

University-discovered biomedical patents & equitable health technology diffusion in times of a pandemic

Shiri Mermelstein and Hilde Stevens (PhD), I3h Institute, Solvay School of Economics and Management, Université Libre de Bruxelles (ULB), Belgium



The rapid development of Covid-19 vaccines would not be possible without decades of public research, taxpayers' funding, and the transfer of knowledge from academic and national research institutes to the industry. **What role can academic Intellectual Property (IP) and technology transfer policies play in pandemic preparedness and universal access to vaccines?**

Introduction

Previous studies have argued that considering their substantial investment in Covid-19 vaccines and antivirals, governments should ensure their fair supply at cost price to the global public [1]. Until national-level policies are introduced, institutional IP practices can be considered as a key instrument to avoid a **“too early” privatisation of biomedical knowledge**. Academic Technology Transfer Offices valorise research outputs in the form of IP (a mix of patents, know-how and regulatory exclusivities), licenses, product development partnerships and spin-out of new companies. Yet despite their critical role in liaising the commercialisation of sometimes life-saving inventions, little is known about shifts in TTO's IP strategies over time. Recent qualitative studies suggest that minimal access terms such as non-exclusive and royalty-free licenses were installed by top UK and US academic patent-holders during the pandemic to prevent patent thickets and guarantee the effective diffusion of vaccines building on their inventions [2].

Objectives

- (i) This paper explores the **patent landscape of technologies employed in Covid-19 vaccines**, specifically focusing on public-sector patenting and licensing before and during the pandemic.
- (ii) Next, we plan to examine the broader impact of institutional IP policies, and draw implications pertaining to health economics.

Methodology

Systematic search strategy to identify:

- (1) Patents filed by universities, affiliated hospital labs, national and non-profit research institutes;
- (2) Joint patent filings, universities and spin-offs formed by the universities.

Analytical approach: Descriptive and basic regression analyses. Main outcomes of interest are the proportion and characteristics of public sector patenting and licensing strategies over time, stratified by the applicant category, vaccine technology, patent filing date, regulatory authorisation(s) and launch status of end-products across countries, and, where feasible, government funding agency [4,5,6].

Product-Level Data

Patent and licensing data on 14 pandemic vaccines were linked with public procurement deals covering 172 nations. Main sources included:

Patent status-product data: (1) The Medicines Patent Pool's *VaxPaL database* offers detailed information on international patent filings by either Covid-19 vaccine developers or external entities such as universities and spin-offs; (2) Published mRNA patent analyses [1,3].

Licensing and changes in patent ownership: US Securities and Exchange Commission's company filings (*SEC.gov*); *Patent Reassignment*; *The Lens*.

Vaccine procurement deals & COVAX Donations: *UNICEF Covid-19 Market Dashboard*.

Qualitative Evidence

We also conducted seven semi-structured interviews with a purposive sample of **high-profile scientists-inventors** ($n=6$) and **directors of Technology Transfer Offices** ($n=1$) whose work directly contributed to the development of Covid-19 vaccines at European, UK, and US universities. Anonymised interview data were used to inform the design of the panel data and statistical analyses and to elucidate contradictions in our findings.

Table 1. Overview of the patent data	
Period covered (years)	30
Patent families	180
Jurisdiction-specific patent applications	5926
Jurisdictions	130
Patent applicants	53
Covid-19 Vaccines Developers	14*
Vaccine technology types	4
Total observations (patent-country-vaccine units)	6627

Table 2. Regional market share of vaccines covered in the patent data	
Low Income	100%
Lower Middle Income	88%
Upper Middle Income	93.4%
High Income	93.1%
COVAX	100%
African Union	100%
Total	93.5%

Table 3. Public vs private sector patenting & licensing					
	Academic & Public Institutions	Mature spin-offs	Public-private co-inventors	Incumbent firms	Total
Patent Families	50 (27.8%)	61 (33.9%)	9 (5.0%)	60 (33.3%)	180 (100.0%)
Application period					
2020-2022	20 (40.0%)	26 (42.6%)	7 (77.8%)	23 (38.3%)	76 (42.2%)
1993-2022	30 (60.0%)	35 (57.4%)	2 (22.2%)	37 (61.7%)	104 (57.8%)
Licensing type					
Exclusive	45 (90%)	58 (95.1%)			
Non-exclusive	5 (10%)	3 (4.9%)			
Country-specific applications					
2020-2022	1,116 (18.8%)	2,072 (35.0%)	94 (1.6%)	2,644 (44.6%)	5,926 (100.0%)
1993-2022	219 (19.6%)	220 (10.6%)	47 (50.0%)	123 (4.7%)	609 (10.3%)
2020-2022	897 (80.4%)	1,852 (89.4%)	47 (50.0%)	2,521 (95.3%)	5,317 (89.7%)
Jurisdiction income level					
High income	905 (83.0%)	1,676 (82.2%)	75 (85.2%)	2,045 (78.5%)	4,701 (80.7%)
Upper middle income	164 (15.0%)	323 (15.8%)	13 (14.8%)	455 (17.5%)	955 (16.4%)
Lower middle income	21 (1.9%)	39 (1.9%)	0 (0.0%)	82 (3.1%)	142 (2.4%)
Low income	0 (0.0%)	1 (0.0%)	0 (0.0%)	23 (0.9%)	24 (0.4%)
Patent Status					
Expired	92 (8.3%)	234 (11.3%)	0 (0.0%)	133 (5.0%)	459 (7.7%)
Filed/National Phase	340 (30.5%)	362 (17.5%)	46 (50.0%)	813 (30.7%)	1,561 (26.3%)
Filed (opposed)	290 (26.0%)	427 (20.6%)	1 (1.1%)	448 (16.9%)	1,166 (19.7%)
Granted (opposed)	1 (0.1%)	2 (0.1%)	0 (0.0%)	266 (10.1%)	269 (4.5%)
Rejected	22 (2.0%)	36 (1.7%)	1 (1.1%)	91 (3.4%)	152 (2.4%)
Restored	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.1%)	2 (0.0%)
Revoked	30 (2.7%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	30 (0.5%)
Term extended	0 (0.0%)	1 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.0%)
Term extensions filed	11 (1.0%)	4 (0.2%)	0 (0.0%)	0 (0.0%)	15 (0.3%)
Withdrawn	329 (29.5%)	1,006 (48.6%)	43 (45.7%)	891 (33.7%)	2,269 (38.3%)
Technology type					
Inactivated Virus	6 (0.5%)	0 (0.0%)	0 (0.0%)	1 (0.0%)	7 (0.1%)
Protein subunit	287 (25.7%)	0 (0.0%)	46 (48.9%)	577 (21.8%)	910 (15.4%)
RNA based	294 (26.4%)	1,220 (58.9%)	1 (1.1%)	1,733 (65.5%)	3,248 (54.8%)
Viral vector	528 (47.4%)	852 (41.1%)	47 (50.0%)	333 (12.6%)	1,760 (29.7%)

Exploratory Analysis

Figure 1. Patent applications associated with select Covid-19 vaccines, 1993 – 2023

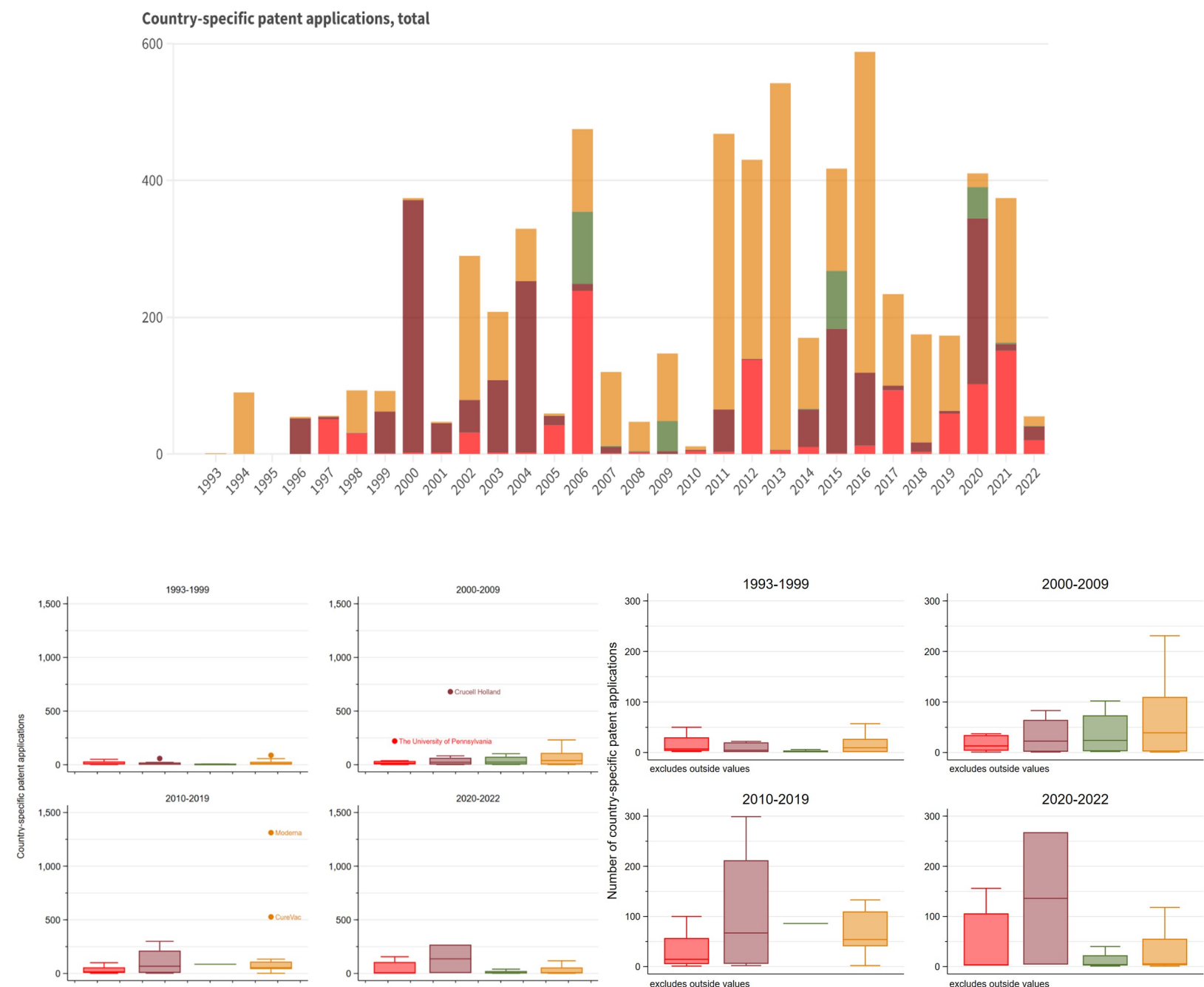


Table 4. Patent families and exclusivity periods

	Technology	Academic, Public & non-profit	Mature spin-off	Public-private co-inventors	Incumbent firms	Patent families, total	Remaining exclusivity years, mean	Remaining exclusivity years, max
Originators								
Bharat Biotech; Indian Council of Medical Research	Inactivated Virus	6	0	0	1	7	11.0	17.4
Sinopharm	Inactivated Virus	1	0	0	1	2	17.4	17.4
Sinovac	Inactivated Virus	1	0	0	1	2	17.4	17.4
Clover Biopharmaceuticals	Protein subunit	1	0	0	2	3	0.4	4.8
GlaxoSmithKline; Sanofi	Protein subunit	4	0	1	5	10	3.7	19.6
Novavax	Protein subunit	4	0	0	2	6	11.2	19.6
Biological E (patent free*)	Protein subunit	0	0	0	0	0	N/A	N/A
BioNTech; Pfizer	RNA based	11	15	0	1	27	11.5	19.8
CureVac	RNA based	0	19	0	4	23	10.8	17.6
Moderna	RNA based	3	3	1	19	26	11.7	19.6
AstraZeneca; Oxford University	Viral vector	2	0	0	0	2	13.0	16.6
CanSino Biologics	Viral vector	6	0	1	10	17	6.2	18.8
Gamaleya Research Institute	Viral vector	5	0	0	5	10	18.3	19.3
Janssen	Viral vector	4	23	2	2	31	1.8	19.2
N Total (%)		60 (30.0%)	70 (35.0%)	9 (4.5%)	61 (30.5%)	200 (100.0%)		

*A patent family is a group of linked patent filings describing the same invention.

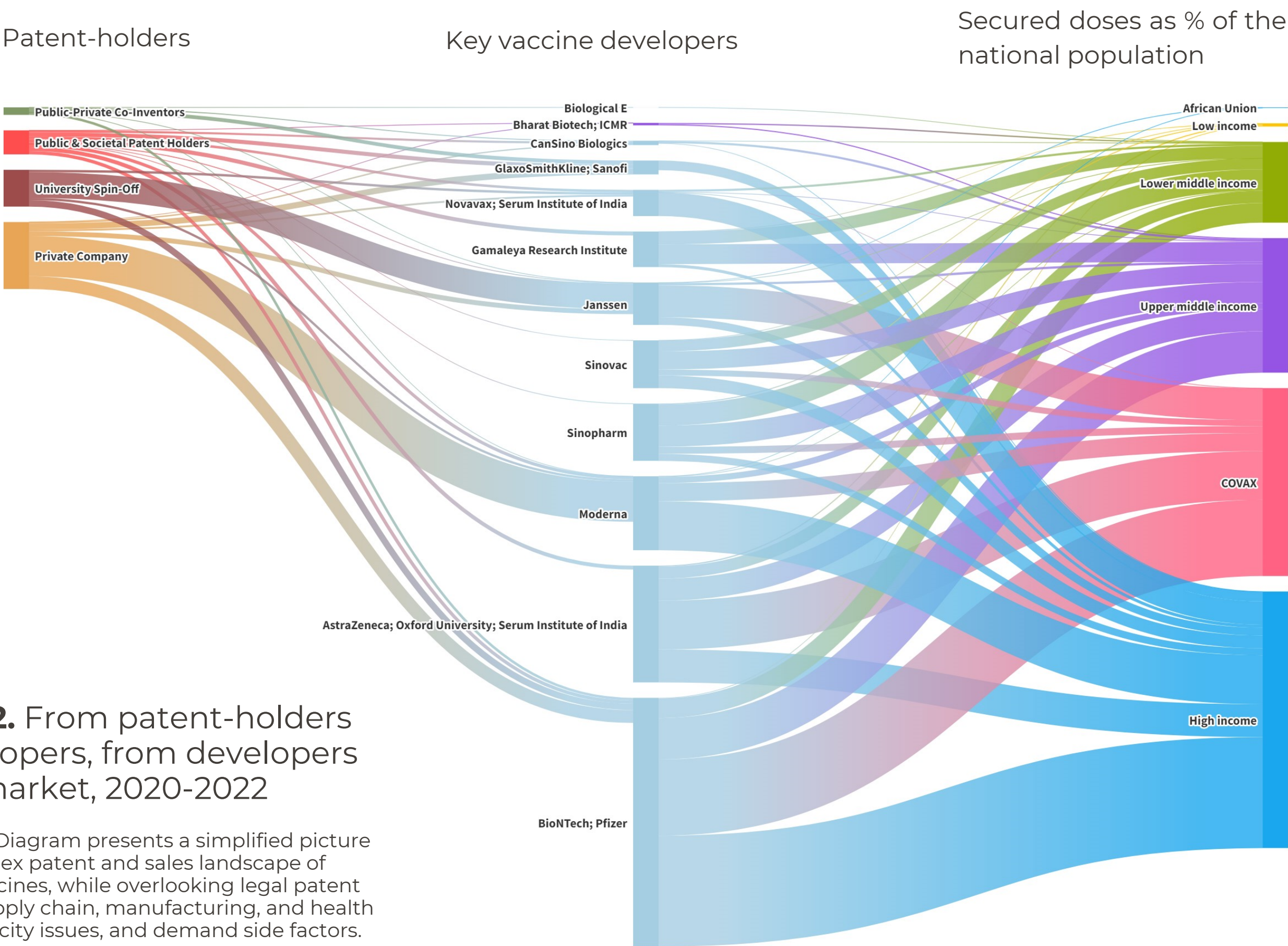
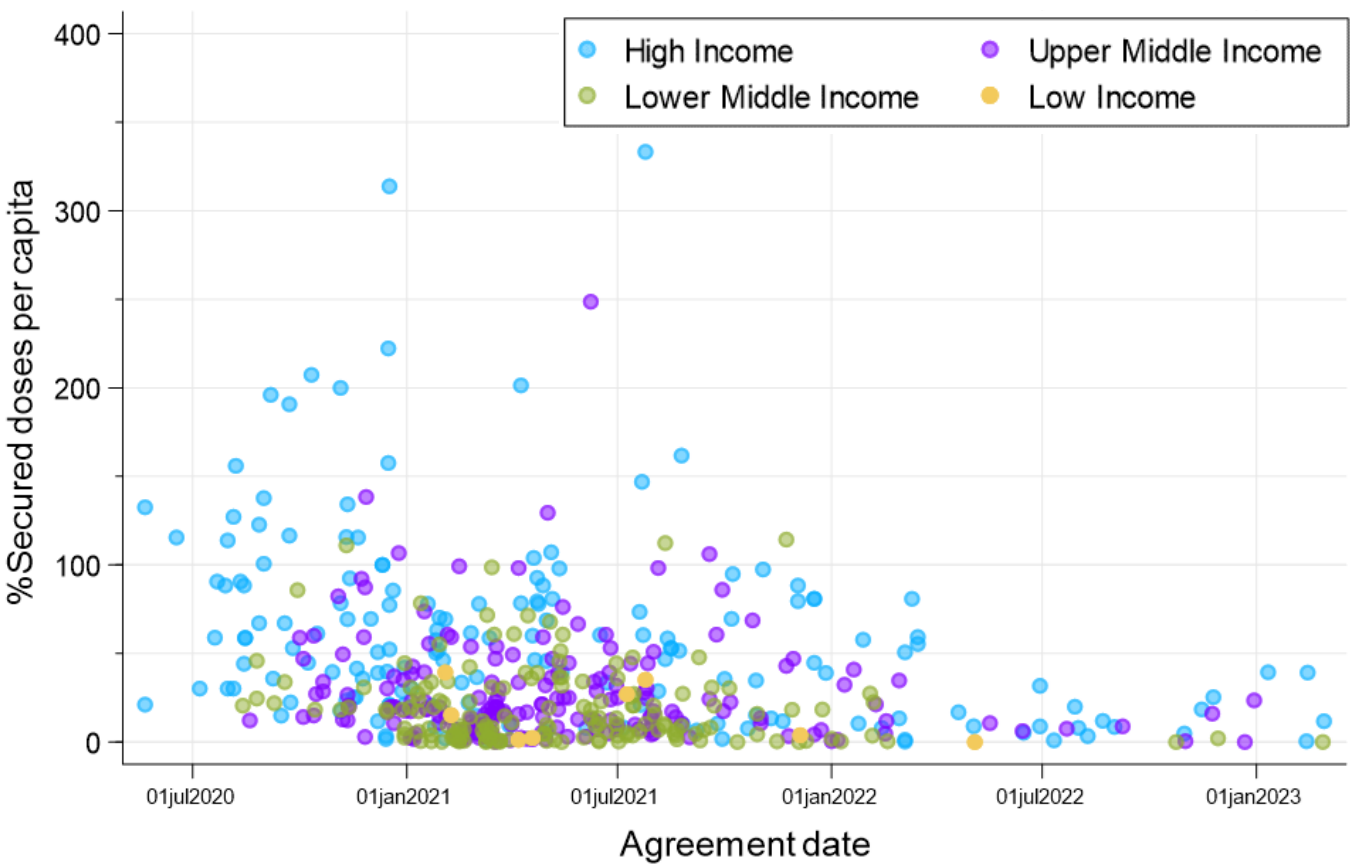


Figure 2. From patent-holders to developers, from developers to the market, 2020-2022

The Sankey Diagram presents a simplified picture of the complex patent and sales landscape of Covid-19 vaccines, while overlooking legal patent disputes, supply chain, manufacturing, and health system capacity issues, and demand side factors.

Figure 3. Distribution of secured vaccine doses per capita according to country income level, 2020 – 2023 (excl. COVAX deals)



Discussion & Next Steps

- **Preliminary, descriptive results** suggest that valorisation strategies vary widely across EU, UK, and North American public sector patent-holders. As confirmed by expert informants, some academic TTOs in Europe have monetised their inventions by **selling** rather than **licensing** out their patents. We find no evidence for wide adoption of non-exclusive licensing.
- As expected, most international patents were filed pre-pandemic by **private enterprises** (79.6%) on compounds and technologies relevant to next-generation vaccine platforms, 35% of those filed by **mature academic spin-offs** from European and Canadian universities. However, the share of vaccine technologies patented by **societal research institutes** is substantial (18.8% of country-specific patents, 27.8% of patent families); all authorised vaccines involve university inventions.
- **In future studies**, we aim to further explore the trade-offs between national and institutional biomedical technology transfer strategies and the associated broader societal benefits and costs. However, we believe that the Covid-19 vaccine dataset may be inadequate for more rigorous analyses. As shown above, this sample is relatively small, focuses on successful vaccine candidates, and is distorted by a few exceptional cases.
- **Pandemic vaccines:** The list of pathogens likely to cause the next outbreak is already known [7]. A comprehensive evidence base on knowledge sources and commercialisation paths of related biomedical technologies could inform public research organisation's technology transfer strategies as well as governmental investment in future vaccines and antivirals.

Acknowledgements

We are grateful to the experts who participated in this study and generously shared their insights with us, and would like to thank Prof Michel Goldman and Prof Bill Hausdorff for their support in contacting experts for the interviews. We thank the Theiopolam Foundation and the Belgian National Fund for Scientific Research (F.R.S-FNRS) for supporting this study (Aspirant doctoral research grant, FC 49905). Both funds had no role in the conduct of this research, and the co-authors reported no conflicts of interest.

References

1. Larian, H. S., Nagar, S., Sarpatwari, A., Barerie, R. E., Avorn, J., Rome, B. N., & Kesselheim, A. S. (2023). US public investment in the development of mRNA covid-19 vaccines: retrospective cohort study. *BMJ*, 380.
2. Keestra, S., Rodgers, F., Osborne, R., & Wimmer, S. (2022). University patenting and licensing practices in the United Kingdom during the first year of the COVID-19 pandemic. *Global Public Health*.
3. Gaviria, M., & Kilic, B. (2021). A network analysis of COVID-19 mRNA vaccine patents. *Nature Biotechnology*, 39(5).
4. Wang, L. X. (2022). Global drug diffusion and innovation with the medicines patent pool. *Journal of Health Economics*, 85.

3. Budish, E., Roin, B. N., & Williams, H. (2015). Do firms underinvest in long-term research? Evidence from cancer clinical trials. *American Economic Review* 105(7).
6. Gassler, F., & Wagner, S. (2022). Patents, Data Exclusivity, and the Development of New Drugs. *The Review of Economics and Statistics*, 104(3), 571-586.
7. Gold, E. R. (2022). What the COVID-19 pandemic revealed about intellectual property. *Nature Biotechnology*, 40(10), 1428-1430.