivators to accept collaboration with researchers working in Croatia included shared research interests, prospects for international collaboration, opportunities to work with specific researchers, followed by opportunities for joint funding and spending time in Croatia. Lecturing opportunities and access to equipment were less important motivating factors. Only a negligible share of respondents reported no motivation to engage in collaboration.

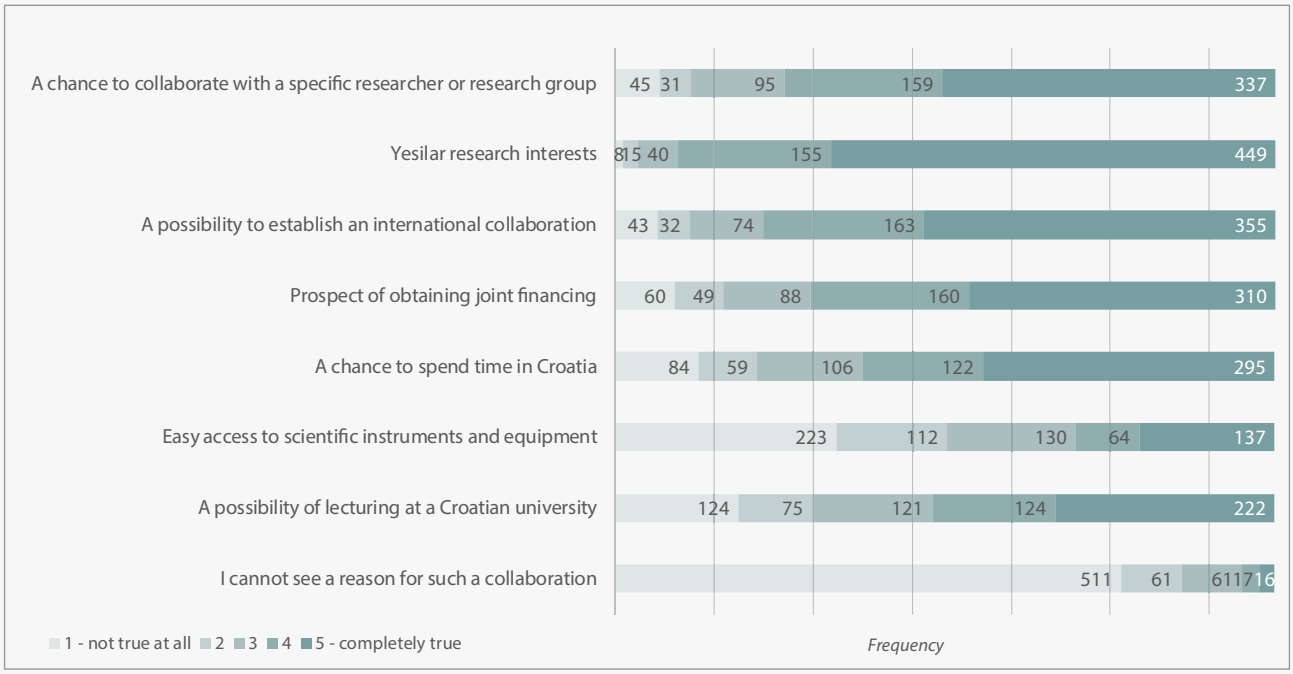


Figure 12. **Perceived factors for accepting collaboration with researchers working in Croatia.** Based on the survey question: What factors could lead you to accept a collaboration with researchers working in Croatia? Respondents had the opportunity to select all the answers that apply (1 means "not true at all", 5 means "completely true").

Initiating Collaboration

We were also interested to find out what factors would motivate researchers abroad to initiate collaboration with researchers based in Croatia (Figure 13).

The most influential factor in encouraging respondents to initiate collaboration was thematic alignment and shared research interests, together with the opportunity to establish an international collaboration, reported by 62% of respondents. Similarly, 60% indicated that the opportunity to collaborate with a specific researcher or research group would strongly motivate them. The prospect of securing joint funding was considered highly important by nearly half of the respondents (46%). In addition, almost half (45%) reported that the opportunity to spend time in Croatia would positively influence their willingness to collaborate. The possibility of lecturing at a Croatian university motivated 33% of respondents, while access to equipment was identified as a motivating factor by a smaller share (21%). Notably, only 2% of respondents indicated that they did not see a reason for engaging in collaboration.

Despite differences in roles and agency between initiating and accepting scientific collaborations, our findings show that both accepting and initiating collaborations with researchers based in Croatia are driven by largely similar motivations. The strongest incentives relate to shared research interests, opportunities for international collaboration, and collaboration with specific researchers, with joint funding prospects and mobility opportunities also playing an important role. Institutional incentives such as lecturing opportunities and access to equipment were less influential, and resistance to collaboration was minimal.

Non-professional Benefits

In addition to assessing the professional benefits of contacts with researchers based in Croatia, we also examined non-professional benefits.

A substantial majority of respondents (80%) reported experiencing non-professional benefits from interactions with researchers working in Croatia, a proportion notably higher than the share reporting professional benefits from these contacts (50%).

Furthermore, we asked respondents to rate perceived non-professional benefits gained from contact with researchers working in Croatia (Figure 14). A very large majority of respondents (79%) identified personal benefits, such as maintaining family ties or friendships, as an important non-professional gain. As many as 64% reported that contact with Croatian researchers enhances their understanding of the current state

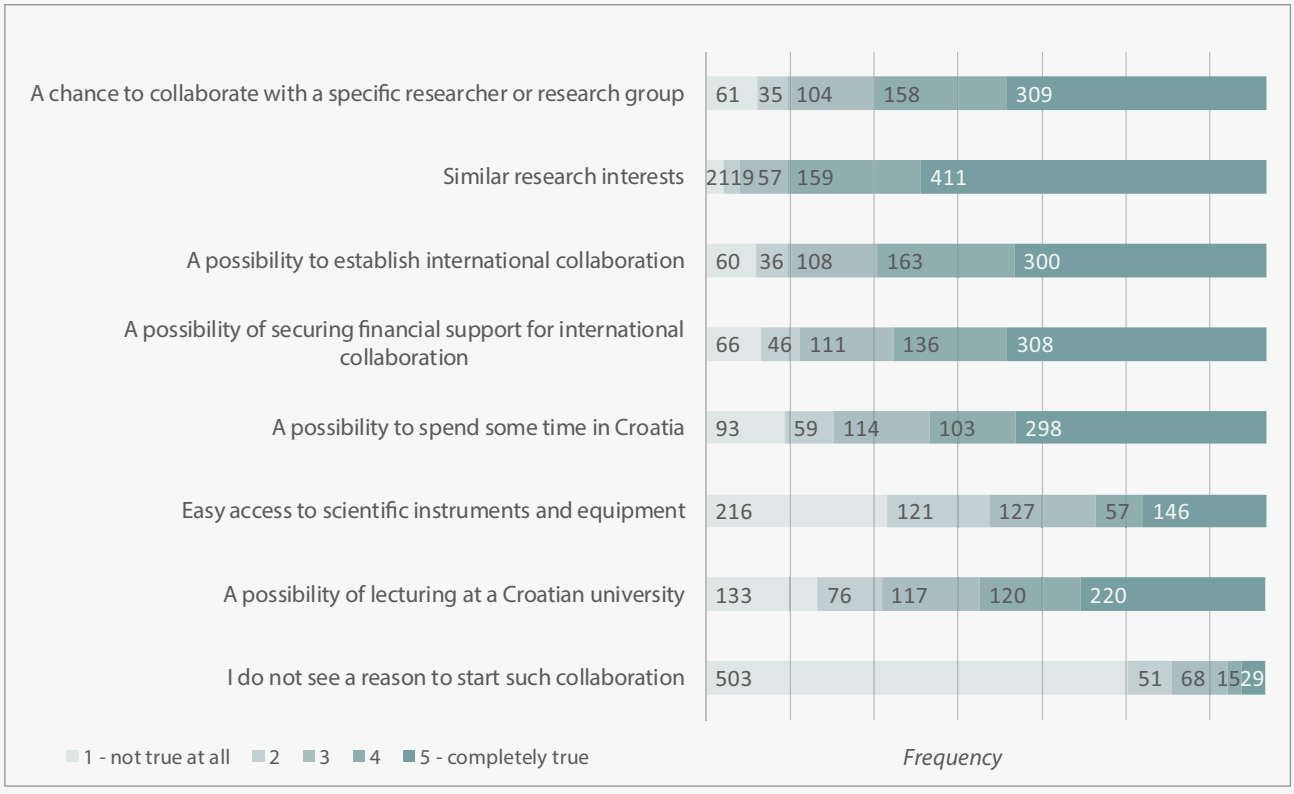


Figure 13. **Perceived factors for initiating collaboration with researchers based in Croatia.** Based on the survey question: What benefits would attract you to initiate a collaboration with researchers working in Croatia? Respondents had the opportunity to select all the answers that apply (1 means "not true at all", 5 means "completely true").

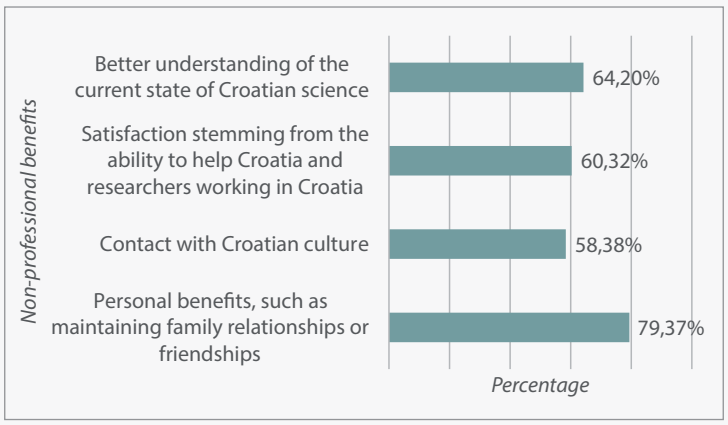


Figure 14. **Perceived non-professional benefits gained from contact with researchers working in Croatia.** Based on the survey question: What non-professional benefits do you gain from contact with researchers working in Croatia? Respondents had the opportunity to select all the answers that apply. Sample size, n = 567.

of science in Croatia and 60% reported that such contact provides a sense of satisfaction derived from contributing to Croatia's scientific community. More than half of respondents (58%) also indicated that maintaining these connections offers meaningful opportunities to remain engaged with Croatian culture.

Sources of Information

To better understand how information about developments in Croatian science is disseminated, respondents were asked to identify the sources through which they stay informed (Figure 15).

A majority of respondents (62%) reported staying informed about developments in the Croatian research community through direct contact with colleagues or professional networks based in Croatia. Social media also emerged as an important information source, with 55% indicating that they use platforms such as LinkedIn or X to follow relevant developments. Conferences and professional events were reported by 29% of respondents as a means of staying informed. At the same time, nearly one quarter (24%) reported that they do not actively follow developments in Croatian science. Smaller shares indicated relying on international journals or media (21%) and Croatian scientific journals or publications (12%) as information sources.

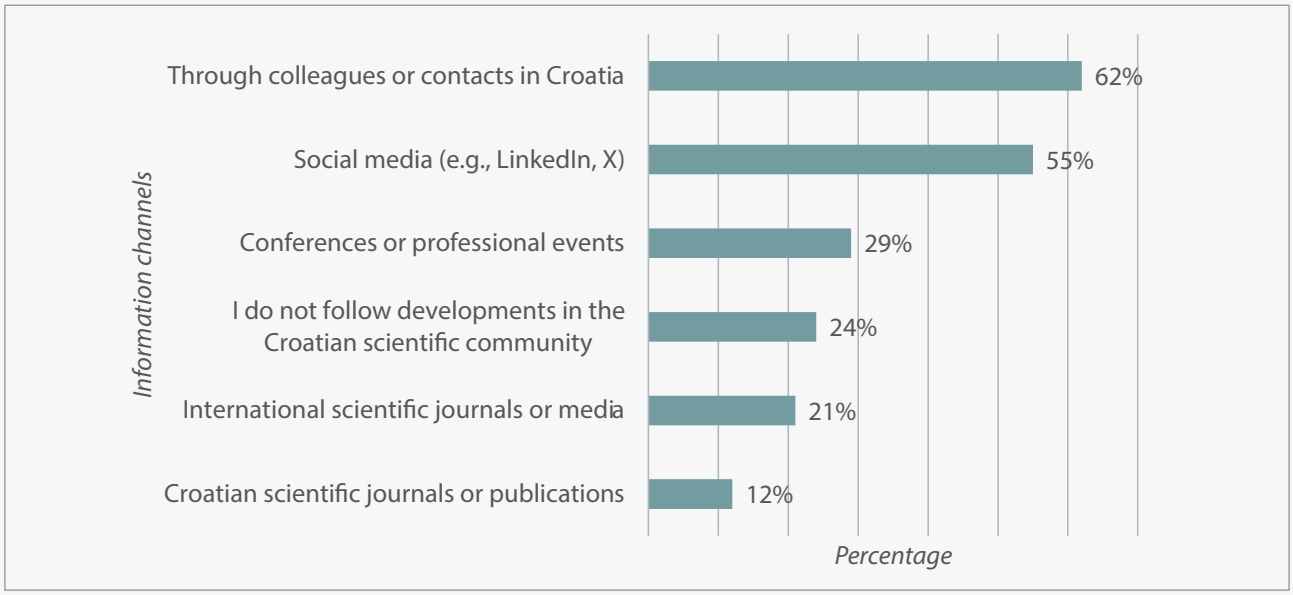


Figure 15. **Information sources for developments in Croatian science.** Based on the survey question: How do you stay informed about developments in the Croatian research community? Respondents had the opportunity to select all the answers that apply. Sample size, n = 666.

Preferred Communication Channels

To better capture how Croatian researchers based abroad prefer to be approached by institutions in Croatia, respondents were asked about their preferred communication channels (Figure 16).

Direct, personalised communication stands out as the strongest preference: 80% of respondents indicated that they would like to be contacted directly by potential collaborators, making this the most favoured method. Invitations to specific scientific events (e.g. conferences or workshops) were also highly valued, with 76% expressing interest in this form of outreach. Email newsletters were supported by over half of participants (53%) and social media outreach was preferred by 48% respondents. Research platforms such as ResearchGate were less appealing and endorsed by only 20% of respondents. Importantly, only a very small minority (3%) expressed a preference not to be contacted by Croatian scientific institutions at all.

These findings demonstrate generally strong openness to engagement and collaboration among the Croatian research diaspora, provided that communication efforts align with their preferred modes of outreach.

Number of Joint Research Projects

Lastly, we assessed the number of joint research projects between researchers abroad and researchers based in Croatia (Figure 17).

A large majority of respondents reported having no prior joint research projects with researchers or research groups in Croatia. In total, 66% of participants reported not to have a single joint research project. A smaller portion of respondents (15%) reported having been involved in one joint project, while an additional

Figure 16. **Preferred communication channels for being approached by institutions in Croatia.** Based on the survey question: How would you prefer to be contacted by Croatian scientific institutions for collaboration opportunities? Respondents had the opportunity to select all the answers that apply. Sample size, n = 666.

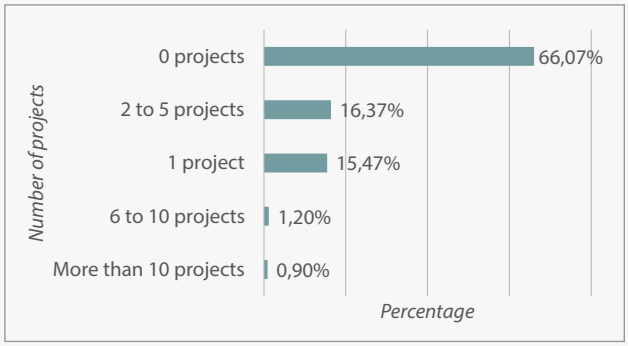


Figure 17. **Number of joint research projects with researchers in Croatia.** Based on the survey question: How many joint research projects have you had so far with researchers or research groups in Croatia? Sample size, n = 666.

16% indicated that they had participated in between two and five collaborative projects, suggesting that a modest segment of the surveyed respondents maintains moderate research engagement with Croatian institutions.

High levels of collaboration were rare: only 1% of respondents reported having undertaken six to ten joint projects, and another 1% indicated more than ten collaborations.

These results clearly show that while some Croatian researchers abroad have established ongoing research partnerships with colleagues in Croatia, most have had little to no prior collaborative experience.

3.4. Return, Immigration and Integration of Researchers

Chapter Summary

The findings in this chapter reveal a nuanced and heterogeneous set of attitudes among Croatian researchers based abroad regarding their return or first-time migration to Croatia. While more than a quarter of respondents (27%) express a positive inclination toward returning or migrating, either definitively or probably, this openness is counterbalanced by substantial uncertainty and resistance. Nearly one-third of respondents (32%) remain undecided, and 39% report negative intentions toward return/migration. These mixed attitudes are further reflected in responses concerning the timing of return/migration. As many as 40% report being unable to specify a timeframe, while 27% state that return/migration is not applicable to them. Among those considering return/migration, plans are predominantly long-term, with relatively few respondents anticipating it within the next two years.

Motivations for return/migration are driven primarily by non-professional factors. Personal and family ties to Croatia emerge as the strongest incentives, alongside a pronounced willingness to contribute to the national R&I system. By contrast, professional benefits, such as career advancement, improved research opportunities, or increased funding, are perceived as weak motivators. This suggests that return/migration intentions are shaped less by individual career prospects and more by a sense of social attachment and potential systemic contribution.

At the same time, researchers based abroad identify significant challenges and obstacles associated with their return or migration to Croatia. Salary and living-standard disparities constitute the most prominent challenges, followed by concerns over limited access to research funding, insufficient scientific development, and perceived lower research quality. Bureaucratic complexity stands out as a major obstacle. Additional obstacles, including personal and family relocation issues, socio-political differences, difficulties in maintaining international standing, limited professional networks, and collaboration constraints, are viewed as moderate but meaningful deterrents.

When seeking guidance related to return or migration, researchers based abroad overwhelmingly favour direct personal contacts with other researchers in Croatia and institutional contact within universities or research institutes where they might seek employment.

Finally, the analysis of factors associated with return or migration intentions indicates that demographic and professional characteristics matter more than migration-related variables. Younger researchers, those at earlier career stages, and individuals with fewer years of research experience are more inclined to consider return, whereas intentions decline with age and career advancement. Although several associations are statistically significant, their limited strength underscores the exploratory nature of these findings and highlights the need for further research to inform evidence-based policy development.

Attitudes towards Return and First-time Migration

First, we analysed the attitudes among Croatian researchers abroad regarding the possibility of returning or migrating for the first time to Croatia (Figure 18). A substantial proportion of respondents (32%) expressed uncertainty. Positive attitudes toward returning/migrating were expressed by a combined 27% of respondents (12% stated that they would "definitely" consider returning/migrating, while 15% indicated that they would "probably" do so). These findings suggest that more than a quarter of the respondents remains open to (re)integration into Croatia's academic or professional system. Conversely, a notable share expressed reluctance to return/migration. A combined 39% reported negative intentions (26% selecting "probably not" and 13% "definitely not"). Overall, the results highlight a complex mixture of openness, hesitation, and resistance toward returning or first-time migrating to Croatia.

Timing of Potential Return or First-time Migration

Next, we analysed attitudes towards the timing of a potential return or first-time migration to Croatia (Figure 19).

The largest proportion of respondents (40%) indicated that it is *hard to say when* they might return/migrate, highlighting a high degree of indecision and a lack of clear long-term planning. A further 27% stated that this question *does not apply* to them, suggesting that for

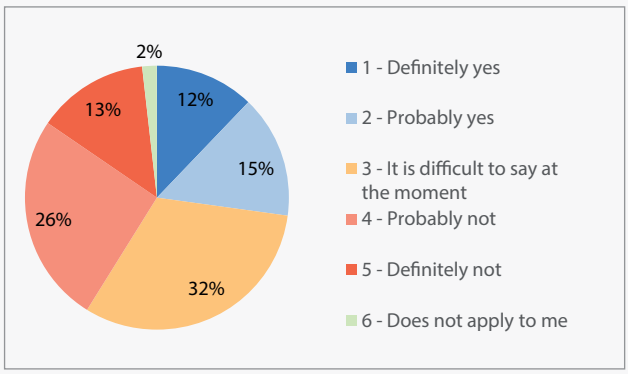


Figure 18. **Attitudes towards returning/migrating to Croatia.** Based on the survey question: Do you consider returning/migrating to Croatia and continuing your professional life there (in academia or elsewhere)? Sample size, n = 666.

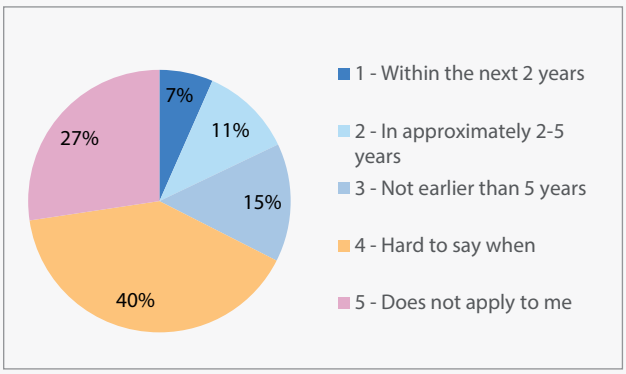


Figure 19. **Timing of a potential return/migration to Croatia.** Based on the survey question: When do you plan to return/migrate to Croatia? Sample size, n = 665.

over a quarter of participants, return/migration is not currently a relevant consideration. Among those who do express some intention to return/migrate, timelines vary considerably. About 15% of respondents reported that they would not return/migrate *earlier than five years*, indicating long-term but distant prospects. Meanwhile, 11% expect a return/migration within *approximately 2–5 years*, and 7% foresee returning *within the next two years*.

Overall, these findings show that while a segment of the Croatian researchers abroad remains open to eventual return/migration, immediate or short-term return plans are less common, and uncertainty remains the dominant response.

Perceived Benefits of Return or Migration

We were also interested to assess potential benefits of returning or first-time migrating to Croatia (Figure 20).

The strongest motivators for return/migration were non-professional in nature. A total of 62% of respondents reported that returning/migrating would offer significant personal benefits, primarily through personal and family ties to their home country. In addition, many respondents were motivated by the opportunity to contribute to Croatia's broader research and scientific system: 49% expressed confidence in their ability to transfer scientific knowledge acquired abroad, and 42% believed they could positively influence the Croatian research environment upon returning.

By contrast, professional incentives were perceived as relatively weak. Only 18% of respondents believed that international experience would provide a competitive advantage within the Croatian scientific community and an equal share reported that they could capitalize on research niches in Croatia. Similarly, 17% viewed return/migration as an opportunity to establish their own research group, and an equal share saw it as a chance to gain experience in a new professional environment. Notably, just 7% identified greater availability of research funding as a benefit of returning to Croatia.

Therefore, non-professional factors, particularly personal and family ties, were the primary motivators for return/migration, alongside a desire to contribute to Croatia's research system. In contrast, professional incentives, such as career advancement, research opportunities, and funding availability, were perceived as weak drivers of return/migration. This indicates that return/migration intentions are shaped more by a sense of social attachment and the potential for systemic contribution than by individual career prospects.

Perceived Challenges Related to Return or Migration

Furthermore, respondents were also asked to rate perceived challenges associated with planned return or first-time migration to Croatia (Figure 21).

Bureaucratic complexity emerges as the key concern, with 63% of respondents strongly agreeing that it would pose a serious difficulty. Securing research funding is another important challenge, identified by 59% of respondents. In addition, 47% pointed to substantial differences in salary levels and overall living standards as an important concern.

We also identified a series of moderate concerns. Maintaining one's international scientific standing is a concern for 28% of respondents, while 27% view career advancement requirements as a potential hurdle. Challenges related to research collaboration are considered important by 26%, as are personal and family-related issues associated with relocation.

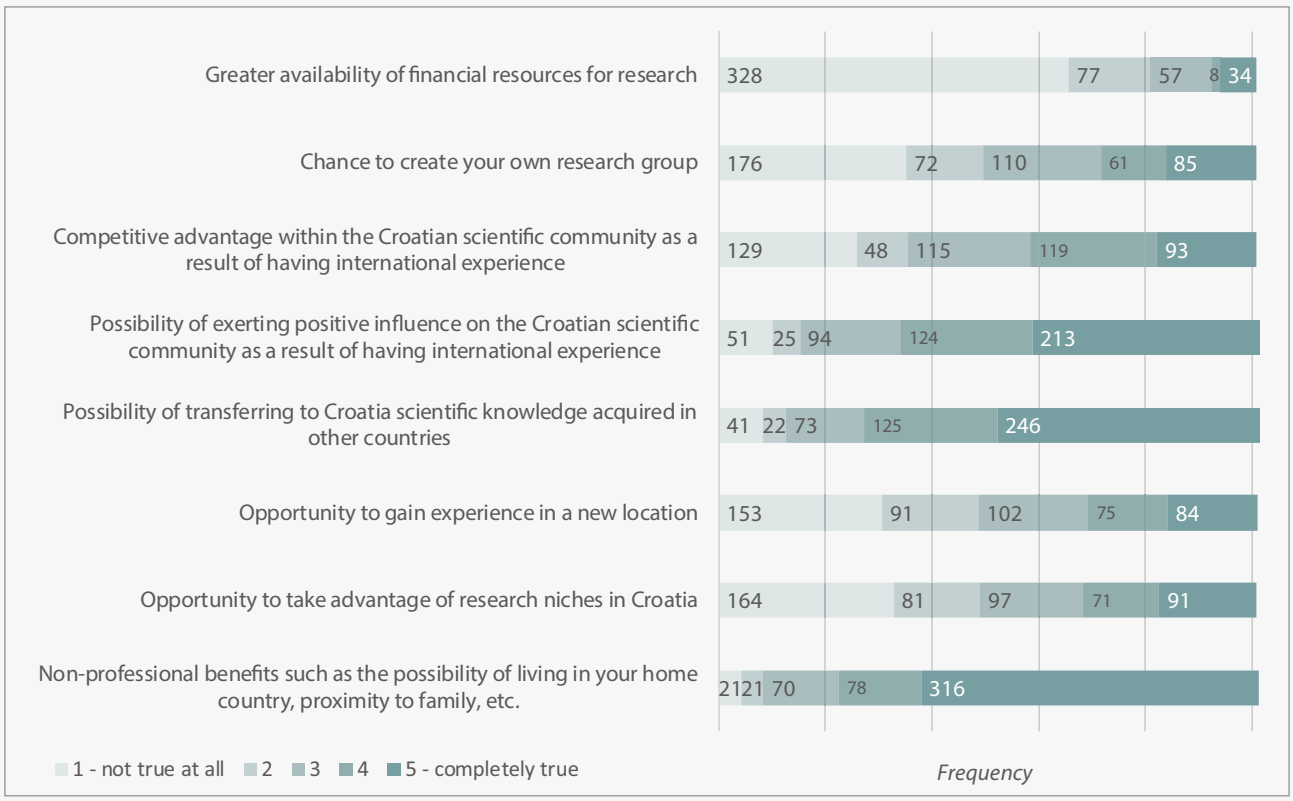


Figure 20. **Perceived potential benefits of returning/migrating to Croatia.** Based on the survey question: If you plan to return/migrate to Croatia, what are the potential benefits? Respondents had the opportunity to select all the answers that apply (1 means "not true at all", 5 means "completely true").

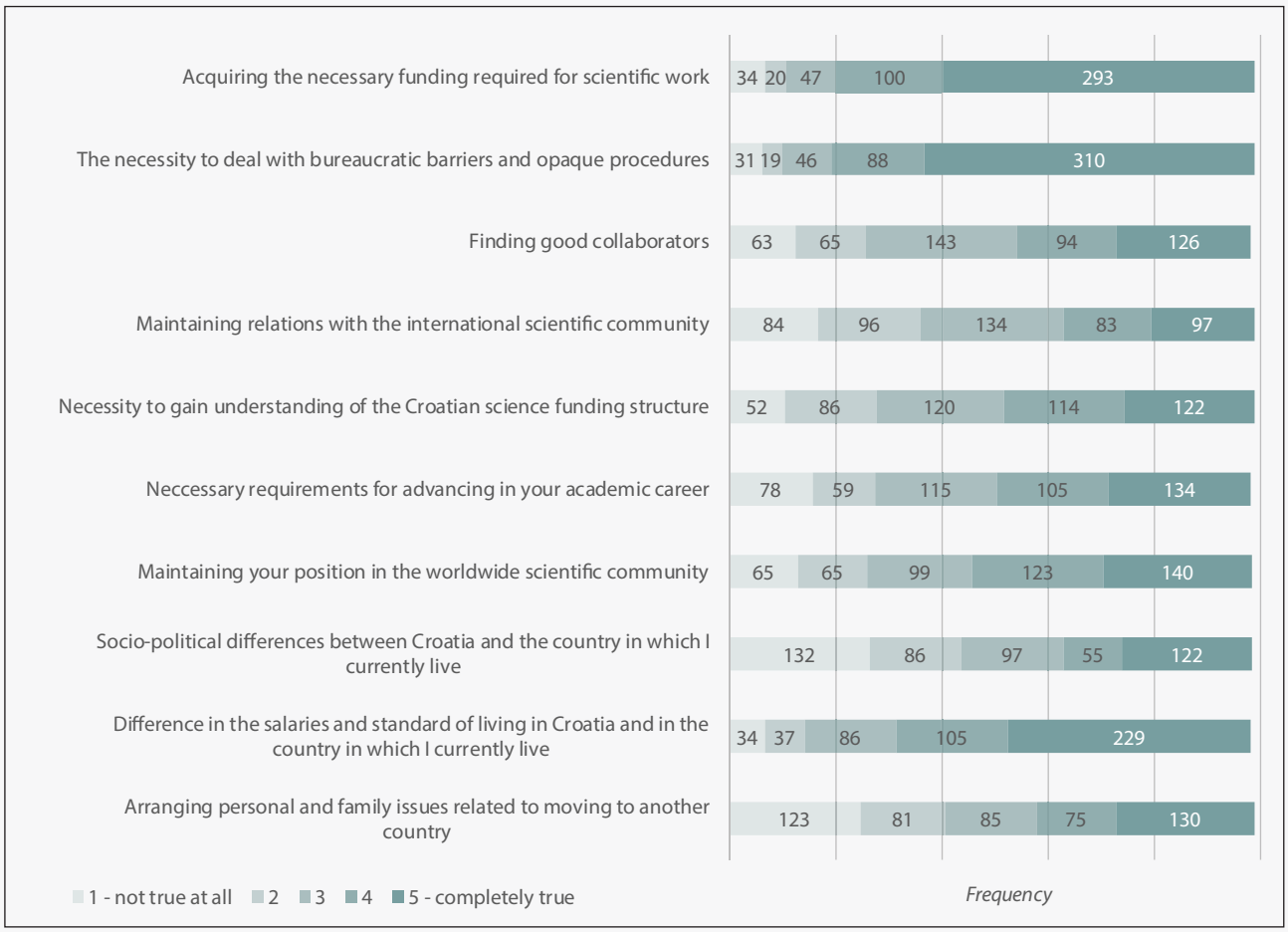


Figure 21. **Perceived challenges associated with planned return/migration to Croatia.** Based on the survey question: If you plan to return/migrate to Croatia, what challenges do you expect to be the most significant? Respondents had the opportunity to select all the answers that apply (1 means "not true at all", 5 means "completely true").

A quarter of respondents (25%) perceive navigating the Croatian research funding system and adapting to socio-political differences as potentially demanding. Finally, 20% expressed concern about maintaining international professional connections.

These results indicate that bureaucratic complexity, limited access to research funding, and lower salary and living standards are the key concerns associated with planned return or first-time migration to Croatia, while issues related to career progression, international standing, collaboration, and personal relocation are viewed as moderate but still relevant challenges.

Perceived Obstacles to Return or Migration

Finally, we asked respondents to rate factors that discourage them to return or migrate to continue their career in Croatia (Figure 22).

The most prominent barrier to return or migration is the disparity in salary and living standards, identified as a major issue by nearly half of respondents (47%). Other important barriers include concerns about insufficient research funding (37%), limited scientific development within their field (36%), and lower overall research standards in Croatia (36%).

Personal and family-related relocation challenges are also considered significant by 29% of respondents, while 28% express concern about socio-political differences. In addition, a lack of professional contacts within the Croatian research environment and the need to adapt to Croatia's academic career progression system are each cited by 20% of respondents. Finally, 17% report difficulties in finding suitable collaborators and concerns about potential loss of international scientific standing.

These findings indicate that lower salaries and living standards represent the most significant barrier to return or migration to Croatia among surveyed researchers, followed by concerns about research funding, scientific development, and research quality. Personal relocation issues, socio-political differences, limited professional networks, and challenges related to collaboration and career progression are viewed as secondary but still relevant obstacles.

Sources of Guidance for Return or Migration

We analysed preferred sources of guidance for returning/migrating and conducting research in Croatia to ensure successful start (Figure 23).

Direct contacts from researchers were most valued. A large majority of respondents (70%) indicated that they would rely on researchers who had already returned/migrated to Croatia from abroad and 50% considered

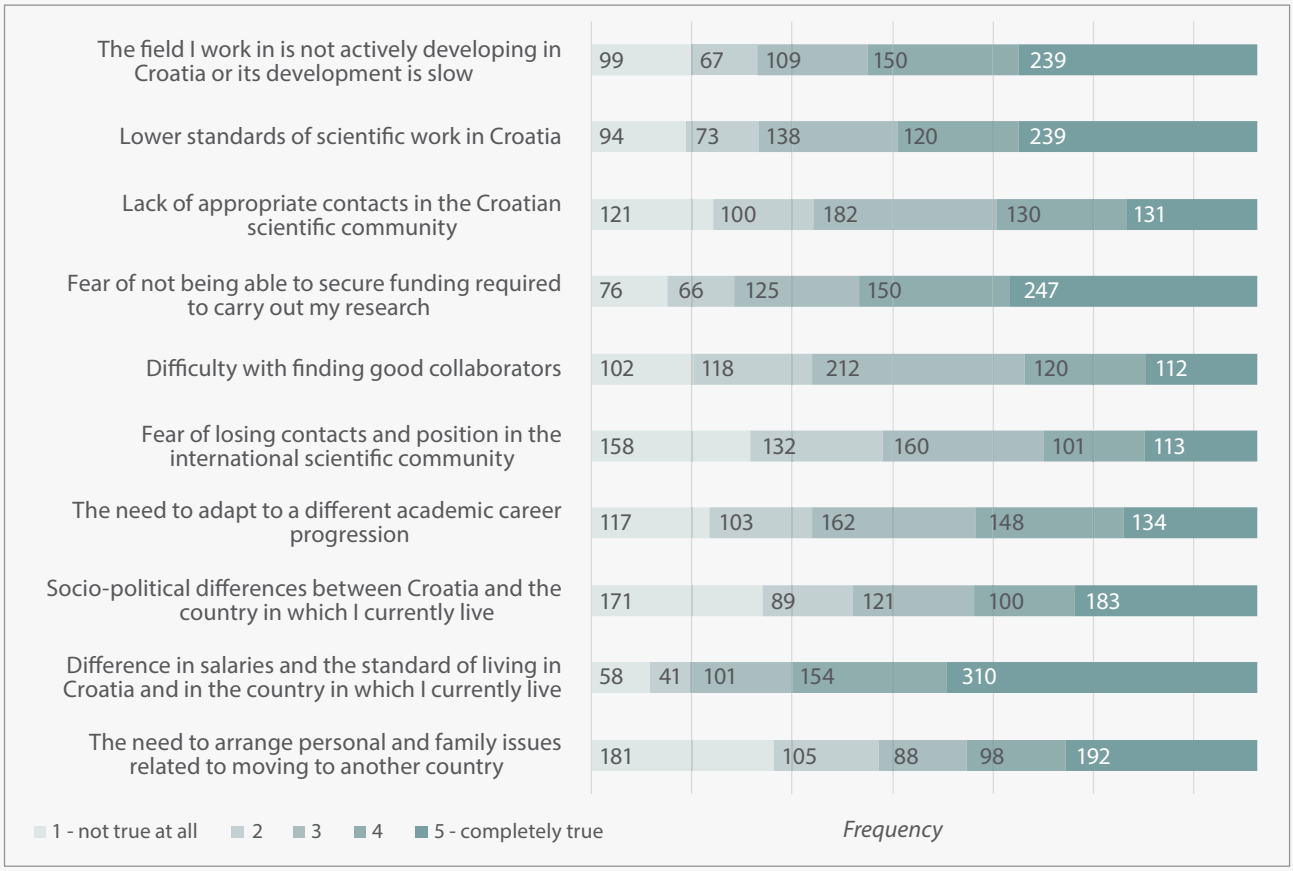


Figure 22. **Perceived key factors discouraging return/migration to Croatia.** Based on the survey question: What discourages you the most from returning to Croatia or continuing your career in Croatia? Respondents had the opportunity to select all the answers that apply (1 means "not true at all", 5 means "completely true").

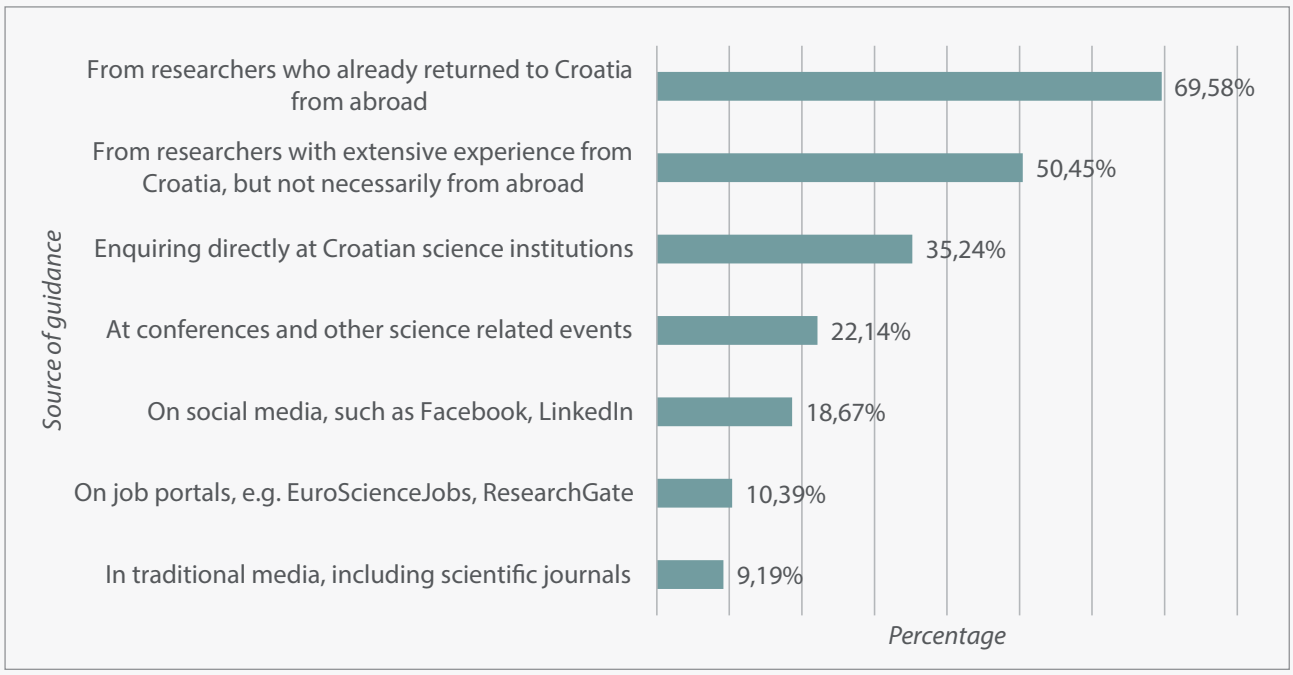


Figure 23. **Preferred sources of guidance for returning/moving and conducting research in Croatia.** Based on the survey question: Where or from whom would you seek advice on returning/moving and conducting research in Croatia to ensure you get the best start? Respondents had the opportunity to select all the answers that apply. Sample size, n = 664.

also useful researchers who have extensive experience in Croatia, but not necessarily international experience. Enquiring directly at Croatian scientific institutions was selected by 35% of respondents. Conferences and science-related events were identified as a less common source of information, with only 22% expressing willingness to seek advice through these channels. Similarly, social media platforms such as Facebook and LinkedIn were not widely trusted for this purpose, with only 19% indicating they would use them. Traditional media, including scientific journals and job portals (e.g. EuroScienceJobs and ResearchGate) received similarly low levels of endorsement, by 10% and 9%, respectively.

Institutional Support for Return or Migration

Respondents also rated institutional sources of support for advice about returning/migrating to Croatia (Figure 24).

Universities or research institutes where respondents would like to work stand out overwhelmingly as the primary source of advice. Nearly three-quarters of participants (73%) selected this option.

The Croatian Science Foundation represents a secondary but notable source of advice, with 22% of respondents indicating they would seek advice there. Other institutions appear to play a much smaller supporting role. Embassies and consulates attracted interest from 13%, while the Croatian Academy of Sciences and Arts was selected by only 12% of respondents. Even lower levels of interest were recorded for the Central State Office for Croats Abroad (9%) and the Croatian Heritage Foundation (5%). NGOs ranked lowest, with only 4% selecting them as a first advisory source.

Factors Associated with Intended Return or Migration

For concluding this chapter, we analysed which characteristics of surveyed researchers are related to their intent to continue career in Croatia. Each factor was studied separately in order to understand who is more likely to consider returning/migrating and which factors should be taken into account in further analyses and policy discussions (Table 5).

Demographic characteristics

Country of birth is significantly related to the intention to return/migrate. Researchers who were born outside Croatia show a stronger intention to return/migrate than those born in Croatia (χ^2=14.50, p=.006, Cramér's V=.15).

Age is weakly related to return/migration intention. Older researchers tend to show lower intention to return/migration, while younger researchers are generally more open (r_s=–.15, p< .001).

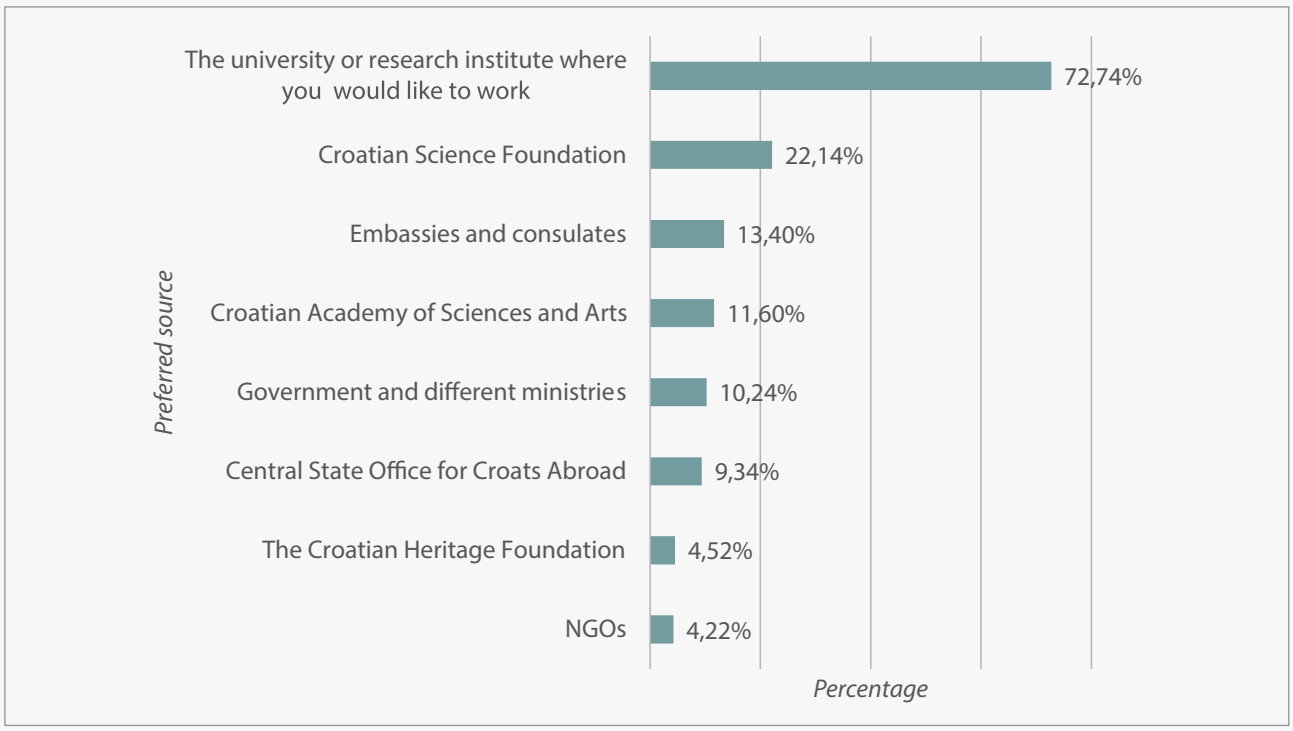


Figure 24. **Preferred institutional sources of support for returning/migrating to Croatia.** Based on the survey question: Which institution would you first ask for advice on returning to Croatia? Respondents had the opportunity to select all the answers that apply. Sample size, n = 664.

There is no significant association between intention to return/migrate and *gender* (χ^2=1.82, p=.84, Cramér's V=.05).

Migration-related characteristics

The association between return/migration intentions and the *country of residence* is very small and non-significant (χ^2 test, p = .90; Cramér's V = .05).

Having *dual citizenship* is not related to the intention to return/migrate (χ^2 = 1.30, p = .87, Cramér's V = .04). Researchers who hold only Croatian citizenship and those with dual citizenship report similar attitudes towards returning/migrating.

The *country where researchers completed their PhD* (Croatia, EU or outside the EU) is not related to their intention to return/migrate (χ^2=8.50, p=.39, Cramér's V=.08).

Professional characteristics

The year in which researchers completed their PhD shows a statistically significant but small association with intention to return/migrate (r_s =–.14, p<.001). A negative association indicates that researchers who completed their PhD more recently tend to express higher intentions to return/migrate.

Association between return/migration intention and *academic position* shows statistically significant association of small strength (χ^2=56.60, p<.001, Cramér's V=.15). Researchers in earlier academic positions (such as doctoral and postdoctoral researchers) tend to express higher intentions to return/migrate.

Career stage shows a negative association with return/migration intention (r_s =–.13, p<.001), meaning that it tends to decrease as career stage increases.

Years of research experience show a statistically significant but small association with return/migration intention (r_s =–.15, p<.001). Researchers with fewer years of experience are more open to returning/migrating, while those with longer research careers are less open to do so.

The association between *field of research* and return/migration intention is statistically significant and of small-to-moderate strength (χ^2=36.90, p=.004, Cramér's V=.16). Natural sciences and engineering researchers are more likely to consider returning/migrating.

The number of joint research projects with researchers based in Croatia is positively related to return/migration intention (r_s =.18, p<.001). Researchers involved in a higher number of joint projects tend to express stronger intentions to return/migrate.

In summary, while this analysis identifies several statistically significant associations, their strength is generally limited, ranging from small to small-to-moderate. As such, these findings should be interpreted as indicative trends rather than definitive conclusions and warrant further investigation. The results suggest that intentions to return or migrate to Croatia vary primarily by age, career stage, and professional characteristics, rather than by migration-related factors. Younger researchers, those who completed their PhDs more recently, and individuals in earlier academic positions or with fewer years of research experience tend to be more inclined to consider returning or migrating, while such intentions appear to decline with age and career progression. Country of birth also shows a modest association, with researchers born outside Croatia expressing somewhat stronger return/migration intentions. By contrast, gender, country of residence, citizenship status, and location of PhD completion are not significantly associated with return or migration intentions. Differences are also evident across fields of research, with researchers in the natural sciences and engineering more likely to consider returning than those in other disciplines.

Table 5. Variables associated with return among surveyed respondents (n = 667)

Variable	χ^2 / ρ	p-value	Statistically significant	Strength of association
Gender	$\chi^2 = 1.82$	.84	No	Very small (V = .05)
Age	$r_s = -.15^{**}$	<.001	Yes	Small
Country of birth	$\chi^2 = 14.50^{**}$	.006	Yes	Small (V = .15)
Country of residence	$\chi^2 = 3.54$	.90	No	Very small (V = .05)
Dual citizenship	$\chi^2 = 1.30$	.87	No	Very small (V = .04)
Country of PhD	$\chi^2 = 8.50$	.39	No	Small (V = .08)
Year of finishing PhD	$r_s = -.14^{**}$	<.001	Yes	Small
Academic position	$\chi^2 = 56.60^{**}$	<.001	Yes	Small (V = .15)
Career stage (R1–R4)	$r_s = -0.13^{**}$	<.001	Yes	Small
Years of research experience	$r_s = -0.15^{**}$	<.001	Yes	Small
Type of organization	$\chi^2 = 28.90^{**}$	.041	Yes	Small (V = .14)
Field of research (overall)	$\chi^2 = 36.90^{**}$	.004	Yes	Small–moderate (V = .16)
Joint projects with Croatian institutions	$r_s = 0.18^{**}$	<.001	Yes	Small–moderate

*p<0.05; **p<0.01

3.5. The role of Croatian Diaspora Organizations in Supporting Researchers Abroad

Chapter Summary

Findings reported in this chapter indicate that most respondents view Croatian diaspora organizations as having an important role in supporting them, with 61% expressing support for such involvement.

Croatian researchers based abroad strongly endorse practical, network-based functions, particularly facilitating international researcher circulation, enabling knowledge exchange with researchers based in Croatia, and promoting scientific achievements both domestically and internationally. Many also support diaspora organizations' involvement in career development through mentoring and fellowships, as well as in strengthening cooperation between Croatian and foreign research institutions and engaging with national policymakers. In contrast, more formalized approaches, such as establishing new representative institutions or organizing integrative meetings, receive relatively limited support.

Despite these expectations, most respondents report little to no direct experience with diaspora support structures: the majority either have not received any support or are unaware of such organizations altogether. Engagement levels are correspondingly low, with most respondents never interacting with diaspora organizations and only a small minority reporting regular involvement.

Role of Croatian Diaspora Organizations

Survey responses show that a majority of participants (61%) believe Croatian diaspora organizations should support Croatian researchers working abroad. A small proportion (4%) indicated that such support should not be provided. Meanwhile, 35% of respondents did not have a clear position on the issue.

We also analysed the perceived role of Croatian diaspora organizations (Figure 25).

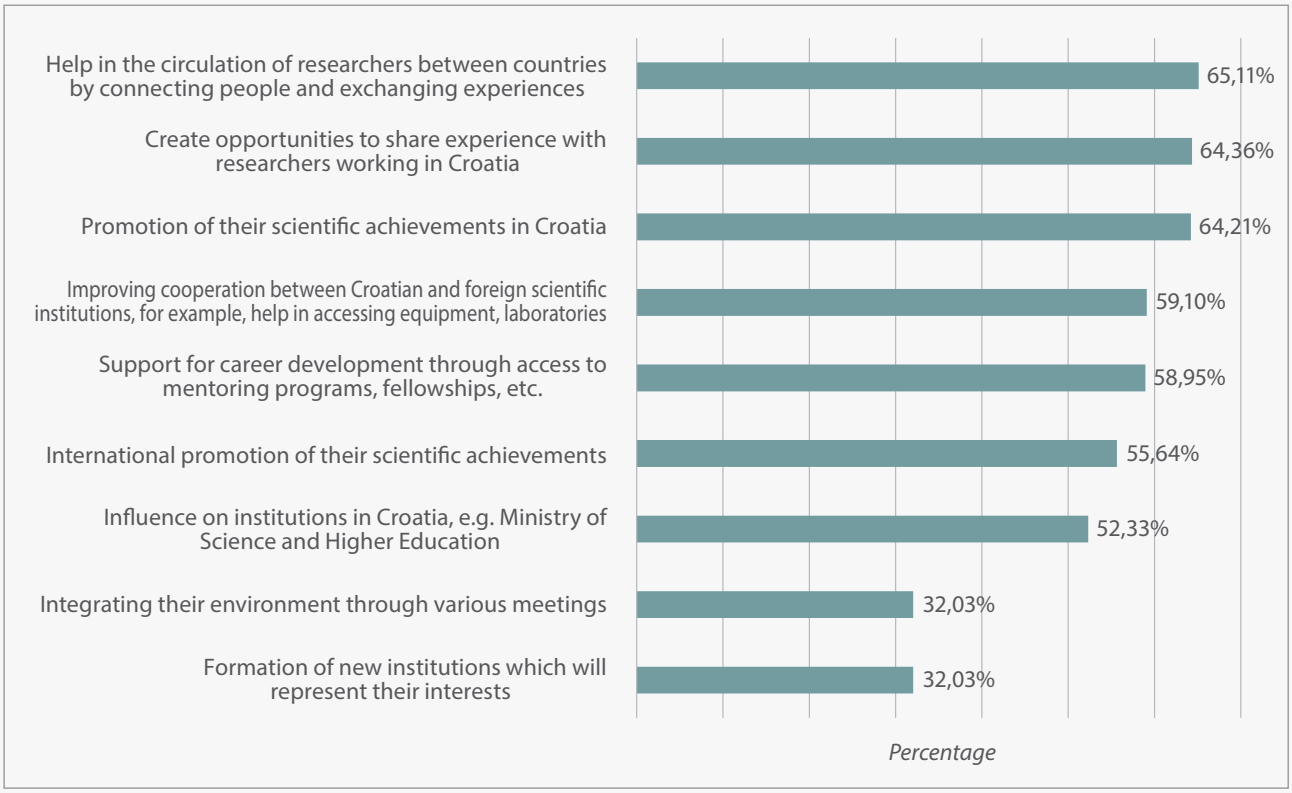


Figure 25. **Perceived role of Croatian diaspora organizations.** Based on the survey question: What role should Croatian diaspora organizations take in supporting Croatian researchers working outside of Croatia? (Select all that applies). Sample size, n = 665.

Support for facilitating the international circulation of researchers, by connecting individuals and enabling exchange, emerges as one of the most strongly endorsed roles of diaspora organizations, supported by 65% of respondents. Similarly, 64% view the creation of opportunities for sharing experience with researchers based in Croatia as an important function, while an equal share supports the promotion of scientific achievements within Croatia. A majority of respondents (59%) believe that diaspora organizations should also contribute to career development through mentoring schemes, fellowships, and similar initiatives, and the same proportion value efforts to improve cooperation between Croatian and foreign scientific institutions, including access to research infrastructure such as equipment and laboratories. In addition, 56% support the international promotion of Croatian researchers' scientific achievements, and just over half (52%) agree that diaspora organizations should play a role in influencing Croatian institutions, including the Ministry of Science, Education and Youth.

By contrast, more institutionalized forms of engagement receive more limited support: only 32% favour the establishment of new institutions to represent the interests of Croatian researchers abroad, and the same proportion support integrating the research environment through organized meetings.

Receiving Support

A clear majority of respondents reported not receiving support from organizations or networks of Croatian researchers working abroad (Figure 26). Sixty percent did not experience structured assistance from professional associations, online communities or institutional networks. An additional 33% stated that they are not aware of such organizations. Only 7% of respondents indicated that they are actively supported by these organizations or networks.

Frequency of Engagement

Frequency of engagement with organizations or groups that support Croatian researchers abroad appears to be very limited (Figure 27). The vast majority of respondents (77%) reported that they never interact with such organizations. An additional 15% stated that they engage only rarely, about once a year or less, reinforcing the pattern of low participation. Occasional engagement, defined as a few times per year, was reported by 6% of participants, while only 2% indicated frequent interaction on a monthly or more regular basis.

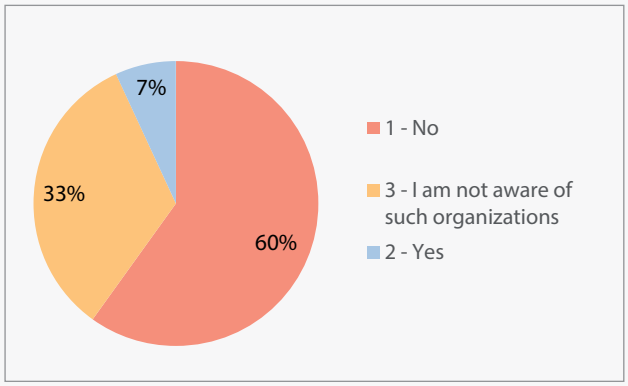


Figure 26. **Receiving support from organizations or networks of Croatian researchers working abroad.** Based on the survey question: Are you supported by organizations or networks of Croatian researchers working outside of Croatia? (e.g., professional associations, online communities, embassies). Sample size, n = 666.

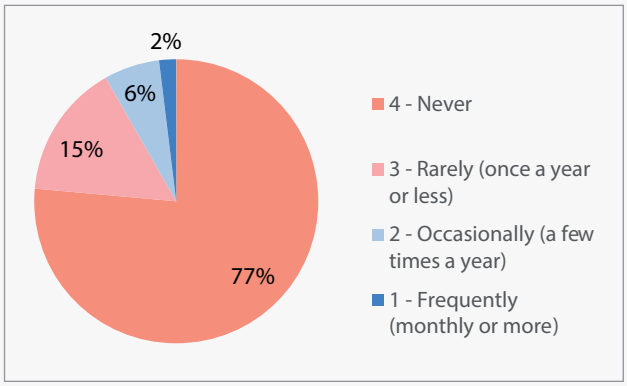


Figure 27. **Frequency of engagement with organizations or groups that support Croatian researchers abroad.** Based on the survey question: How often do you engage with organizations or groups specifically supporting Croatian researchers working outside of Croatia? Sample size, n = 666.

4.

Conclusions and Policy Recommendations

4.1. Conclusions

This study provides the first systematic empirical mapping of Croatian researchers based abroad. It addresses a significant empirical gap in understanding of Croatia's research and innovation (R&I) human capital outside Croatia. Although the sample is non-representative and reflects self-selection bias, the consistency of observed patterns enables cautious, yet analytically grounded interpretation.

The findings challenge a classical brain drain narrative. Croatian researchers abroad are predominantly early-career scholars whose mobility trajectories are embedded within doctoral and postdoctoral training in highly developed research systems, particularly in the United States, Germany, and the United Kingdom. **Their migration decisions are structured primarily around criteria concerning career formation and access to research infrastructure, rather than lifestyle preferences.** This pattern aligns with recent literature emphasizing that contemporary scientific mobility is multidirectional, career-embedded, and shaped by systemic asymmetries between research systems rather than simple push–pull dissatisfaction models (Khan, 2021; Czaika & Reinprecht, 2022; Lang, 2021).

From a theoretical perspective**, the Croatian case is better interpreted through the lens of brain circulation and structured transnationalism rather than linear loss** (Chen et al., 2022; Ito et al., 2025). Mobility here reflects participation in global academic labor markets characterized by hierarchical integration, where researchers from smaller or widening European Research Area (ERA) countries are disproportionately trained and employed in core systems with greater funding stability and research intensity, and greater levels of internationalization. Croatia's R&D intensity of only 1.49% of GDP in 2024 (Croatian Bureau of Statistics, 2025) and fragmented institutional structure with comparatively low levels of integration in transnational academic networks and labor markets further contextualize this pattern. Mobility thus emerges not as an aberration but as a structurally rational strategy within asymmetrical knowledge systems.

At the same time, the study demonstrates that transnational connectivity persists. A large majority of respondents maintain contacts with researchers in Croatia while abroad, yet collaboration remains sporadic and weakly institutionalized. Networks are predominantly path-dependent, formed prior to emigration rather than through policy-driven mechanisms. From a social capital perspective (Lin, 2001; Putnam, 2000), this suggests the presence of bonding capital (shared national and cultural ties) and latent bridging capital (access to international research ecosystems), but insufficient institutional activation. Recent comparative studies underscore that such capital does not translate automatically into systemic gains; instead, enabling governance structures are necessary to convert relational ties into durable institutional linkages (Echeverría-King et al., 2022; Ortega-Paíno & Oliver, 2022).

Return intentions further reinforce this interpretation. **Although a minority expresses openness to return, many remain undecided or negative, with long-term projected timeframes. Crucially, motivations for potential return are primarily personal (family ties, and willingness to contribute), whereas professional incentives such as funding stability, research infrastructure, and career transparency are perceived as comparatively weak**, as previous research has confirmed (Hornstein Tomić, 2018, 2023; Hornstein Tomić, Kurilić, Bagić, 2023). Salary disparities and bureaucratic complexity represent major deterrents. These findings resonate with recent evidence from widening EU contexts indicating that reintegration decisions are shaped less by attachment deficits and more by structural opportunity within national research systems (European Commission, 2023; Khan, 2021).

Comparatively, Croatia's situation is not unique. Poland's recent efforts to formalize diaspora engagement through structured networking and circulation initiatives illustrate how institutionalization can enhance collaboration without relying exclusively on return. Spain's RAICEX network demonstrates the importance of recognizing diaspora scientists as science diplomacy actors embedded within global innovation systems. Ireland's integration of diaspora engagement within its broader research competitiveness strategy underscores that diaspora policy is most effective when aligned with systemic reform of research careers and performance-based funding. These cases suggest that successful diaspora governance does not treat mobility as a demographic anomaly but as a structural feature of contemporary research ecosystems requiring coordinated institutional response.

Within the ERA framework, Croatia's experience reflects broader tensions faced by widening countries: participation in European research programs is expanding, yet domestic institutional capacity and funding intensity remain below EU averages. ERA policy priorities (talent circulation, attractive research careers, research assessment reform, open science, and widening participation) provide an enabling architecture for addressing these asymmetries. However, implementation remains contingent upon national governance capacity and administrative reform.

Taken together, **the findings indicate that Croatia does not face a simple depletion of human capital but rather an under-institutionalized system of transnational knowledge circulation. Croatian researchers abroad maintain social and professional ties and express willingness to engage; however, the national R&I framework lacks mechanisms capable of converting transnational**

connectivity into sustained collaboration, institutional partnerships and innovation outputs.

The analytical implications of these findings are clear. If mobility is structurally embedded within global academic labor markets and if social capital alone does not generate systemic benefits, then policy must shift from the brain drain narratives toward institutionalized governance of brain circulation, including greater efforts to facilitate (temporary) return. This requires activating bridging capital through structured collaboration instruments, aligning research careers reform with ERA policy commitments, reducing administrative barriers that constitute structural push factors, and embedding Croatian researchers based abroad within innovation and performance-based funding frameworks. The following policy recommendations derive from this theoretical and comparative logic, aiming to transform Croatia's researchers abroad from a dispersed community to a resource that can be strategically tapped into, and an integrated component of the national R&I capacity.

4.2. Policy Recommendations

Policy Context

Croatia has adopted several strategic and legislative documents addressing relations with the Croatian diaspora and broader demographic and migration challenges.

The *National Development Strategy of the Republic of Croatia 2030* (GoC, 2021a) recognizes researchers as a key component of human capital and an important driver of innovation and economic competitiveness. The strategy emphasizes the importance of creating working conditions that encourage researchers to remain in Croatia while also stimulating the return of Croatian scientists from abroad and strengthening cooperation with Croatian researchers working in leading international research centers. In this context, cooperation with Croatian scientists abroad is recognized as an important element of strengthening the national research and innovation system.

The legal basis for relations between the Croatian state and the diaspora is established through the *Act on Relations between the Republic of Croatia and Croats Outside the Republic of Croatia*, which regulates institutional cooperation with Croatian communities abroad and places particular emphasis on preserving Croatian cultural and national identity. The Act also established the Central State Office for Croats Abroad as the key coordinating institution responsible for diaspora policies and created the Government Council for Croats Outside the Republic of Croatia, an advisory body aimed at strengthening cooperation between the Croatian government and representatives of Croatian communities abroad.

The broader strategic framework for diaspora engagement is further defined by the *Strategy on Relations between the Republic of Croatia and Croats Outside the Republic of Croatia* (GoC, 2011), the first comprehensive policy document addressing Croatia's relationship with its diaspora. Building on this framework, the *National Plan for the Development of Relations between the Republic of Croatia and Croats Outside the Republic of Croatia until 2027* (GoC, 2022), defines priority policy areas for strengthening cooperation with Croatian communities abroad, including professional networking, knowledge exchange, and the strengthening of economic and institutional ties. Its implementation is supported by an accompanying Action Plan 2022–2024 and analytical assessments of development needs and potentials in relations with Croats abroad.

At the same time, broader demographic considerations are addressed in the *Strategy for Demographic Revitalization of the Republic of Croatia until 2033* (GoC, 2023), which identifies migration management and cooperation with the Croatian diaspora as important instruments for addressing demographic decline and labor market challenges.

In addition, Croatia's *Smart Specialization Strategy 2023–2029* (MSEY, 2023) defines priority research and innovation domains and emphasizes the importance of strengthening international research collaboration and knowledge transfer in strategic sectors. While the strategy does not explicitly address engagement with Croatian researchers abroad, its focus on internationalization and research excellence provides an important policy framework within which diaspora collaboration initiatives can be developed.

Croatia has developed a range of policy instruments to strengthen scientific cooperation with its diaspora. In 2004, the **Ministry of Science, Education and Sports introduced the *Scientist Return/Znanstvenik povratnik* initiative** to support the return and reintegration of Croatian researchers from abroad. The program enabled higher education institutions and public research institutes to recruit returning scientists, with positions approved and funded by the Ministry. Since 2025, this mechanism has been decentralized, with provisions for recruiting returning researchers incorporated into institutional Performance Agreements. Between 2015 and September 2025, a total of 105 scientists returned under this framework.

In 2005, the **Croatian Science Foundation launched the *Brain Gain*** program framework to facilitate the return of Croatian researchers and attract foreign scientists. The ***Guest*** program supported the participation of international researchers in projects in Croatia, while the ***Returnee*** program targeted established researchers with independent careers abroad. These measures aimed to strengthen research capacity, enhance international visibility, and support the establishment of independent research teams.

In 2007, the ***Unity through Knowledge Fund*** (UKF) was established as a joint initiative of the Ministry and the World Bank under the Science and Technology Project (STP I and STP II). The Fund supported collaborative research between Croatian-based researchers and members of the scientific diaspora, with a focus on strengthening international collaboration and facilitating knowledge exchange. Between 2007 and April 2020, UKF supported 150 projects, with total funding of approximately €14.3 million. Of this amount, approximately 67% was provided by the Ministry, with additional contributions from international partners, the private sector, and domestic research organizations. Projects supported by the Fund subsequently secured an additional €22.5 million from European and international funding sources, including EU Framework Programs (FP7 and Horizon 2020), Interreg programs, and Structural Funds.

With the introduction of regular UKF calls, the Croatian Science Foundation suspended the 'Brain Gain' programs to avoid overlap between instruments.

Additional measures included the ***NEWFELPRO*** **program** (2013–2017), **administered by the Ministry of Science and Education**, and the ***Research Cooperability Program*** **(RCP)/*Program znanstvene suradnje*, implemented by the Croatian Science Foundation** and financed through the European Social Fund under the Operational Program 'Efficient Human Resources 2014–2020', as well as the national budget. The RCP supported collaboration between researchers in Croatia and the scientific diaspora, strengthened networking, and contributed to early-career development and knowledge transfer. Implemented in 2019, the program funded 23 projects with a total investment of approximately €5.6 million.

Beyond the national context, it should be highlighted that in May 2025 the **European Union launched the *Choose Europe for Science* initiative** with the objective of attracting leading researchers from across the globe, thereby ensuring that Europe remains at the forefront of scientific excellence and continues to draw outstanding talent. The initiative is supported by a range of measures, including the €500 million *Super Grant Program* (2025–2027) implemented through the European Research Council (ERC) to advance frontier research, the introduction of legal safeguards to uphold academic freedom and protect scientific inquiry across the Union, and a pilot program under the Marie Skłodowska-Curie Actions (MSCA) aimed at fostering sustainable career pathways for early-stage researchers, with a budget of €22.5 million. The initiative also presents a strategic opportunity for Croatia to strengthen its capacity to attract and support international researchers, and to develop programs aimed at systematically and continuously connecting Croatian researchers abroad with domestic research institutions.

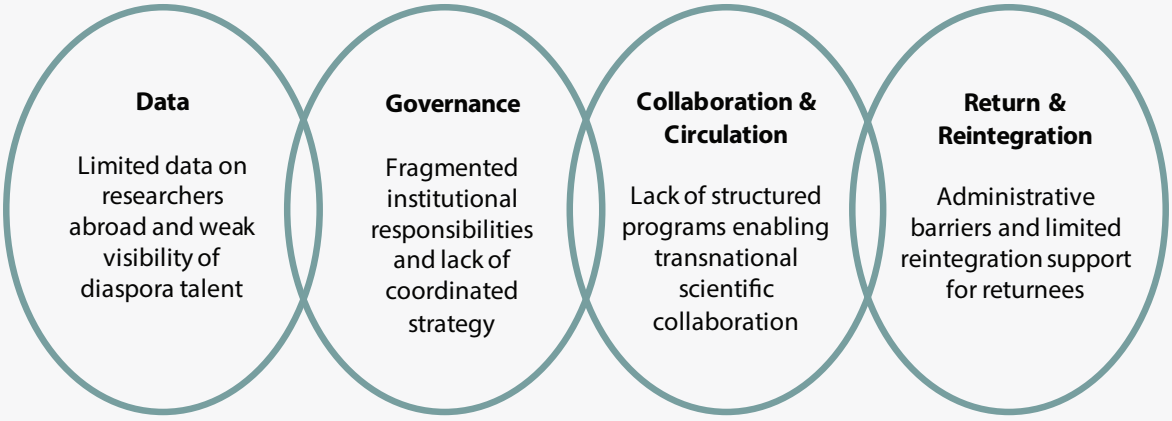
Strategic Premise: From Brain Drain to Structured Brain Circulation

The empirical mapping of 667 Croatian researchers abroad demonstrates that Croatia does not face scientific disengagement, but rather structurally under-institutionalized engagement.

- 87% maintain contact with researchers in Croatia, however 66% have never participated in a joint research project.
- 27% express positive return intentions, 32% remain undecided, and 39% do not intend to return.

Box 5: **Policy Recommendations**

Policy Challenges in Engaging Croatian Researchers Abroad



- Structural constraints (salary disparities, funding limitations, bureaucratic complexity, and concerns regarding research quality) outweigh purely professional, and often personal motivations for return.

These findings align with brain circulation and brain linkage frameworks, which conceptualize scientists as transnational actors embedded in global knowledge networks (Saxenian, 2005; Meyer, 2001). However, circulation is not activated automatically. Social capital exists in both bonding (national ties) and bridging (international networks) forms, but its potential is constrained by the lack of enabling institutional infrastructure.

The recommendations presented below therefore build on the empirical findings of this study and incorporate the perspectives of Croatian researchers abroad as the key stakeholders in the national research and innovation system. This approach is consistent with policy frameworks that emphasize the importance of incorporating beneficiary feedback into the design of effective public interventions (World Bank, 2014).

The central policy challenge is therefore not to restrict outward mobility, but to develop mechanisms that effectively leverage transnational scientific capital in line with the European Research Area (ERA) priorities and Croatia's Smart Specialization Strategy.

Addressing this challenge requires a coordinated policy framework operating across four complementary pillars: governance, data and visibility, collaboration and circulation mechanisms, and return and reintegration pathways. Together, these pillars aim to transform existing informal connections into structured channels for transnational scientific collaboration and knowledge circulation.

These recommendations primarily reflect the characteristics of the study sample, which is largely composed of first-generation migrants and early-career researchers. As such, they are principally designed to address the needs, motivations, and constraints of this group. **Croatian descendants of the second and third post-migrant generation may face different barriers**: such as weaker institutional ties, language constraints, cultural differences in professional ethics or conceptions of university, limited social capital, or different forms of transnational engagement, **which would require additional, specifically tailored policy approaches** beyond the scope of these recommendations. In this context, particular attention should be given to the role of diaspora organizations and bridging programs targeting G2+ generations as key mechanisms for addressing these gaps and fostering sustained connections with domestic research institutions.

Pillar 1: Governance

1. National Science Diaspora Strategy

Croatia should transition from the symbolic recognition of its scientific diaspora toward a formally embedded governance framework aligned with existing national policy frameworks, including the National Development Strategy 2030, the Smart Specialization Strategy 2023–2029, and the Strategy for Demographic Revitalization until 2033. Furthermore, an additional challenge is to account for the needs of researchers from the second and third post-migrant generations, as well as their families, whose research cultures may differ from those in Croatia and the EU. This approach would ensure policy coherence and avoid the creation of parallel institutional structures. The strategy should:

- Establish a clear coordination mandate within the Ministry of Science, Education and Youth, with specified roles for the Croatian Science Foundation, the Agency for Science and Higher Education, and other stakeholders (e.g., the Croatian Employers' Association, the Croatian Chamber of Economy).
- Define measurable performance indicators for diaspora collaboration programs (e.g. co-publications, co-supervised doctorates, joint grant applications, circulation flows, reintegration outcomes).
- Integrate diaspora collaboration indicators into performance-based funding frameworks.
- Provide regular monitoring of engagement intensity.
- Strengthen the internationalization of the research system, including wider use of English (and other strategic languages) in research and administrative environments.
- Improve support for international and mixed-nationality research teams, including considerations for dual-career households and family integration.

Comparative experience (e.g., Poland's Polonium program; Spain's RAICEX network) suggests that diaspora engagement is most effective when embedded in accountable governance structures rather than *ad hoc* initiatives.

2. *Reducing Administrative and Governance Barriers*

Administrative predictability is a precondition for both circulation and return.

Reforms should include:

- Streamlined recognition of qualifications and employment procedures.
- Clearer, transparent, and internationally aligned recruitment procedures for returning researchers (and international researchers in general),

including defined evaluation criteria, timelines, and recognition of international experience.
- Simplified grant administration and reporting.

Pillar 2: Data and Visibility

3. National Science Diaspora Registry

A global scientific community cannot function without visibility of its members.

The existing *Map of Croatian Scientists*[1] developed by the Penkala Association provides an important starting point. However, it should be upscaled into a comprehensive National Research Diaspora Registry, supported by formal institutions.

Given that:

- 87% of respondents are acquainted with researchers in Croatia,
- 80% would welcome direct contact from potential collaborators,
- many currently uninvolved researchers express willingness to engage.

A structured repository would convert informal networks into institutionalized collaboration channels.

Key actions:

Enable advanced search and thematic filtering aligned with the Smart Specialization priorities.

Institutional support for maintaining data actuality and quality, and technical maintenance.

4. Institutional Outreach and Engagement Mechanisms

The registry should be complemented by active outreach mechanisms.

Actions should include:

- Engagement of Croatian embassies, consulates and Croatian associations in diaspora mapping and communication, verification of registry data, and dissemination of collaboration opportunities.
- Targeted communication with diaspora researchers (via email, social media and events).
- Institutional facilitation of researcher-to-researcher connections and professional networking by designating responsible units or contact points within key institutions (e.g. the Ministry of Science, Education and Youth) to coordinate outreach and maintain continuous engagement.

These measures would activate the registry by facilitating direct researcher-to-researcher connections and institutional collaboration.

Pillar 3: Collaboration and Circulation

5. Thematic Scientific Connectivity Program

Empirical findings show that 38% of respondents reported limited opportunities to meet researchers in Croatia, while 60% visit Croatia several times per year.

This creates a clear policy window.

A Thematic Scientific Connectivity Program should:

- Organize field-specific networking events during peak return periods (winter and summer).
- Include structured workshops and "scientific speed-dating" sessions based on research profiles.
- Focus on thematic alignment (green transition, digital technologies, health, AI, biotechnology, etc.).
- Provide follow-up seed grants to convert meetings into proposals for exploratory collaborative projects, workshops, summer schools or symposium organization.

Since 76% of respondents value invitations to specific scientific events, this represents a highly demand-driven instrument.

In-person events should complement virtual matchmaking through the upgraded registry.

6. Thematic Collaboration Research Grant Program

Building on the former UKF, NEWFELPRO, Research Cooperability Program (RCP) as well as good practices from Horizon Europe, MSCA Staff Exchanges, COST, etc., Croatia should establish a competitive, long-term, continuous and predictable Thematic Collaboration Research Grant Program requiring at least:

- One researcher based in a research-performing organization in Croatia (including the business sector),
- One Croatian scientist based abroad,
- A defined knowledge transfer component,
- Involvement of early-career researchers (doctoral candidates and post-doctoral researchers).

Calls should be aligned with national development priorities and Horizon Europe synergies. In addition to joint research funding, complementary circulation instruments could further strengthen collaboration between Croatian institutions and researchers abroad. These may include competitive visiting professorships and short-term circulation fellowships, as well as structured remote mentoring and co-supervision of doctoral candidates. Such arrangements would allow diaspora scientists to contribute to research projects,

[1] https://www.mapa-znanstvenika.hr/#/map-page

doctoral training, and knowledge transfer without requiring permanent return.

Expected output should include, for example:

- Co-authored publications,
- Joint Horizon Europe and other grant applications,
- Co-supervised PhDs,
- Shared datasets and lab-to-lab cooperation,
- Translational outputs (prototypes, patent applications, spinoffs, didactic and course materials, exhibitions etc.).

This instrument moves beyond networking toward measurable scientific and innovation impact and helps address Croatia's translational gap (strong public-private co-publications but relatively weak patenting intensity).

Pillar 4: Return and Reintegration

7. Establishing a Croatian Returning Science Network

Given that 27% of respondents express positive return intentions and 32% remain undecided, structured return facilitation could significantly influence outcomes.

Importantly, 70% of respondents rely primarily on guidance from scientists who have already returned.

A Croatian Returning Science Network should therefore:

- Establish a formal peer-mentoring and "ambassador" system connecting prospective returnees with peers in similar disciplines or career stages.
- Provide informal, experience-based mentoring on institutional culture, funding access, and career progression.
- Develop a centralized and regularly updated institutional information system on return procedures, recognition of academic credentials, employment opportunities, and research funding, building on the existing initiatives such as the *Guide for Returning Scientists*.[2]
- Ensure that returning Croatian researchers are integrated into broader "one-stop" administrative support services for returnees, while extending access to similar support mechanisms for international researchers, including assistance with housing, schooling, taxation, and partner employment.

Peer-to-peer guidance reduces uncertainty and lowers perceived risk associated with return.

8. *Reforming Research Careers and Reintegration Pathways*

Reintegration policy cannot succeed without broader research system reform.

Qualitative responses highlight concerns regarding transparency, fairness, merit-based recruitment, and bureaucratic rigidity. These structural factors represent major deterrents to return.

Croatia should therefore:

- Introduce internationally advertised tenure-track positions with transparent criteria and external peer review.
- Provide competitive start-up packages for early- and mid-career researchers.
- Align evaluation frameworks with research assessment reform principles (CoARA), recognizing collaboration, mentoring, open science, and societal impact.
- Enable dual affiliation arrangements and remote mentoring and short-term circulation.
- Expand structured reintegration fellowships for all career stages.

Such reforms respond directly to identified push factors and strengthen Croatia's alignment with ERA commitments.

Concluding Reflection

Croatian researchers abroad are embedded in global knowledge networks and maintain strong affective and professional ties to Croatia. The empirical evidence demonstrates that willingness to collaborate exists, but institutional pathways remain weak.

Diaspora research policy must therefore be understood as an integral component of broader research and innovation reform of Croatia.

The primary objective is therefore not large-scale repatriation, but structured circulation and collaboration.

With improved career transparency, funding competitiveness, administrative efficiency, and strategic governance, Croatia can activate transnational social capital as a driver of scientific excellence, innovation capacity, and long-term development resilience.

[2] https://udruga-penkala.hr/vodic-za-znanstvenike-povratnike-u-hrvatsku/

5.

Strengths and Limitations of the Study

5.1. Strengths of the Study

This study represents the first mapping of Croatian researchers abroad, addressing a substantial empirical gap in the existing literature. Its broad thematic scope ensures that key issues are systematically examined, thereby offering a comprehensive and holistic account of the experiences of Croatian researchers in international academic and research environments.

The survey's translation into multiple languages (English, Spanish and Portuguese), combined with a multi-channel dissemination strategy (including personal academic networks of participants, diaspora organizations, Croatian diplomatic networks, and the LinkedIn platform) significantly enhanced its global reach.

Furthermore, the study is based on a relatively large and diverse sample, encompassing participants from a wide range of countries (individuals born in Croatia as well as descendants of Croatian emigrants from different emigration waves), various research fields and career stages. This diversity strengthens the robustness and relevance of the findings.

5.2. Limitations of the Study

The study has several limitations that should be acknowledged as well.

The sample was non-probabilistic and was recruited using a snow-ball sampling method. Furthermore, the participants were self-selected. These factors introduce selection bias and result in a non-representative sample, thereby limiting generalizability of the findings. Moreover, the outreach methods likely favored well-networked and younger individuals.

Instead of standardized, psychometrically validated measurement scales, the study employed an author-developed questionnaire, partially adapted from the comparable survey of the Polish research diaspora conducted by the Polonium Foundation (Czerniawska et al., 2018)., which affect the validity and reliability of the findings. In fact, the data regarding the internal consistency of the employed multi-item scales (ranging from $\alpha = .134$ to $\alpha = .865$) indicate that while some scales are psychometrically sound, others require revision.

Due to the type of data collected, the study relied primarily on bivariate analyses and did not employ multivariate modelling; consequently, it cannot provide an in-depth analysis of potential confounding factors. The reported associations were generally weak, and even when they were statistically significant, effect sizes were mostly small.

As much as the diversity of participants is a strength, it proves at the same time to be a weakness. Mixing the sample of participants who are born in Croatia and first-generation migrants, with descendants of Croatian emigrants from various emigration waves who are born abroad, distorts the findings to some extent. Differences in motives, practices and barriers for connecting to the Croatian academic environment, and finally for returning are blurred. Whilst first generation migrants claim personal or family ties to constitute a primary motivation for returning, such ties are no longer available for many descendants of Croatian emigrants. Furthermore, they often lack the capacity of speaking Croatian, which constitutes a major barrier for returning to Croatia and integrating into the - Croatian-language-based - academic eco-system, as qualitative research has shown (Hornstein Tomić, Kurilić & Bagić, 2023). Findings of this study, such as that the country of birth is modestly related to the intention to return/migrate, and that researchers born outside of Croatia show somewhat stronger intention to return than those born in Croatia, need further exploring and explaining.

By mixing participants, precision and differentiation is compromised, which also indicates the limitations of a quantitative research approach. Having both, a diverse mixed sample of participants, and quantitative methodology, together translate into limitations for credible and applicable policy recommendations, too. This is particularly evident with regards to the section addressing return, immigration and integration of researchers.

In essence, the analysis provides a broad exploratory overview and indicates trends rather than offering definitive conclusions.

Despite these limitations, this study offers valuable insights for policymaking and provides strong foundations for systematic mapping, as well as more in-depth and potentially longitudinal research.

6.

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About the Authors

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