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Quantifying public and private investment in European biopharmaceutical research and development

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Abstract

Robust biopharmaceutical research and development (R&D) ecosystems require investment from both the public and private sectors. In Europe, there is an interest in growing biopharmaceutical R&D given its contribution to public health and the economy, which requires an understanding of current public and private investment. In addition, recent European draft legislation has focused on the public sector's contributions to biopharmaceutical R&D to inform pharmaceutical prices. However, there is little empirical evidence on the specifics of public and private funding for medicine R&D in Europe. This paper performs aggregative data collection to quantify 2019 investment in biopharmaceutical R&D by the public and private sectors in 6 countries: Belgium, France, Germany, Norway, Poland, and the United Kingdom. We find that, across these countries, the private sector accounts for just under two-thirds of investment. We contrast results to those obtained using high-level R&D indicators from the Organization for Economic Co-operation and Development (OECD) and contextualize differences. We then provide 2013–2019 estimates for Belgium, France, Germany, and the United Kingdom (countries with data to support such analysis), and show that total spending grew over those years, although proportions attributable to each sector remained stable. These findings should provide further evidence for debates on policies to effectively grow the biopharmaceutical R&D sector.

Lay Summary

In Europe, the pharmaceutical policy debate tends to focus on 2 themes: encouraging robust biopharmaceutical R&D and improving access to biopharmaceuticals that are on the market. There have been questions both on how to target public sector investments to encourage private sector participation in R&D and also on whether the prices paid for pharmaceuticals are justified given public sector contributions to biopharmaceutical R&D. For these debates, high-quality data on public and private investments are essential. However, there is little empirical evidence on R&D spending that can be attributed to each sector. In this paper, we collected granular public and private sector data on spending on medicine R&D in 6 European countries, finding that about two-thirds of investment in pharmaceutical innovation in these countries stems from the private sector. We contrast these findings to those from commonly used supranational indicators, contextualizing results. Overall, both private and public investments are complementary in their roles in medicine R&D, with both needed to spur robust innovation ecosystems.

Key words: R&D; pharmaceutical innovation; public sector; private sector; synergies; Europe.

Introduction

Biopharmaceutical research and development (R&D) has improved patient lives worldwide and is an engine of economic growth.[1,2] It is generally agreed that the "triple helix" of interactions between private industry, government, and academia is a cornerstone of biopharmaceutical innovation, leveraging each sector's capabilities to bring innovations to the public.[3] Thus, an array of public policies across countries seek to foster these collaborations and stimulate biopharmaceutical R&D via targeted public sector spending and the creation of an environment ripe for private sector investment. In Europe, regional and national governments have described the importance of supporting biopharmaceutical R&D due to its effects on public health, employment, trade, and science.[4,5]

Before reaching the public, a biopharmaceutical must progress through a lengthy R&D process. First, basic research yields scientific knowledge, such as the identification of disease targets. Preclinical or translational research applies that knowledge to a potential treatment for medical needs. Clinical research then involves trials to test whether these treatments are safe and effective.[6] Once complete, regulatory approval can be sought and a medicine can be marketed. Although the time from compound discovery to regulatory approval is, on average, 10 to 15 years, some observers argue that newer medicines can take 30 to 35 years to reach the market when measured from initial scientific inquiry into an area of research.[7,8]

The literature has shown that the private and public sectors are interwoven and complementary in their support of biopharmaceutical R&D.[9] Although investment in biopharmaceutical R&D stems from both sectors, public investment is typically in the earlier stages of R&D and the private sector is disproportionately involved in the later stages.[10] Economists generally agree that market failures in the production of general scientific knowledge can usually be addressed by public investment, and that public spending "crowds in"

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additional private sector investment. Thus, public investment is the foundation that leads to further subsequent private investment to build on that knowledge base.[10]

Given the complementary nature of public and private investments, understanding the landscape of each sector's investment is key to devising policies to encourage biopharmaceutical R&D and for governments to target public sector spending. However, outside of the United States, there is a paucity of evidence on specific levels of public and private funding of medicine R&D that stakeholders can point to in support of their positions. In Europe, pharmaceutical policy debates have been framed around supranational science and technology indicators on R&D spending, such as from EuroStat or the Organisation for Economic Co-operation and Development (OECD).[11,12] Although these indicators are rigorous and well established, they are often used to track R&D for industries broader than biopharmaceuticals, such as health R&D overall. There is a need for estimates that focus on biopharmaceutical R&D more specifically, as accurate data are paramount to inform public policy.

Outside of spending, the literature has leveraged other measures such as publications or patents to assess public and private contributions to biopharmaceutical R&D.[13,14] As with any measure, these are subject to limitations.[9] For instance, publications may overestimate public sector R&D, as academics tend to publish and the private sector may be less likely to, for instance to protect trade secrets. Data from patents of biopharmaceuticals may skew in favor of the private sector as firms typically seek to commercialize products. The literature using these measures has typically focused on investment in the United States, investment in specific stages of R&D, or investment on specific pharmaceutical products.

In addition, some studies have used proprietary databases on R&D spending or conducted survey research to estimate private and public investment in biopharmaceutical R&D. For instance, a 2022 study leveraged data from EvaluatePharma, a private database that tracks R&D, to study global biopharmaceutical R&D spending by sector in 2020.[15] The authors found that the private sector, including venture capital and biopharmaceutical firms, contributed 74% of spending and the public and nonprofit sectors the remaining 26%. A 2020 study by the UK Clinical Research Collaboration used surveys in combination with publicly available data to analyze the breakdown of health-related R&D spending in the United Kingdom, estimating that, in 2018, 50% of R&D spending was by businesses; 43% by the public sector, including universities; and 7% by the charity sector.[16]

Another strand of the literature has aggregated data on biopharmaceutical R&D investment via data collection, assembling estimates by collecting granular information from a variety of sources. Although these data inevitably have limitations, these aggregative stocks can provide a useful insight to the biopharmaceutical R&D investment landscape. For instance, a paper that conducted an extensive aggregative data-collection exercise found that, in 2012, 59% of US investment in biopharmaceutical R&D stemmed from the private sector.[17] However, when comparing overall figures with Europe, the study tabulated estimates from supranational sources and did not provide a breakdown of public and private investment in the region. A set of papers on the United Kingdom constructs aggregative estimates to examine public and private investments in biopharmaceutical R&D for different therapeutic areas.[18-21] One of these, Sussex et al,[18] whose data-collection methodology we follow and describe in detail below, estimated that, for the United Kingdom, about 58% of R&D funding for 9 disease areas from 2008–2012 came from the private sector, 28% from the public sector, and 14% from the charity sector.[18]

Generally, the literature based on proprietary databases, surveys and aggregative data collection finds that, across all stages of research and development and across a swath of therapeutic classes, the private sector accounts for between 50% and 75% of investment in biopharmaceutical R&D. To our knowledge, a study focused on estimating overall public and private spending for a selection of European countries has not been conducted. This paper adds to the literature by providing 2019 estimates of public and private sector contributions to biopharmaceutical R&D in 6 European countries and estimates for 2013–2019 for 4 of these for which comparable time-series data are available, estimated following an aggregation of publicly available sources on R&D investments. These estimates provide a more recent landscape of public and private investment in medicine R&D in Europe, adding to the evidence base for policymakers and other stakeholders.

Data and methods

This paper constructs new estimates of public and private investments in biopharmaceutical R&D across 6 European countries by following the comprehensive data-collection exercise of R&D spending by sector set out in Sussex et al[18] for each country in the study sample.

Sussex et al[18] estimated the extent to which government and philanthropic funding of medical research spurs follow-on private investment in biopharmaceutical R&D in the United Kingdom, using data from 1982 to 2012. Although their research question is beyond the scope of this paper, we follow their methodology to construct aggregative stocks of sectoral biopharmaceutical research expenditures across countries. For public sector investment in R&D, Sussex et al identified the primary government entities that invest in biomedical and health R&D in the United Kingdom. Then, they located historic data series from each and interpolated and scaled data where necessary, such as to adjust England figures to include Wales, Scotland, and Northern Ireland, or to assign investment to different disease areas using scaling parameters from bibliometric data. For private sector investment, the authors retrieved R&D figures reported by the Association of the British Pharmaceutical Industry, a trade group. Finally, for philanthropic investment, Sussex et al drew active research grant expenditures from the Wellcome Trust grant database and from the UK's Association of Medical Research Charities. A similar methodology, identifying and aggregating data series, has been applied to the United States to estimate R&D spending in 2012.[17]

Following this methodology, we set out to collect and estimate biopharmaceutical R&D figures by sector and country for 2019, the last pre-pandemic year of data available. We did not seek more recent data because the COVID-19 pandemic led to disruptions to the biopharmaceutical R&D ecosystem and we did not want to capture figures reflective of that shock.[22] For 4 of the 6 countries, we were able to collect comparable data from 2013 through 2019. Data were collected in the first quarter of 2022 and converted to 2019 Euros. The specific data-collection process for each of the sectors proceeded as discussed in the following.

For public sector investment in R&D, we researched and located direct funding by government entities, such as via

Ministries of Health or National Health Systems, public funding for R&D in higher education, and funding for state-owned research organizations. After obtaining these data, some figures required scaling because they reflected R&D spending beyond biopharmaceuticals. We then researched and applied appropriate scaling factors. To illustrate, for the United Kingdom, 1 source of data was from the Biotechnology and Biological Sciences Research Council (BBSRC). The BBSRC figures include R&D for medicines but also for food, agriculture, and energy. We found that, in 2016–2017, BBSRC spending on R&D in pharmaceuticals, immunology, neuroscience, stem cells, and biology accounted for 42% of total BBSRC R&D spending; this scaling factor was applied to the BBSRC data to obtain a spending estimate that related to biopharmaceuticals specifically. All data sources and scaling factors used are available in Table A1 in the supplementary material.

For private sector spending, The Pharmaceutical Industry in Figures annual reports by the European Federation of Pharmaceutical Industries and Associations (EFPIA) were used to obtain private sector R&D expenditures. We supplemented this source by searching for R&D expenditures by small biotechnology companies that would not typically be included in EFPIA figures, ensuring that we were not double-counting spending.

Although we replicated the Sussex et al[18] methodology for philanthropic biopharmaceutical R&D data in the United Kingdom, for the 5 remaining countries we were unable to locate comprehensive databases and were limited to internet searches only. As a result, we do not report philanthropic spending in analyses that compare the countries.

Once we collected and scaled the data, we obtained estimates of the levels and ratios of private and public spending on biopharmaceutical R&D in each country. We assessed these figures as a percentage of Gross Domestic Product (GDP) and compared results with those obtained using OECD indicators that have been used in policy discussions on R&D. These indicators are the Government Budget Allocations for Health R&D (GBARD) indicator for the public sector and Business Enterprise Expenditure on R&D (BERD) performed in the pharmaceutical industry for the private sector.[23] The GBARD Health and Pharmaceutical BERD indicators have specifically been used by European Parliament to quantify public and private contributions to pharmaceutical R&D, respectively.[11] This analysis illustrates the extent to which different data aggregation methodologies yield different estimates of public and private data.

Finally, using 2013–2019 data collected for 4 of the 6 countries for which data were available, we describe the total, public, and private contributions to biopharmaceutical R&D over that period.

Limitations

As with other measures of public and private R&D expenditure, we recognize that the data collected in this paper have limitations. Although all countries reported detailed statistics on government entity R&D expenditure in annual reports or databases, research was required to understand the funding sources within a country and to ensure there was no double counting. There were also countries for which EFPIA private sector estimates did not vary over time, such as Norway and France, suggesting imprecision in those figures. We note that private nonprofit funds are captured in private figures.

In addition, in some cases, the data reported were not specific to the biopharmaceutical industry, which required the identification of parameters to scale spending estimates appropriately. In analyses that track spending over time, Norway and Poland are not included due to the lack of comparable public sector data prior to 2017 and 2016, respectively, and the lack of private biopharmaceutical small and medium enterprise (SME) spending for Poland in the years prior to 2019. Inevitably, aggregative estimates hinge directly on identifying entities that spend on R&D, the availability of these data, and any scaling assumptions. We list all data sources and scaling factors in Tables A1 and A2 in the supplementary material for transparency.

Furthermore, although we have attributed R&D spending to biopharmaceuticals to the extent possible, our data collection does not include all basic research outside of traditional biopharmaceutical-related disciplines, although we recognize that innovations in biopharmaceuticals as well as other industries benefit from increases in knowledge across disciplines. Equally, basic research in biopharmaceutical-related disciplines may have applications in other industries. In addition, we do not report philanthropic or charity figures because we were unable to replicate the Sussex et al methodology for charity spending across all 6 countries. Nonetheless, we did obtain charity R&D expenditures for the United Kingdom following Sussex et al, which we contextualize in the Discussion section of the paper. These issues will introduce imprecision to the estimates reported in this paper. Finally, these data do not net out cross-sector royalties, licensing fees, or tax benefits.

Results

For each country, the data collected included different components of public and private investment, as described in the Data and methods section. By aggregating these estimates by sector, we estimated levels of 2019 private and public sector spending on biopharmaceutical R&D across 6 European countries, yielding estimates by sector and country as shown in Figure 1. The specific entities in each country for which data were collected are listed in Tables A1 and A2 in the supplementary material.

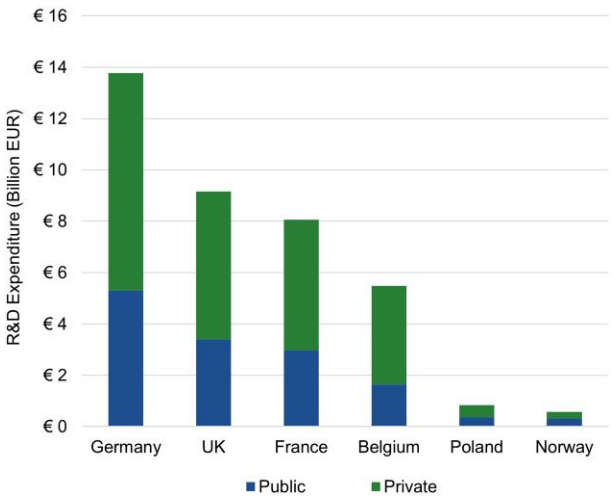

Figure 1. Estimates of biopharmaceutical R&D expenditure by sector and country, 2019. All figures in 2019 Euros (EUR) and rounded.

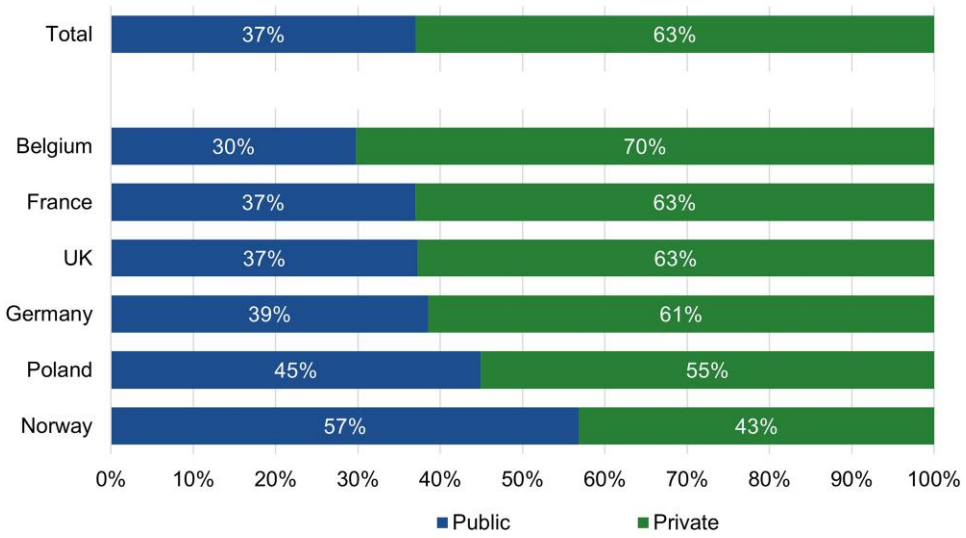

Figure 2. Percentages of public and private biopharmaceutical R&D expenditure, 2019. The total takes into account the levels of spending by each sector across the countries.

Figure 1 shows that total biopharmaceutical R&D spending across the public and private sectors in the 6 countries amounted to €37.8 billion. Of this total, €14.0 billion was attributable to the public sector and €23.8 to the private sector. Total levels of 2019 biopharmaceutical R&D spending across the 6 countries varied, ranging from €0.6 billion in Norway to €13.8 billion in Germany. Relating the total R&D spending in the 6 countries to 2019 GDP as reported by OECD, total spending on biopharmaceutical R&D ranged from 0.1% of GDP in Poland to 0.9% in Belgium (data not shown).

Focusing on estimates for private and public spending, 2019 private sector spending ranged from €0.2 billion in Norway to €8.5 billion in Germany. Total 2019 public sector spending ranged from €0.3 billion in Norway to €5.3 billion in Germany (Figure 1).

For each of the 6 countries, we obtained the percentage of spending on biopharmaceutical R&D that corresponded to the public and private sectors in each country, as shown in Figure 2. We also aggregated public and private amounts across the 6 countries and obtained public and private percentages from that total to provide a broader perspective.

Figure 2 shows that, at the country level, the private sector accounted for 43% to 70% of investment in biopharmaceutical R&D, with Norway and Belgium at the bottom and top of the range, respectively. The public sector accounted for 30% to 57%. Aggregating public and private spending amounts across the 6 countries, the proportions of public and private spending were 37% and 63%, respectively. These figures do not account for philanthropy sector investment as discussed in the Limitations section.

Since we were only able to estimate philanthropic funding for the United Kingdom following the Sussex et al[18] methodology, we conducted a separate analysis to estimate the United Kingdom's public, private, and philanthropic fraction of total spending on biopharmaceutical R&D. Including philanthropic data as an additional sector in 2019, the United Kingdom's public sector contributed 35%, the private sector 58%, and the philanthropic sector 7% (data not shown).

We contrasted the results shown in Figures 1 and 2 to those obtained with supranational indicators. Figure 3 shows 2 panels of levels and percentages of private and public sector biopharmaceutical R&D spending in each of the 6 countries. The data in the upper panel correspond to the aggregative estimates and the data in the lower panel correspond to the supranational estimates. Broadly, the supranational indicators suggest that 4 of the 6 countries have a higher proportion of public spending, whereas the estimates in this paper suggest that this is the case only in Norway. Using supranational indicators, the proportions of spending attributed to each sector across all 6 countries together yields a 47–53 public–private biopharmaceutical R&D investment split (data not shown), compared with the 37–63 public–private split with the aggregative data.

While some countries such as Germany have similar sectoral breakdowns across both the estimates constructed in this paper and those obtained from supranational sources, others are quite different. Differences in the percentage of private sector spending were largest in the United Kingdom, with a 48 percentage point difference across sources. In terms of levels, the aggregative data for Germany, the United Kingdom, France, and Belgium estimate both public and private spending for biopharmaceutical R&D to be larger than what is obtained with supranational indicators. The aggregative data for Poland and Norway estimate greater private spending on biopharmaceutical R&D but reduced public spending relative to the supranational indicators for those countries.

Finally, Figure 4 describes the aggregative expenditure of Germany, France, the United Kingdom, and Belgium on biopharmaceutical R&D over time, for 2013 through 2019. Our sources for these countries were updated every year and were comparable over that time period. For example, the French Ministry of Higher Education and Research publishes an annual report on R&D figures, through which we were able to build a time series of public spending.

Total spending as measured in 2019 Euros decreased slightly from 2013 to 2014 and 2015 to 2016, from €31.9 billion to €31.5 billion and €33.9 billion to €33.7 billion, respectively. From 2016 to 2019 there was a growth trend in total R&D spending, with the proportion of spending between sectors remaining remarkably stable. We note that comparable data available for 2020 for 1 of these 4 countries suggest that total R&D spending in real terms fell by 2.5% relative to 2019 (data not shown). This was likely driven by the COVID-19 pandemic.

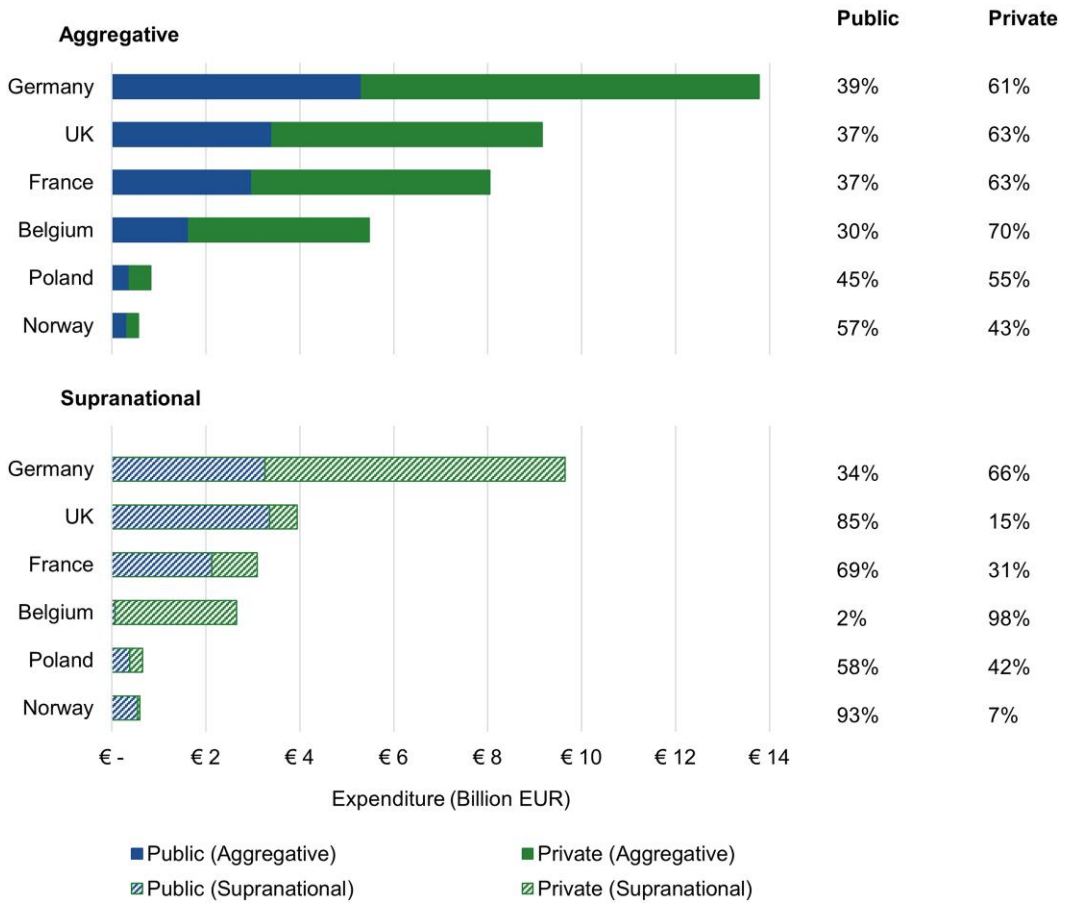

Figure 3. Comparison of estimates of biopharmaceutical R&D levels and percentages by country, 2019. Ordered by highest to lowest total aggregative spending. All figures in 2019 Euros (EUR) and rounded.

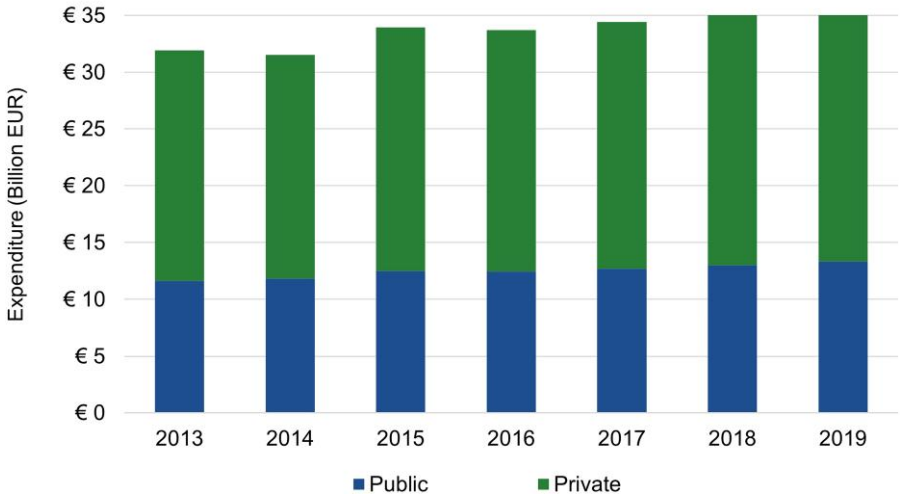

Figure 4. Expenditure on biopharmaceutical R&D by sector for Belgium, France, Germany, and the United Kingdom, 2013–2019. Time-series data for each country acquired from the same sources as 2019 data. All figures in 2019 Euros (EUR) and rounded.

Discussion

We estimated the percentage breakdown of 2019 public and private investment in biopharmaceutical R&D across 6 European countries. In aggregate, across the 6 countries, the private sector accounted for 63% and the public sector accounted for 37% of 2019 spending on biopharmaceutical R&D. Four of the 6 countries had comparable data available from 2013–2019 and we found that proportions of public and private spending remained stable during that period. Philanthropic spending was considerably more challenging to identify relative to public and private data. Since many philanthropic organizations obtain funding from both the public and

private sectors, those funds could be attributable to either sector.[24] Among the countries in this study, we believe the UK philanthropic percentage (7% in 2019; data not shown) is an upper bound for the percentage of a country's total biopharmaceutical R&D attributable to the philanthropic sector.

Our results stand in contrast to those obtained using supranational sources, although this is not surprising given differences in indicators, definitions, and data-collection methodologies. To illustrate, our aggregative method aimed to narrow expenditures to R&D for biopharmaceuticals only, whereas the Health-related GBARD indicator is broad, encompassing all of a government's health- and health care-related R&D budget beyond biopharmaceuticals. In addition, it is a budget-based measure that does not capture spending that may have occurred but for which there was no formal budget allocation, and it does not necessarily include university funding that is later allocated to pharmaceutical or health-related research.[25,26] Although the BERD indicator is related to biopharmaceuticals, we understand that industry classifications may lead firms that support biopharmaceutical R&D to be classified broadly, potentially underestimating biopharmaceutical BERD since certain non-pharmaceutical firms that support biopharmaceutical R&D may not be included. Effective policy hinges on the availability of accurate and timely data. In this context, the use of imprecise figures may lead to public sector underinvestment, or investment that is not targeted effectively. The new figures in this paper can further aid in the development or evaluation of public policy.

Using the aggregative data, we also found that spending on biopharmaceutical R&D ranged from 0.1% of GDP in Poland to 0.9% in Belgium. Poland's percentage of R&D over GDP across industries has had high growth, increasing from 0.7% in 2010 to 1.4%.[27] We expect biopharmaceuticals to become a larger share of Polish R&D, as Poland has been characterized as a new hotspot for biotechnology startups as the country transitions from the manufacture of generics and biosimilars to more innovative biopharmaceutical activity, in part due to relatively low costs of research, the educated labor pool, and government incentives such as non-dilutive cash grants to de-risk investments, and tax breaks.[28] We also note that Belgium has the highest biopharmaceutical R&D expenditure per capita in Europe.[29] This has been attributed to strong collaboration across the public and private sectors, strong industry clusters, a skilled workforce, and incentives for businesses to invest in R&D.[29] These cases are suggestive of how public policy can both foster an environment that encourages a nascent biopharmaceutical industry, as in Poland, and also strengthen and entrench a more established biopharmaceutical industry, as in Belgium.

Although we attribute the high percentage of private sector spending in Belgium to the policy environment and existing public sector spending there, we recognize that the presence of large, multinational biopharmaceutical firms is another driver of private sector investment. When large multinational biopharmaceutical corporations make localization decisions, a country's labor force, proximity to and strength of university programs, strong intellectual property regimes, and government incentives for innovation are considered.[30] However, while those factors are necessary, they are not sufficient to determine localization. Countries compete to attract private firms and private firms may also have strategic business considerations that drive their localization decisions. Although the literature shows that public investment crowds-in private investment and that public policy priorities are often set to attract private sector ventures,[9,11] disentangling the extent to which private sector investment in biopharmaceutical R&D is attributable to public sector spending is an open empirical question.

A recent policy debate on pharmaceutical innovation and access in Europe relates to calls for the transparency of R&D costs of biopharmaceuticals, which could then inform pricing decisions based on public sector contributions to each medicine.[31] In its 2020 Pharmaceutical Strategy, the European Commission (EC) stated that it would engage with Member States to implement nonlegislative measures to improve the transparency of R&D costs.[4] The EC's 2023 draft pharmaceutical legislation, amended in 2024, states that manufacturers must "declare to the public any direct financial support received from any public authority, publicly funded body or philanthropic or not-for-profit organisation or fund, irrespective of its geographic location….in relation to any activities for the research and development of the medicinal product…."[32] Although one may think that the estimates of public sector funding of biopharmaceutical R&D presented in this paper could be used in the context of R&D cost transparency, this would be infeasible for 3 reasons. First, basic science, often funded by the public sector, spurs countless innovations, past, present, and future, both biopharmaceutical and non-biopharmaceutical, making impossible the allocation of these investments to specific products. Second, the fixed costs and R&D costs of compounds that progressed through the R&D pipeline but did not make it to market would also need to be accounted for, but to our knowledge there is no agreed-upon methodology to do so. Finally, the investments required to develop a particular medicine occur across geographies and time periods, often decades, whereas our data span a limited number of countries and years.

Our view is that the data in this paper provide policymakers with a new picture of public and private sector investments, showing the extent to which both sectors are involved. This can help to anchor debates and policy positions on further investment. Overall, there is a need for higher quality data on public sector expenditures on biopharmaceutical R&D in Europe, given the limitations inherent in measures such as GBARD Health. The United States has made strides in this regard with its National Institutes of Health (NIH) RePORTER, an online database that allows the public to explore NIH-funded research projects over the past 25 years, including funded projects, funding institutions, funding amounts, and on outcomes of the funding in the form of publications, patents, and clinical studies.[33] A similar online repository that includes Europe would help to track actual public sector expenditures instead of budget allocations. World RePORTER, a platform that aims to aggregate RePORTER data with similar data from Europe, shows promise.

Conclusion

A robust biopharmaceutical industry tends to hinge on both public and private investment. The estimates of spending on biopharmaceutical R&D in Europe presented in this paper provide a new look at the involvement of both the public and private sectors. Our finding that all countries have sizeable private and public investments supports the hypothesis presented by the academic literature that public and private spending are not duplicative or substitutable in medicine development.[18,34] That said, further research is needed on the

extent to which public and private investments can create greater synergies and increased productivity in European biopharmaceutical R&D.

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Supplementary material

Supplementary material is available at *Health Affairs Scholar* online.

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Conflicts of interest

Please see ICMJE form(s) for author conflicts of interest. These have been provided as supplementary materials.

Notes

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