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From gut feelings to data assets: ethnographic explorations of the gut's metabolic political economies

Roberta Raffaetà [1]✉ & Luciano Ferrari [2]

The paper contributes to ongoing discussions about the sociopolitical implications of microbiome research reflecting on the "metabolic political economy" of the gut and cautioning against overlooking the complex tensions and ambiguities inherent in the commercialization of microbial science. It investigates the multiple processes underlying the gut's valuation practices in the context of interactions between academic research and a startup active in the field of wellness. We argue that over the last few decades, the (re)discovery of the gut and its microbiome as a symbiotic, ecological, sensing, and thinking organ has been appropriated and captured by a number of actors. Employing the working framework offered by the concept of "biovalue" and "assetization", we focus on the wellness and digital health industry, their collaboration with academic research, and the resulting fragmentation of the gut's valuation practices. Through the ethnographic exploration of a personalized nutrition startup based in the UK and its partnership with a research institution in Italy, we expose how gut microbiome knowledge production takes place at the intersection of multiple and complementary scientific, economic, and health-related values and expectations. Our study unveils a nuanced relationship between data, academic dynamics, and economic drivers, with data playing a determining role in the value acquisition of the gut, well beyond its progressive features. Critically, our analysis emphasizes the necessity to examine the sociopolitical implications and future health management scenarios resulting from the gut's role as an asset.

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Introduction

Across disciplines, the gut is not simply considered an organ where metabolic transactions take place. In the cognitive and life sciences, for instance, it has repeatedly been associated with neurological diseases (Liang, Wu, and Jin, 2018), mood disorders (Bioque et al., 2021), and mental wellbeing (Yong, 2016). These studies suggest the existence of a "second brain" in the gut, composed of the ecological community of microbes living within it: the gut microbiome. Although the correlation identified between the gut microbiome and cognitive functions says little at this point about the mechanisms of their relationship and causative path (Mayer, Nance, and Chen, 2022), this complexity does not mitigate the growing scientific and public interest in the field, nor the hopes fueled by the idea of cognition and mood being eco-systematically governed by our microbes: a real "probiotic turn" (Lorimer, 2020). Recent Netflix documentary "Hack Your Health: The Secrets of Your Gut" (2024), for instance, engaged with the gut's central role in maintaining overall health, praising its multifaceted nature by featuring a number of microbiome celebrities.

In the social sciences and humanities, Elizabeth Wilson (2015) was one of the first to challenge conventional understandings of the gut as a "lower" organ, pointing to its active role in shaping the mental state of individuals. Her work calls for a rediscovery of the gut as a site for a multi-dimensional understanding of health, encouraging a shift away from anthropocentric, reductionistic and deterministic perspectives.

We engage with Wilson's seminal work and its resonances with a posthuman and new materialism approaches by showing how this understanding of the gut is also becoming part of a metabolic political economy. Inspired by Hanna Landecker's (2013) reflections on biological metabolism as in dialogue with Marx's definition of labor as metabolic exchanges between humans and nature, our goal is to extend this framework to the domain of gut microbiome science and the wellness/health industry. In doing so, we follow the prompt of Barua and colleagues (Barua, White, and Nally, 2020) to rethink metabolism by reconciling its two genealogical strands: both as a biological process and as a political-economic phenomenon. In this article we illustrate ethnographically how the gut journeys across various sites and agendas, riding the wave generated by the 'microbiome revolution' within the framework afforded by the concept of "biovalue" (Waldby (2002)) and supported by the analytical tools offered by scholars analyzing bioeconomy through the concept of "asset" (Birch and Muniesa, 2020; Birch, 2017a).

In other words, our interest is to bring the philosophical posthuman and new materialism theories at test through the empirical lens offered by the microbiome, analyzed through the analytical tools offered by social sciences' debates on bioeconomy. We do so by ethnographically exploring how the gut 'travels' across three sites (the gut, a startup, a research institution), following how it becomes assetized in the promissory hype of microbiome research. Specifically, we ask: what does the gut become when embedded in (multiple, diverse) valuation practices? How do scientists and other relevant actors unlock the value(s) hidden within gut data assets? And what is the gut's role in these processes?

We agree with Wilson (2004, 69) and others that the gut is "psychological, cultural, geological, oceanic and meteorological". We add to the list "economic", by illustrating how the gut is constituted by political-economic dynamics that enroll it as a valuable agent in a neoliberal framework of health governance. This allows us to claim that scientists should not be blamed for their disinterest in the posthuman lesson. On the contrary: the gut has been incorporated very rapidly, enlisting it as a guiding principle for many projects. What remains unknown is the ethico-political horizon of these projects and who stands to benefit most from them.

We argue that analyzes of the gut cannot celebrate the entanglements of this more-than-human organ while remaining blind to its broader sociopolitical and economic implications. Driven by this objective, we explore its translations and operationalization in the contemporary technoscientific arena. By doing so, our goal is to bring some of the sociopolitical implications of the gut's metabolic political economy to the fore. We believe that failing to do so would result in a partial representation of reality, one which incorporates a posthuman celebration of the gut and its microbiome but inexorably detached from the world where this celebration takes place along with its ramifications. In line with others (Hendrickx, 2022; Gilbert, 2018; Lorimer, 2020), we urge caution in reading the (gut) microbiome and its entanglements as a panacea for human health in the Anthropocene. Other scholars have empirically analyzed the microbiome through its socio-economic implications (Widmer, 2021; van Wichelen, 2023; Pinel, 2021) or called for such analysis (Greenhough et al. 2020). In dialogue with them, we contribute to this work by illustrating how the rise of data-driven biology (Lee, 2017) and its application in microbiome research (Kotliar and Grosglik, 2023)—coupled with the gut's dynamic prospects within biomedicine—, has transformed the gut into a new frontier claimed by whoever can broker such knowledge in real time-space. We further this idea by identifying one specific place where the gut (and its microbiome) has already been appropriated by various actors for these purposes: the academia-industry nexus.

Theoretical Framework

From 'Gut Feminism' to personalized medicine. In Gut Feminism (2015), drawing from feminist theory and philosophy of science, Wilson argues that the gut is not merely a passive contributor to mental processes but, in fact, "*is* an organ of the mind, [which] ruminates, deliberates, comprehends" (5, original emphasis). She further claims that "mood is not added onto the gut secondarily, disrupting its proper functions; rather, temper, like digestion, is one of the events to which the enteric substrata is naturally (originally) inclined" (66). This perspective draws on the findings of psychiatrists and eating disorder scholars Fichter, Pirke (1990), who suggested a psychosomatic structure linking depression-like states with nutritional disorders in bulimia nervosa. Their work complements Wilson's argument, emphasizing the interconnectedness of mental and physical health.

Wilson's focus on the gut is the outcome of an intellectual effort to understand biology from a feminist standpoint. In a previous work (Wilson, 2004), she declared the end of the "ontological apartheid" (68) between biological and psychological functions, deriving her insights from Darwin and his—then silenced—emphasis on the materiality of emotions. This materiality is described as the result of an "ontological complication" with animals, humans, plants, and rocks. From this perspective, evolution is not simply biological but also "psychological, cultural, geological, oceanic and meteorological", thus affirming a "permeable, heterogeneously constituted biology" (69).

Wilson's work and the gut-brain axis exist in tension with the postgenomic turn in the life sciences, which suggests biology is not simply determined by our genes but, more precisely, by their encounter with environmental influences. Socio-anthropological studies have emphasized how, in this ecological and interactionist framework, physiological dynamics results from a web of connections and entanglements between body and environment (Landecker and Panofsky, 2013; Richardson and Stevens, 2015; Meloni et al., 2017; Niewöhner and Lock, 2018; Formosinho,

Bencard, and Whiteley, 2022): inside and outside (Landecker, Kelty (2019)), human and non-human (Haraway, 2008), life and non-life (Povinelli, 2016). These shifts in our understanding of human bodies (and beyond) have made a healthy contribution to the dislodgment of anthropocentric perspectives and deterministic logics of control, allowing for more ecological appreciations of biology and its interconnection with many other processes not considered within the *bios* as of yet.

In recent decades, the (re)discovery of the gut and its microbiome as a symbiotic, ecological, sensing, and thinking organ has been appropriated and captured by various actors. To study it, scientists analyze stool, which stands as a proxy—although partial, as the microbial composition within the gut varies across different sections of the digestive tract—for the gut microbiome. They do so to look for causal links between microbes and say, variations in the health state of individuals. This makes stool a crucially important material for professionals working in the microbiome field. Jeff Leach, a scientist hunting unexplored gut microbes in rural parts of Africa, was called Doctor Mavi (Swahili for "poop") by the Hazda, underlining his interest in their excrement, which may contain the secret to restoring the health of diseased Westerners. Leach and his colleagues considered the Hazda's stool and guts as walking biobanks, preserving the ancient microbial diversity that results from being one of the world's last remaining hunter-gatherer group (2013). Hunting the guts of "uncontacted [*sic*]" (Clemente et al., 2015) or otherwise named non-Western people is a common trope in microbiome research, an approach already on the radar of many scholars (Benezra, 2023; Maroney, 2017; Lorimer, 2020).

In this article, we focus on other actors with multiple interests in capitalizing on the gut at the nexus between academia and industry. The synergy between knowledge production and market interests—each moved by multiple and complementary scientific, economic, and health-based values and expectations—increases healthcare personalization in terms of both medical treatments and health governance. While this promises to be an emancipatory innovation, doubts remain among many observers (Prainsack, 2020; Fox, 2020; Reardon, 2019) about personalized medicine's sociopolitical and economic implications, especially in places where structural injustice is endemic (Green, Prainsack, and Sabatello, 2023). The entanglement of the gut with sociopolitical, economic, and scientific dynamics sketched above sets the stage for exploring how its biological matter transforms into sources of value(s), a process best understood through the lenses of biovalue and assetization.

Gut as asset. In this article we take biovalue as a main term to explore various economic dynamics. Biovalue, as explored by Catherine Waldby (2002), deals with the transformation of biological materials—such as tissues and stem cells—into marketable and economically valuable products and services, which end up shaping the landscape of contemporary biotechnology. With this term, Waldby brings attention to the generative and transformative productivity of living entities and how they can be instrumentalized in ways useful for human projects.

We choose "biovalue" as guiding concept instead of "biocapital" (Sunder Rajan, 2006) or else, because we agree with Helmreich (2008) that a capitalocentric perspective can limit the capacity to understand the generation of value from and through nature: capitalism has a metamorphic nature that makes its definition changing and uncertain and therefore needs situated analysis (see also Bear et al., 2015). We take 'value' instead of 'capital' as a useful lens from which multiple capitalistic dynamics and politics (biocapital, academic capitalism etc.) enfold as if through a prism. Biovalue, for us, is a more open term that allows to keep "economic, cultural, social, and symbolic species of capital" (Helmreich, 2008, p. 474) together and to emphasize the entanglement of knowledge, society and economy.

This approach owes back to Bourdieu (1975), who established a parallel between researchers and capitalists. Since then, scholars have often discussed the entrepreneurial and "quasi-firm" attitude/nature of contemporary science (Etzkowitz, 2003; Mirowski, 2011; Latour, Woolgar (2013)) and the introduction of the terms "academic capitalism" (Hackett, 2014; Slaughter, Larry (1997)) and "entrepreneurial universities" (Etzkowitz, 2004) further underscored the increasingly central involvement of university institutions and academic research centers in the market economy (see also Franssen et al., 2018; Červinková, 2009). This has produced hybrid research settings, partly entrepreneurial and partly research-based, whereby multiple—and at times conflicting—evaluative frameworks and goals are maintained and through which different forms of value production are assessed and negotiated (Stark, 2009).

A crucial intervention into this debate has been works in bioeconomy—especially on the concept of 'asset' - which permits to give support to the inspiring but very broad and somehow abstract framework given by 'biovalue' (Birch and Tyfield, 2013). 'Asset' is defined as a "unique resource vested with characteristics of specificity and unrepeatability, [which] can be owned or controlled, traded and capitalized to provide future earnings" (Birch and Muniesa, 2020, 2). The concept of asset conveys well our intention to bring attention to situated meanings and processes of value rather than relying on a given-for-granted understanding of 'capital'. Assets, indeed, are inherently different from commodities; the latter are standardized, tradable, material goods (e.g., gold), which become assets when *made so* through processes of assetization and valuing (e.g. gold jewelry owned by a deceased famous actress and sold at auction). Assetization processes can transform simple entities (e.g. gut stool) into marketable assets (e.g., microbiome data) (Langley, 2020; Birch, 2017b). Biological matter—stool, cells, tissues, etc.—accrues value through social practices of valuing. Birch (2017a, 3) has identified three main socio-economical practices of this kind: capitalization, assetization, and financialization.

Capitalization involves the construction of capital and value through social practices such as accounting, standard setting, and market regulations rather than the inherent properties of material entities. Muniesa (2014, 40) defines it as "the [discounted] amount a capitalist would be prepared to pay now to receive a higher future flow of money". Financialization emphasizes the role of financial markets and instruments over trade and commodity production in shaping economic activities. Assetization leverages notions of ownership and exclusivity to conceptualize value in relation to organizational entities (e.g. biotech firms) rather than commodity production (Birch, 2017a, 9). In other words, it is the process of generating value through the ongoing management of valuation practices. Our study shows that the gut participates in both assetization and commodification dynamics. Therefore, to mirror this imbrication, we use the term "gut" incorporating both its biological matter (stool) and its assetization (gut data, apps, etc.) and explore what is *made* of it through our specific case study.

Methodology

We investigate the gut's role at the crossroads between research and profit, fragmenting its univocal definition into a multiplicity of valuation practices. Considering the growing interest in the gut's potential and its various entanglements across disciplines, this paper ethnographically analyzes two actors: MicroLab and

Foodomics. Our goal is to unpack the intricate role of gut data assets and their valuation practices in the gut's bioeconomy. MicroLab and Foodomics are two pioneering and leading actors in the field. MicroLab is a public academic research lab based in Italy and dedicated to microbiomic research. Foodomics is a privately owned startup based in the UK and the US specializing in personalized nutrition based on microbiomic data. These two actors retain different yet complementary interests which, as we will see later in the text, stand at the basis of their successful cooperation.

Ethnographic fieldwork was carried out between October 2022 and June 2023. Due to the constraints of the COVID-19 pandemic, most interactions took place online, with only one in-person visit to one of the institutions. The research was grounded in a thematic analysis of accessible online resources (~50 between Foodomics' informative articles and podcasts directed to users), complemented by semi-structured interviews (~10), the length of which varied between 45 min and 2 h. Interviewees were selected from key figures in the two organizations: laboratory directors, researchers (both doctoral and post-doctoral), academics, and other professional figures. Efforts to engage with users and customers via social media were made but mostly yielded limited responses or outright refusals to participate.

Pandemic-related restrictions made it necessary to adapt traditional fieldwork methods to the situation. Digital ethnography was used to collect qualitative data, while interviews were conducted via videoconference. The interview questions explored the participants' roles, the nature of their work, and their views on the collaboration between academia and industry within the microbiome sector. Additionally, online materials produced by and relating to both organizations were gathered and analyzed to compound the research. These included academic publications, news and informative articles, press releases, social media activity, public interviews and talks, radio and tv shows, podcasts and website content, all of which offered valuable insights into the multiple valuation strategies for the gut utilized by the two organizations. Data analysis was carried out through thematic analysis and grounded theory in order to identify key patterns and themes. The process involved coding the available data, analyzing it for recurring themes, and developing theoretical frameworks to understand the case study's value production dynamics.

The research adhered to GDPR guidelines and followed standard procedures for managing personal data. Ethics approval was obtained from the relevant ethical board committee and the European Research Council. All participants provided informed consent; full confidentiality and anonymity was assured at all times. Finally, the manuscript was shared with research participants prior to submission to confirm their consent and gather feedback.

Making the gut valuable

What happens to the the gut when it is embedded in valuation practices? And what is its role in making these practices possible? To answer these questions, we investigated how the gut allows the intersection of academia and industry and analyzed the dynamics of this encounter, examining the multiple values embodied and facilitated by the gut during its capitalization process.

Situated at the nexus of biology and biomedicine, gut science is simultaneously linked to the translational research agenda, personalized medicine, and the commodification and financialization of health practices. There are several enterprises operating at this nexus that are capitalizing on the gut's biovalue. Recently, a Hong Kong microbiome research center specializing in translational research has used the slogan "Innovate with Gut", playing on the double meaning of innovation derived from the gut microbiome and the bravery embraced in the center in order to innovate within the field.

Fig. 1 Smart Toilet. Credits to Tam Mankei.

Danone has just launched a stool tracker app called "MyUniqueMoments"[1] to provide health advice to users who take photos of their stool. At the Microbiome Summit held in Hong Kong in January 2025, a shiny "Smart Toilet" had the center stage among the many technological innovations (Fig. 1). It represented a futuristic conceptual design, put together with "Noah's Ark" (a stool bank).

This is one of the many prototypes deriving from the pioneering work of US startup BiomeSense, founded in 2018 with over $3.4 m in funding and originated within the University of Chicago. With a team of renowned scholars, scientists, and external advisors, BiomeSense centers on GutLab, a "smart toilet" set to launch in 2024, which is capable of sequencing stool nearly in real time. Specifically, it combines "continuous microbiome measurements, cutting-edge analytics, and a proprietary database into a single transformative solution to provide continuous, at-home tracking and analysis of the microbiome" (BiomeSense 2024). Their mission is to:

> Unlock the next stage of [the] microbiome from a clinical research and scientific perspective by increasing data and getting time series maps with the hope that the average consumer could have access to this technology and build microbiome monitorization into their daily life, something that is not possible with today's lab-based solutions.
> Kevin Honaker, interview for GCV, 2023

BiomeSense's goal is to combine the potential profits from GutLab's sales with the advancement of scientific research; the startup's scientific team laments the lack of a reliable and curated microbiomic database due to its "huge potential to affect human health, development, and immunity, making it the new frontier of

precision medicine" (BiomeSense, 2024). They aim "to help solve this data crisis by creating a time series million plus dataset, and scale that up to five to ten million records over the next few years in a faster manner at a fraction of the cost" (Honaker). While the price to access GutLab's technology has not yet been mentioned, it is unlikely that the microbiome-analyzing smart-bathroom will be cheap. But how would the enormous amount of gut data recorded by GutLab's smart toilet be *made* valuable in practice? And by whom? To answer these questions, we now turn to the case of MicroLab and Foodomics and their (peculiar) working relationship.

From stool to data and from data to asset.

> […] Even the study of individual [microbial] species and strains is not very useful to draw meaningful conclusions. It is necessary to adopt a holistic view of the microbiome focusing on its ecosystemic nature rather than the individual characteristics of each species. […] And for that, *a lot* more data is required.
> Filippo, MicroLab (original emphasis)

Filippo is a postdoctoral researcher at MicroLab, an institution specializing in next-gen sequencing technologies; their primary focus is exploring the interactions between gut microbes, humans, and health. Our first interaction took place online, when Filippo introduced me[2] to MicroLab's work in the field of metagenomics – a form of "dry" biology that uses computational tools to study microbial communities living in the gut and explore their functional potential through analysis of stool samples. The resulting data provides valuable insights into the gut's central role in human health. Years ago, MicroLab partnered with Foodomics, a successful startup that uses MicroLab's advanced gut analyses to sell personalized nutritional advice through an app. Crucially, Foodomics's early success was amplified by the scientific and public recognition of one of its co-founders, Dr. Fischer. Today, the collaboration with MicroLab further strengthens the startup's position in the gut market.

In the field of metagenomics, MicroLab is a hub for innovation, converting various resources into valuable assets. Leveraging its team's collective knowledge and expertize, the lab translates scientific findings into publications and practical tools (e.g. software and pipelines) for gut research. By actively collaborating with external partners (e.g. Foodomics) and carefully managing its resources (e.g. gut data), MicroLab strengthens its position as a leading voice in gut health, while simultaneously enabling further research. Thus, MicroLab's activities transform and assign value to the gut's biological matter not only by turning it into a source of epistemic authority enhancing its reputation in the field, but also (potentially) into an asset valuable to Foodomics.

Following different dynamics, Foodomics navigates the intersection of profit-driven operations and scientific inquiry within the food and nutrition sector. Data derived from the guts of many people are by far the most important and valuable resource for both MicroLab and Foodomics. For MicroLab, the gut's raw microbiomic data are the prime resource for the lab's analyzes. For Foodomics, gut data constitute a competitive advantage over competitors, in the sense that having more data allows the startup to improve its services and explore new avenues in microbiome-based personalized nutrition. Both institutions seek to enforce their control and exclusivity over the gut data they own, transforming them into assets that can be managed to generate more value.

However, the two institutions are aiming for different results from the assetization of their own gut data. MicroLab is primarily interested in pursuing basic research on the gut microbiome's composition, functioning, and connections with health. Matteo, one of MicroLab's members working with Foodomics, explained:

> […] there is a general interest in the "cardio-metabolic health, diet, and microbiome" line of research within the lab; Foodomics supplies the lab with *lots* of data, but this doesn't mean that our research is directed towards augmenting the value of their service. […] We do our research, and if something that might interest them comes out, then we talk about it.
> Matteo, MicroLab (original emphasis)

The gut-as-data provides multiple values to MicroLab: reputation, prestige, and credibility. This facilitates the lab's engagement in further research endeavors, perhaps even beyond the gut's limits.

Foodomics, meanwhile, prioritizes profit as its primary goal. The transformation of gut-as-data into marketable assets is central to its strategies, which include direct-to-consumer (DTC) and gut microbiome tests. These tools enable Foodomics to deliver tailored dietary programs to its users based on their unique lifestyle and metabolism; the gut-as-data paradigm ultimately assures economic viability for the startup, while simultaneously advancing a scientific understanding well beyond it.

Social engagement practices are a pivotal component of value production for Foodomics. The gut, its nourishment, and methods for enhancing its health are the targets of outreach initiatives, suggestions, and communications, aiming to cultivate a sense of mystique and community around the gut. Open-access informative articles, free weekly newsletters with nutrition tips, and a podcast on food and science serve as accessible platforms for engaging with new and longstanding gut-enthusiasts and customers. Member-exclusive sessions with nutrition coaches and advertisements for ongoing research aim to foster a sense of belonging within the Foodomics ecosystem. These initiatives are designed to enhance users' satisfaction by educating them, growing their literacy about the gut and surrounding factors, and amplifying the company's scientific credibility and market appeal.

The gut community also extends to research partnerships: collaborations with external institutions such as MicroLab offer valuable insights and enrich Foodomics's datasets. This collaboration allows both scientific exploration of the gut and economic growth for the startup, which relies on potential advances in predicting gut health and diet through data. Microbiome science is still in its infancy; causal links between gut microbes and bodily responses (both in metabolism and disease control) have yet to be conclusively established. Instead, scientists mostly rely on strong probabilistic associations between the microbiome and gut health. This is why research institutions such as MicroLab are constantly "hungry" for data, as observed by Alberto (MicroLab):

> In the past four years [of partnership with Foodomics] we went from working with roughly 1,000 people's data to 25,000–30,000. On top of that we now have new tools that allow our analysis to be much more precise. […] In practice, this meant that we had to revise some of our initial findings to account for the new results. […] Microbiome science is still imprecise and evolving, and the amount of data one can work with makes a very big difference.
> Alberto, MicroLab

According to Matteo (MicroLab), industry-academia collaboration involves "mutually beneficial relationships that constitute an advantage for both parties: we get to analyze lots of data, which

we wouldn't be able to access otherwise […]; and they get to benefit from some of our results."

From this collaboration, MicroLab published an article showcasing their IT tools for analyzing gut data. These tools have broader applications beyond the gut, extending to various human and environmental analysis. Their dissemination in the marketplace of ideas (Mirowski, 2011) not only enhances MicroLab's reputation and opportunities for translational health outcomes, but also strengthens Foodomics' capability to predict gut health and its exposure. In this scenario, the quantity and quality of data at one's disposal play an even more crucial role as assets. In stark contrast to traditional biomedicine, microbiome science is less legitimated by fixed formulas or established dogmas; it is more driven by continuous experimentation, hope, and potential for future applications. Observed through this lens, microbiome data (and industry) epitomize the speculative nature of the asset (Cooper and Waldby, 2014; Birch and Tyfield, 2013): a long-term bet made by investors, the value of which depends on the asset's potential to yield future revenue.

Gut data, while precious, are not open to everyone: Foodomics carefully regulates which institutions are granted access, enhancing the data's exclusivity, uniqueness, and ultimately value as an asset. The evolving, unknown, and promissory nature of these data enables the ability to access, (re)analyze, and potentially subvert previous findings; it aligns with the unstable dynamics of markets. Therefore, the growing privatization of gut data stimulates inquiries into the wider issues of accessibility, monopolization, and personal autonomy in health decisions within the landscape of neoliberal technoscience.

Value(s) extraction at the academia-industry nexus. How do scientists unlock the value hidden within gut data assets? And what is the gut's role in this process? Through our investigation, we observed two strategies used by scientists to harness value(s) from the gut. The first is translating the lab's specialized knowledge and expertise on the gut into tangible products or commodities for trade and marketing (e.g. software, IT tools, apps, and DTC test kits). The second is assetization of the gut and its data to generate continuous flows of value.

Here, the quality, quantity, and operability of the gut data owned by an institution are key. By managing access to and monopolizing their data, institutions like Foodomics are able to transform the gut into a valuable asset (datasets) that can be rented out to external actors to generate continuous flows of value(s). The gut is not a mere spectator in this process; its inherent flexibility, adaptability, and promissory and dynamic nature make it an ideal candidate for the model (Geiger and Gross, 2021). The (gut) microbiome is valuable exactly for its possibility to be quite easily translated into other domains—notably biotechnology (Helmreich, 2003, 2007), generating "new kinships and biopolitics organized less around practices of "sex" than politics of "transfer" (Helmreich, 2003, p. 340).

However, our case study is set apart from others by Foodomics' unconventional approach to value extraction within the gut's bioeconomy. Rather than charging its research partners (as highlighted in other studies; see Pinel, 2021), Foodomics leverages its gut data assets to extract value from its customers through a monthly subscription fee. To achieve this, Foodomics' gut data assets undergo partial commodification through the company's personalized nutrition app, which operates via rentiership dynamics—or the generation of continuous revenue streams by granting users access to exclusive resources or services (Foodomics' proprietary personalized nutrition insights) through a subscription model rather than outright sale.

This integrated form of value production exists at the intersection of processes of assetization and commodification and rent-based extraction. While assetization and commodification are distinct processes—assets being exclusive, long-term sources of value and commodities being standardized, tradable goods – Foodomics' approach uniquely blends these practices. The gut data, as an asset, retains exclusivity and potential for future value creation, while its partial commodification e.g. through the app or DTC test kits allows for immediate monetization in the form of personalized services and subscription fees. This process is facilitated by the academia-industry nexus, a space where the gut is continuously appropriated and capitalized upon due to the collaborative yet non-competitive nature of the involved actors. By actively managing exclusivity over gut data while partially commodifying it through consumer-facing products, Foodomics' approach reflects Birch and Muniesa, 2020 argument that assetization processes thrive within technoscientific capitalism by balancing scarcity and accessibility to sustain value creation. This enhances the app's ability to attract new customers, further boosting the value of Foodomics' gut data. Crucially, the monetary value generated by Foodomics through this model is largely reinvested in further research through collaborations with actors such as MicroLab.

Filippo (MicroLab) reported that "our [MicroLab's] research is primarily data-driven. If we [MicroLab's researchers] happen to identify interesting signals from the data we analyze, we delve deeper. […] This also applies to Foodomics's data: we are independent in our research, and if something we find ends up being beneficial to Foodomics, then that is a by-product of our research, not its main goal." From this perspective, the gut is not merely a subject of study, but also a rich and largely unexplored data reservoir fostering MicroLab's research. The alien, mysterious, and promissory nature of the gut provides a vast landscape for scientists to explore, transcending traditional market demands and contributing to foundational scientific understanding. This approach shows the gut's role in enabling institutions such as MicroLab to prioritize and defend their right to basic science, while also allowing incidental discoveries with commercial implications.

This stance may seem counterproductive in a research setting so closely tied to the bioeconomical sector, but it provides the foundation for the symbiotic relationship between MicroLab and Foodomics. Both entities leverage their gut data assets to create value in different markets: one centered on academic recognition, the other on commercial products. This collaboration exists at what we term the academia-industry nexus, a point in space-time where gut data are appropriated and managed by relevant actors to cultivate mutual interests without significantly compromising individual goals. Due to the gut's multifaceted nature and its adaptability to diverse evaluation practices across multiple scenarios, both MicroLab and Foodomics can leverage their respective resources, assets, reputation, visibility, and—most importantly—results to generate epistemic, monetary, and reputational value.

Conclusion

On the bedrock of more speculative understandings of the gut, in our case study the gut has multiple co-existing values and implications that are merged, negotiated, and simultaneously enacted. This creates various forms of capital that can be further translated and combined. We have shown how the gut acquires value through different "registers of valuing" (Heuts and Mol, 2013) and "grammars of worth" (Morrison, 2018) performed and enacted by diverse social actors. The gut as an economic agent may intersect with many things. This is typical of transactions in academic capitalism, where biological matter can generate, assign, and accumulate various forms of value beyond the monetary (Fochler, 2016, 928).

In this dynamic, it is essential to recognize the role played by private individuals. The gut data marketization analyzed in our

study necessarily relies on (privileged) paying customers who willingly invest time, money, and personal data into gut research, inevitably reinforcing what Jenny Reardon (2019) terms the "postgenomic condition". This is the period following the sequencing of the human genome, marked by mounting genomic, health, and biosocial inequalities, when the divide between the Global North and Global South is destined to expand indefinitely. The marketization of the gut raises various issues: the question of who will be able to access this technology; the increasing normalization of the expert-patient figure; DIY approaches to individual health; the widening gap between those who can and cannot afford this "new frontier of precision medicine"; and the forms of individual and collective health governance that we promote and support through these exclusion dynamics.

Our study shows that the gut is not simply a place of entanglement and symbiosis with an other-than-human and post-anthropocentric dwelling. We have demonstrated how this narrative takes different paths, each with its own negotiations, potentialities, risks, and consequences that we have termed "metabolic political economy" to balance posthuman, new materialism accounts of the gut through the theoretical tools afforded by debates on biovalue and assetization. In so doing, the article has partly contributed to debates in bioeconomy too, by bringing attention to the nexus of scientific inquiry and market-driven innovation. Echoing Hendrickx's (2022) provocative piece on the importance of embracing weirdness in (anthropocentric) scientific research, we—together with others—caution against rhetoric that overlooks the ambiguities and tensions of the microbial condition (Paxson, Helmreich (2014); Benezra, 2023; Kotliar and Grosglik, 2023; Wolf-Meyer, 2024; Parke, 2021). This issue becomes apparent once we understand how the microbial gut participates in the currently-ongoing processes of appropriation and marketization. We have shown that the gut is not simply a place where physiological metabolic exchanges take place, but also a site that triggers the economic dynamics of value generation. Our study highlights how the gut's metabolic political economy includes sociopolitical, economic, and scientific dynamics, positioning it as a site where assetization and commodification processes coalesce, driving both market innovation and epistemic production. We therefore advocate for embracing the gut's inherent complexity while remaining aware of the real-time scenarios and practical implications arising from the fragmentation of its multiple evaluation practices.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Notes

1 https://apps.apple.com/hk/app/myuniquemoments/id1480197334?l=en-GB.

2 The use of the first person refers to the author who conducted the ethnography.

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Author contributions

Roberta Raffaetà wrote the first two sections and the conclusion, shaping the overall conceptualization. Luciano Ferrari conducted the ethnography and wrote the remaining sections of the body, framing the analysis within the political-economy literature.

Competing interests

The authors declare no competing interests.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This article is part of a project that has received funding from the European Union's Horizon 2020 Research and Innovation Programme (GA n. 949742 ERC–HealthXCross). Ethics approval was granted by the relevant Research Ethics Committee and by the European Research Council (EMN-949742-001).

Informed consent

Informed consent was obtained from all participants in this study and/or their legal guardians.

Additional information

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