

An innovative measure for digital firms' internationalization*

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Abstract

In this research note, we propose a novel and innovative measure for the internationalization of digital firms. Our measure overcomes some of the weaknesses that inhibit traditional measures of internationalization in their application to digital firms. The measure uses Google Trends data and captures the volume and distribution of a digital firm's recognition in the digital universe. In addition to developing the measure, we conduct empirical tests to apply our internationalization measure to traditional and digital firms and compare our results to data from UNCTAD's Transnationality Index. Our empirical comparison offers insights into the internationalization of digital firms. We discuss these insights and offer an impetus to developing a theory of digital internationalization.

Keywords: degree of internationalization, digital companies, firm internationalization, Google Trends, measuring internationalization, volume of internationalization

JEL classification codes: C43, E22, F2, F6, F23, L86, M16

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1. Introduction

Digital business models have a long and turbulent history. Originating in the early eighties, they showed euphoric international growth that ended abruptly in the burst of the dot-com bubble. As the financial crisis hit the global economy in 2008, investment and policymaking focused elsewhere. At the same time, successful digital companies turned into digital multinational enterprises (DMNEs) with a global customer footprint and immense political outreach.

While academic research has remained mostly ignorant of the phenomenon, some of the socioeconomic issues surrounding DMNEs, such as political influence (e.g. Cambridge Analytica, Twitter), regulatory oversight (e.g. Binance, Wirecard), tax compliance (e.g. Google, Facebook) and data privacy (e.g. Facebook), have sparked global controversy.

In 2017 UNCTAD first analysed and provided a ranking of the top 100 digital companies, in the *World Investment Report 2017* (UNCTAD, 2017), which investigated the effect of digital MNEs on global investment patterns. The novel analysis in UNCTAD (2017) explained the diverse international footprint of digital companies and developed the foreign direct investment (FDI) lightness index, which captures the light investment footprint of digital MNEs and the impact of digitalization on all industries. Not needing a physical presence in foreign markets to reach consumers, these companies have a very light foreign-asset presence. Digital companies are a very dynamic group that, on the basis of firm-specific advantages in intangible and digital assets, as well as network effects, are able to reach scale in a short time and expand abroad seamlessly. These new asset-light business models are disrupting modes of operation and cross-border processes, affecting the development strategies of host economies in important policy areas such as taxation and employment creation (Trentini et al., 2021).

Subsequently, the academic community recognized DMNEs as a special case of an MNE with unique characteristics, business models, internationalization processes and development implications for host economies.

Digital companies rarely need to physically invest overseas to reach new markets, and their assets are commonly concentrated in a single strategic location. In addition, DMNEs often do not generate sales from customers (i.e. users) but from advertisers, making it difficult to allocate their revenues to a specific geographic location. For these reasons, traditional measures of internationalization may not fully capture the degree of internationalization (and importance) of DMNEs.

The ability of digital companies to break the relation between revenues gained abroad and physical presence in the host economy facilitates their ability to minimize tax payments and deprives many host economies of important fiscal revenues.

In addition, the reliance of DMNEs on intellectual property has made it easier to shift profits to low-tax jurisdictions, further reducing their effective tax rates (called Base Erosion and Profit Shifting – BEPS) (UNCTAD, 2022).

The OECD-led international “Agreement on a Two-Pillar Solution to Address the Tax Challenges Arising from the Digitalisation of the Economy” aims at restoring the nexus between where value added activities take place and where profits are taxed. Pillar One specifically targets the largest DMNEs, which are “the winners of globalization” and restores taxing rights to the “market” countries where DMNEs sell goods and services.

Last year, UNCTAD updated the work first published in UNCTAD (2017) and provided new insights into the landscape of the world's top digital MNEs (Trentini et al., 2022). The update showed that some digital MNEs reached massive scale in only a few years. Also, of the many new digital companies established since 2018, only a small fraction was included in the new ranking because operational data were missing. Among those included, born digitals and businesses facing consumers (B2C firms) – the main objectives of BEPS Pillar One measures – were shown to be among the “asset-lighter” groups of companies.

In this research note, we propose an alternative measure of internationalization that focuses on the market relevance of companies using Google search data. We argue that such a measure is particularly suitable to study DMNEs complementing traditional transnationality indexes – including the FDI lightness index – with valuable information on rapidly emerging DMNEs, based on granular geographical data, that captures the market – i.e. user – outreach of DMNEs' operations. These new measures could be a useful tool to gain new insights into the evolution and international outreach of DMNEs but also a helpful instrument to guide policymakers in assessing the scope of BEPS Pillar One. Finally, we discuss the implications and outline use cases of our proposed Google Trends DOI measure.

2. Theories and measures of traditional internationalization

2.1 Theories of internationalization

International business research has produced a rich array of theories explaining the internationalization behaviour of firms. Internalization theory (Rugman, 1980) and the eclectic paradigm (Dunning, 1980) describe firms' decisions to internationalize in a specific market (through a specific entry mode). Other theories focus more on the firm's internationalization process across markets and modes. Most traditionally, the learning model of internationalization (Johanson and Vahlne, 1977) predicts that firms will venture into countries that are institutionally, physically and psychically close to them, gradually committing more resources as they learn and then venturing farther into more distant (different) markets.

In the 1990s, the rapid internationalization of some MNEs, especially DMNEs, put this paradigm in question and initiated the internationalization theory of new ventures that was later popularized under the term “born globals” (Oviatt and McDougall, 1994). The theory of born globals explains why some companies do not follow slow, incremental internationalization. However, the literature on born globals suffers from empirical challenges. Commonly defined as companies that have reached a share of foreign sales of at least 25 per cent within a time frame of two to three years after their establishment – often before their public listing – the internationalization process of born digitals is difficult or impossible to measure. This is because accounting data for sales and assets are generally unavailable before the firms’ listing. Moreover, these private firms often do not report detailed data for geographic segments, which impairs the application of traditional measures for degree of internationalization.

Most recently, some researchers have refined the concept of born globals and initiated theorizing on so-called born digitals (Monaghan et al., 2020; Ojala and Pasi, 2006). These are DMNEs that exhibit rapid international growth based on digital business models. Direct stakeholder engagement, automation, network effects, flexibility and scalability generally characterize these digital business models. Using strategies described as “hyperspecialization” and “hyperscaling” (Giustiziero et al., 2023), DMNEs can offer their goods and services without “boots on the ground”. As a result, they can enter markets through limited FDI, even when, in traditional theories of internationalization, large cultural and geographic distances would preclude market entry. In contrast, DMNEs often show a positive relationship between cultural and geographic distances and the choice of FDI as a market entry mode (Stallkamp et al., 2023). At the same time, DMNEs are highly sensitive to tax and legal institutions and choose their country of incorporation strategically rather than historically (Casella and Formenti, 2018; Meyer et al., 2023; UNCTAD, 2017).

Born digitals and DMNEs defy traditional internationalization. On the one hand, they internationalize quickly and break the traditional (negative) relation between distance and market entry. On the other hand, they are thin on assets, thick on user recognition and opaque regarding their cash flows and sales. We argue that these characteristics of DMNEs make it difficult to apply traditional measures of firm internationalization to DMNEs.

2.2 Measures of internationalization

Accompanying these traditional theoretical frameworks, international business scholars have developed various measures to capture firms’ degree of internationalization. Traditional approaches to measuring firm internationalization can be categorized into three groups (Marshall et al., 2020; Sullivan, 1994): performance-related measures, structural measures and attitudinal measures.

Performance-related measures focus on costs and revenues and include the ratio between foreign sales and total sales (FSTS) or foreign profits as a percentage of total profit (FPTP). Structural measures are based on the locational placement of firms' resources or assets. They include the ratio of foreign assets to total assets (FATA), foreign employees over total employees (FETE) or overseas subsidiaries as a percentage of total subsidiaries (OSTS), and psychic dispersion of international operations (PDIO). Attitudinal measures of internationalization are rare and focus on, for example, top managers' international education or experience.

Most comprehensively, there are approaches to creating compound measures of these three groups. The most recognized and frequently applied compound measure is the Transnationality Index (TNI), published by the United Nations Conference on Trade and Development (UNCTAD). The measure combines structural attributes (FATA, FETE) with a performance-related measure (FSTS). The TNI has the advantage of relying on mostly available information of comparable quality across countries and companies – especially for publicly listed ones – and of combining all operative areas of a company. Public companies are obliged to report in the notes of their financial accounts the business and geographic segmentation of their operations and assets. The only variable that is less often reported – despite growing pressure to improve on environment, social and governance (ESG) reporting – is foreign employment (Trentini, 2021).

A major drawback of the TNI and in general of indexes distinguishing foreign versus domestic measures is the home-market bias. Companies from small home economies are more likely to have high internationalization rates, as they are forced to penetrate foreign markets to reach significant scale. As UNCTAD notes, the TNI “does not take into account the size of the home country, nor does it distinguish between companies whose activities are concentrated in a few foreign countries and companies whose activities are spread across numerous host countries” (UNCTAD, 2007, p. 13). As a consequence, a high TNI value can reflect a home country's locational advantages (a small market, for example) rather than indicate strong international competitiveness on the part of the home-country firms (Trentini, 2021).

One solution to the home-country bias is the use of the Geographic Spread Index, which is the square root of the share of foreign affiliates times the number of host economies. UNCTAD computes and ranks financial companies by this index because the nature of financial companies' assets – highly liquid and thus easily transferred across borders – differs from that of non-financial MNEs, making the interpretation of the foreign assets index less meaningful. This relates to the issue of the appropriateness of the foreign asset index for digital companies, which typically report only a very limited amount of fixed tangible assets, and could provide a valid alternative for measuring their internationalization (Trentini, 2021).

Most recently, Marshall et al. (2020) proposed the RIMS (ratio of international market shares) measure as an alternative compound measure of firm internationalization. The RIMS measure captures the “average depth of penetration across the breadth of all the markets for the rest of the world excluding the firm’s primary market and then compares this to the depth of penetration within the firm’s primary market” (Marshall et al., 2020, p. 1136).

Contrary to the other measures of internationalization, RIMS is not based on a simple foreign-to-domestic distinction but a distributional measure of internationalization. Distributional measures are based on the idea that the internationalization of a company is not determined by its home market or its operations outside of this home market. Rather, in an international company, its home-country operations should not be distinguishable from its operations in all other markets (Fisch, 2012). Distributional measures commonly use some form of Herfindahl Index (HHI) to measure how evenly a company’s operations are distributed across all countries (not just home versus domestic). A fully internationalized company ($HHI = 1$) would have equal and evenly distributed operations in every country. The origin of the company and a distinction between foreign and domestic is not applied. Although scholarship considers distributional measures superior, their availability is limited because they require detailed data for a company’s operations in every country – data not available for the majority of MNEs. Table 1 summarizes traditional approaches to measuring the degree of internationalization for MNEs.

Despite their wide application, traditional measures have several limitations (Marshall et al., 2020). Owing to the unique characteristics (i.e. rapid scaling and opaque structure) of DMNEs, these limitations, we argue, are even more salient when applied to firms that use digital business models.

First, many measures are country-centric, distinguishing only between domestic and foreign operations. Applied to traditional MNEs, the measures do not capture the number of countries or in which countries the firm operates or how diverse this set of countries is. In addition, the measures are very sensitive to home-country size. Applied to DMNEs, this country-centric perspective is even more problematic since digital ventures are highly mobile and incorporate strategically in locations of favourable taxation or regulation. As a result, the domestic market is often not their primary market of operations – which upends the fundamental logic of many traditional measures of degree of internationalization.

Second, traditional internationalization measures focus on the placement of MNEs’ resources or the sources of their performance. DMNEs can serve their market from any location and do not require location-based assets in all the markets they serve (Stallkamp et al., 2023). Consequently, applying structural measures of internationalization to DMNEs leads to biased results. Similarly, DMNEs’ cash flows are more difficult to place in specific countries. During their growth phase, many

DMNEs do not generate positive cash flows. If they do, they are not earmarked for a particular location. Whereas it is easy for MNEs operating in the physical world to identify their buyers and their locations, in the digital world business models are less transparent. More importantly, the source of a DMNE's sales may not reflect its market-side internationalization. Take, for example, the case of Facebook.

Table 1. Weaknesses of measures of internationalization

Measure	Weaknesses
Foreign sales to total sales (FSTS)	<ul style="list-style-type: none"> Based on crude domestic-to-foreign dichotomy (home-country bias, ignorance of distribution of sales across foreign markets) Sales are potentially biased because of tax optimization (attribution of sales to parent versus subsidiary)
Foreign assets to total assets (FATA)	<ul style="list-style-type: none"> Based on crude domestic-to-foreign dichotomy (home-country bias, ignorance of distribution of assets across foreign markets) Assets are potentially biased because of tax optimization (e.g. intellectual property and patent allocation)
Foreign profits to total profits (FPTP)	<ul style="list-style-type: none"> Based on crude domestic-to-foreign dichotomy (home-country bias, ignorance of distribution of profits across foreign markets) Profits are potentially biased because of tax optimization (e.g. transfer pricing)
Foreign employees to total employees (FETE)	<ul style="list-style-type: none"> Based on crude domestic-to-foreign dichotomy (home-country bias, ignorance of distribution of employees across foreign markets)
Overseas subsidiaries of total subsidiaries (OSTS)	<ul style="list-style-type: none"> Based on crude domestic-to-foreign dichotomy (home-country bias, ignorance of distribution of sales across foreign markets) Equal weighting of target markets
Number of countries with operations	<ul style="list-style-type: none"> Equal weighting of target markets Ignores size of country operations Assumes equal relevance of markets
Psychic dispersion of international operations (PDIO)	<ul style="list-style-type: none"> Equal weighting of target markets Ignores size of country operations in its unweighted form Assumes symmetric distances Relevance of psychic distance dimensions may vary
Transnationality Index (TNI)	<ul style="list-style-type: none"> Compound measure including FSTS, FATA and FETE Based on crude domestic-to-foreign dichotomy (home-country bias, ignorance of distribution of sales across foreign markets) Balances individual weaknesses of compounds through aggregation
Diversification	<ul style="list-style-type: none"> Distribution-based measure (Herfindahl-based) Requires country or at least regional revenue data
Ratio of international market shares (RIMS)	<ul style="list-style-type: none"> Distribution-based measure (Herfindahl-based) Requires country or at least regional revenue data

Source: Authors' compilation.

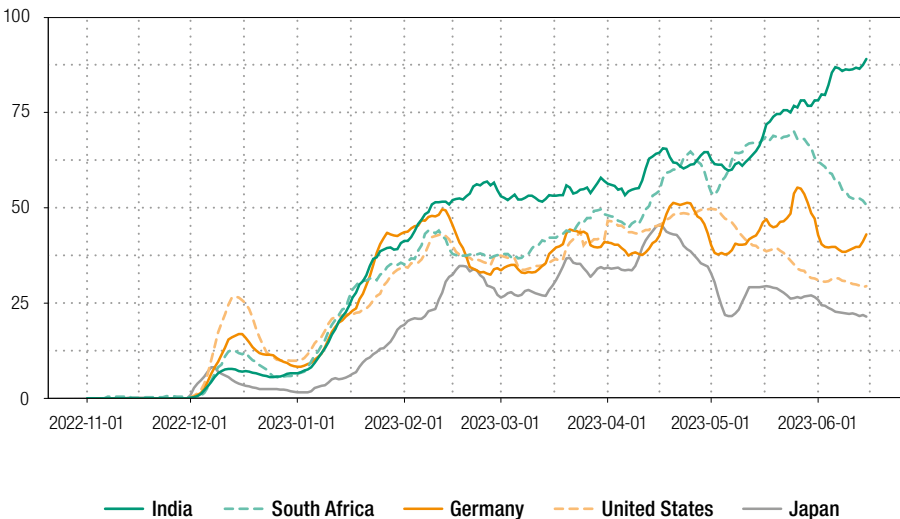
Although Facebook's primary selling proposition is its global outreach to users, it generates revenues from advertising customers. In measuring the degree of internationalization, the source of cash flows (i.e. advertisers) captures only one aspect of market-side internationalization and disregards the immense importance of user-side internationalization.

3. Digital MNEs and their internationalization

Before addressing measurement, it is important to conceptualize DMNEs and their internationalization properties. This section refers to work included in UNCTAD (2017) and the background research in Casella and Formenti (2018).

DMNEs are often born global with high speeds of internationalization. ChatGPT, for example, first received digital recognition and search activity in December 2022. On 1 April, just five months later, it exceeded Twitter in net recognition for the first time. DMNEs' fast pace of internationalization cannot reliably be measured or studied using annual accounting data. Figure 1 shows the immense speed of internationalization of ChatGPT in the digital world, using search queries from Google Trends.

Figure 1. ChatGPT: Relative search volume on Google, November 2022–July 2023



Source: Authors' compilation, based on Google Trends.

Note: Data are smoothed, using a seven-day moving average.

DMNEs are *centralized* organizations. Their digital business models allow them to internationalize from a central location with little investment in their host countries. Thanks to their digital business models, DMNEs do not require substantial assets in any foreign market. Rather, they are *thin on assets*, serving users and advertisers through digital distribution channels.

Often, DMNEs *strategically incorporate* their headquarters in countries that offer preferential taxation or regulatory environments. In such cases, the classic distinction between domestic and foreign becomes blurred. This impairs the application of many of the most common measures of internationalization. Conversely, MNEs create subsidiary networks across the globe from their historically evolved headquarters to serve their customers most efficiently.

Despite their large scale, DMNEs are *highly specialized* in automated digital processes for their users. Users are not necessarily paying customers, as in traditional MNEs. Rather, they form the platform that the DMNE seeks to commercialize. The efficiency of operations is of little concern because digital platforms scale effortlessly and without many resources across individual users.

Though foreign assets are thin and not necessary for DMNEs to make a substantial impact on a country, outreach to users is of utmost importance for their financial valuation and ability to generate cash flows. As such, DMNEs are intensely market or user oriented.

Despite the high importance of market relevance, the *location of sales is often opaque* and consequently difficult to identify. Table 2 summarizes the conceptual differences between MNEs and DMNEs, focusing on their internationalization.

Table 2. Differences between MNEs and DMNEs

Characteristic	MNEs	DMNEs
Internationalization speed	Gradual and learning-based	Born global
Location-based asset requirements	Location-based assets necessary for operations	Location-based assets only for compliance or strategic reasons
Organization	Decentralized network of subsidiaries	Centralized
Scalability	Low because of high capital requirements	High because of digital rollout
Home base	Historically evolved	Strategically selected
Strategic focus	Widely diversified	Highly specialized
Value chain	Physical	Digital
Orientation	Customer	User
Transparency and reporting	High transparency because of physical product flows	Low because of predominantly digital value chain

Source: Authors' compilation.

4. Limitation of traditional measures of internationalization in their application to DMNEs

The conceptual idiosyncrasies of DMNEs make traditional measures of internationalization particularly problematic and potentially biased. This poses difficulties when DMNEs and traditional MNEs are compared in an empirical sample. DMNEs' low need for location-based assets overemphasizes their decentralized nature. The sales of DMNEs are highly distorted and not necessarily identical to their user outreach which, economically and politically, is far more important. DMNEs' business models differ from MNEs' business models in that MNEs use (foreign) assets to reach foreign customers whereas DMNEs use digital distribution to reach users.

Consider, for example, OpenAI, the firm behind ChatGPT and an archetypical DMNE. The firm's core product (ChatGPT) and distribution are digital, and its core assets are related to research and development. According to media reports, its revenues were \$28 million in 2022,¹ and in 2023, it was reported to have about 375 employees.² OpenAI also has attracted considerable investment, for example, from Microsoft: \$1 billion in 2019 and \$10 billion in 2023, according to open sources.³ Yet, OpenAI and ChatGPT are virtually nonexistent in publicly available accounting data. As the firm's filings and annual reports are not publicly available, traditional measures of internationalization would not identify OpenAI as an MNE with a global reach. Given the substantial media coverage of ChatGPT and its (useful, questionable or even criminal) applications, this appears to be a stark misclassification. According to OpenAI, ChatGPT was available in 162 countries in June 2023.⁴

However, the challenges in applying traditional measures of internationalization to "non-traditional" DMNEs can also relate to the (deliberately) opaque business models of these firms. Regulatory reasons or tax jurisdiction may induce DMNEs to keep the geographic sources of their revenues unknown or even to hide them. In June 2023, for example, the Securities and Exchange Commission accused the world's biggest cryptocurrency trading exchange Binance and its competitor Coinbase of fraudulent reporting. Part of the case against the two DMNEs is that they circumvented United States regulators by illegally channeling United States trades through international offshore companies. In addition, Binance is accused of

¹ Erin Woo and Amir Efrati, "OpenAI's losses doubled to \$540 million as it developed ChatGPT", *The Information*, 4 May 2023.

² Kevin Roose, "How ChatGPT kicked off an A.I. arms race", *The New York Times*, 3 February 2023.

³ Crunchbase, "OpenAI – financials", www.crunchbase.com/organization/openai/company_financials (5 December 2023).

⁴ OpenAI, "ChatGPT supported countries", <https://help.openai.com/en/articles/7947663-chatgpt-supported-countries> (accessed 5 December 2023).

fraudulently misleading United States regulators about the size of its United States assets and sales.⁵ This case, just the latest of many controversial cases about DMNEs' reporting of assets and sales, also illustrates the challenges of applying traditional measures of internationalization to them —even if public accounting data were available.

Given the challenges in applying traditional measures to DMNEs, the question is, what should a useful measure of internationalization for DMNEs entail. First, a useful measure should be comparable between MNEs and DMNEs. Second, it should be based on distributional data rather than a crude binary distinction of home and foreign business, to avoid home-country bias and biases from strategic incorporation. Third, it should be readily available for a universe of opaque digital enterprises. Finally, it should be able to capture rapid internationalization processes and offer more interyear granularity.

In the following section, we propose a measure of internationalization based on Google user data.

5. Proposing a measure of market-side internationalization of digital MNEs using Google Trends

The global dominance of Google as an everyday search engine with a market share of 93.11 per cent allows researchers to reach almost 7 billion people and gather valuable data on their socioeconomic behaviour.⁶ The second most used online search engine, Bing, reaches only 2.77 per cent of the global market share. The overwhelming majority of people not only use Google to search for information but, first and foremost, to navigate the Internet in their daily behaviour as consumers, stakeholders and even employees or investors. As such, Google accompanies us in our private behaviour. Allowing us to replicate the socioeconomic behaviour of billions of individual users, Google provides a uniquely broad survey instrument for researchers in various disciplines.

To capture the non-traditional internationalization of digital MNEs, we propose to use the *globaltrends* package.⁷ The package uses country-level scores of a particular search term – in our specific case, a digital MNE – to develop two conceptually distinct measures of internationalization. The *volume of internationalization (VOI)*

⁵ Matthew Goldstein, Ephrat Livni and Emily Flitter, "Coinbase accused of breaking market rules as crypto crackdown widens", *The New York Times*, 6 June 2023.

⁶ Globalstats, "Search engine market share worldwide", <https://gs.statcounter.com/search-engine-market-share> (accessed 5 December 2023).

⁷ Harald Pühr, "globaltrends-Measure global trends with Google Trends (R package)", 23 June 2021 <https://github.com/ha-pu/globaltrends>.

captures the global volume of digital interest by Google users in a specific company. To scale and ensure comparability, the VOI is scaled to a reference group of highly searched terms: “gmail,” “map,” “translate,” “wikipedia,” and “youtube” (which can be altered by the user to test for robustness). In simple terms, the VOI captures how often a search term (firm, person, product, event) is searched for relative to the most often searched terms. It can be conceptualized as a measure of global scale or size. This first measure of volume can – similarly to the value of foreign assets for UNCTAD's top 100 MNEs – help select a group of highly relevant (high-growth) DMNEs from which to compile and update the ranking of top 100 DMNEs.

The *degree of internationalization (DOI)* is more relevant to our research note and is used in further analyses. It is a distribution-based measure that captures how evenly distributed the VOI is across all countries. As with most other distributional measures (e.g. RIMS), the DOI is scaled between 0 and 1. A DOI of 0 would result from a person that is only searched for in one country. A DOI of 1 would mean the person has equal search activity, interest and recognition in *all* countries. The two measures, DOI and VOI, are empirically related as size often correlates with global outreach. Still, they are conceptually distinct since a small company may also have a very high DOI if it sells equally few products in all countries. In this case, the company may be small, but it has a very international footprint. In line with most traditional distributional measures of internationalization and the theoretical construct of internationalization, the baseline DOI does not weight countries according to their size, economic relevance or number of Internet users (the globaltrends package allows weighted DOI for robustness checks).

We argue that this distinction between volume and degree of internationalization is particularly important for digital MNEs since digital business models can more easily be rolled out across countries, even by smaller firms. On the other hand, manufacturing firms face scale restrictions and must grow their operations to become international, establishing a clearer correlation between size and degree of internationalization. In our analysis and discussion below, we focus on the Google Trends DOI since its interpretation is more directly related to an MNE's degree of internationalization than the Google Trends VOI.

Before discussing the use of Google Trends data to measure internationalization, it is important to consider what Google Trends data validly reflects. Users rely on Google to search for information and to navigate the Internet. As such, Google search queries are highly valid measures of interest, recognition and awareness. Relaxing the definition of internationalization from a purely transactional or operational conceptualization to a more market-oriented view, we argue that search interest on Google can also serve as a proxy measure for international digital outreach. As with all proxy measures, the use of the Google Trends measure has some limitations and advantages, especially regarding DMNEs, we argue. It is worth noting that traditional performance-related or structural measures of

internationalization are arguably also limited to capturing specific dimensions and do not holistically capture the concept of internationalization or internationality of a firm (e.g. the culture of the company, the diversity within the company, the distance it covers and its impact on people). Thus, although Google Trends measures must be applied with caution, they can capture a meaningful dimension of internationalization such as a user's outreach that other proxies, we argue, are less capable of capturing.

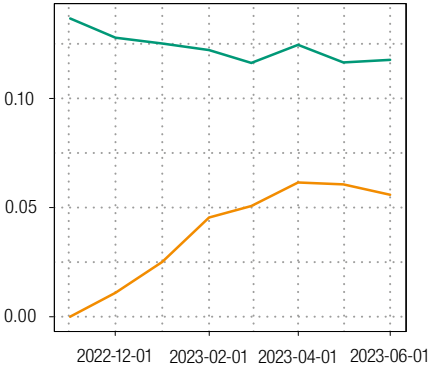
We illustrate potential insights by using Google Trends as a measure for internationalization by applying it to the internationalization of ChatGPT. As mentioned earlier, ChatGPT and OpenAI are virtually nonexistent by traditional measures of internationalization. To this end, we use the `globaltrends` package to download data from Google Trends and compute the VOI and DOI for ChatGPT. Panel A of figure 2 shows the VOI – a measure of the intensity of global interest. Interest in ChatGPT grew rapidly from November 2022 to February 2023, when Microsoft announced its \$10 billion increase in funding for ChatGPT. Interest peaked in April 2023, probably over the publication of GPT-4 (a highly improved version of the model underlying ChatGPT) and substantial regulatory concerns regarding ChatGPT and the application of AI in general. Panel B of figure 2 shows the DOI – a measure of the distribution rather than the intensity of global interest. The line plot shows how ChatGPT's DOI increased from November 2022 onwards and has remained stable since April 2023. A Google Trends DOI of 0.65 is extremely high and comparable to that of the most international DMNEs analysed later. The drop in DOI in February 2023 indicates that the distribution of search volume for ChatGPT has become more “uneven.” This is to say that the search volume has become more concentrated, which indicates a lower degree of internationalization; however, as our data show, the distribution quickly reverted to its more even state.

It is important to mention a trait of distributional measures that is often overlooked. A decrease in DOI does not necessarily indicate a decrease in global interest for the firm. It indicates a more unevenly distributed interest. If, for example, an event increases interest for a particular company in one country (e.g. Amazon's Black Friday sale), then the DOI will decrease because the United States has temporarily become more dominant in the global footprint of Amazon. This Black Friday effect on Amazon's DOI is visible in figure 3, where dotted lines mark Black Friday events. The spikes in the total (global) VOI are mirrored by slumps in the DOI. As Amazon's sales become more strongly concentrated in the United States for one day, the company became temporarily less international.⁸

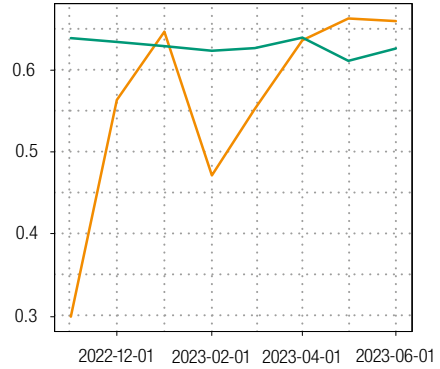
⁸ It is worth mentioning that the same decrease in internationalization would be picked up by FSTS; however, available measures rarely allow for daily data.

Figure 2. ChatGPT: VOI and DOI, November 2022–June 2023

a. Google Trends VOI



b. Google Trends DOI

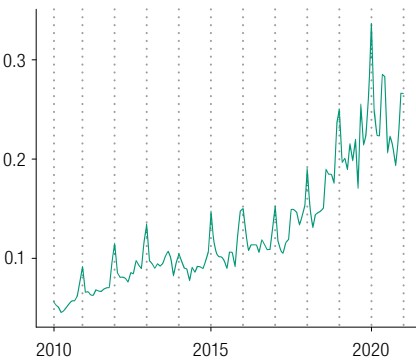


— ChatGPT — Twitter

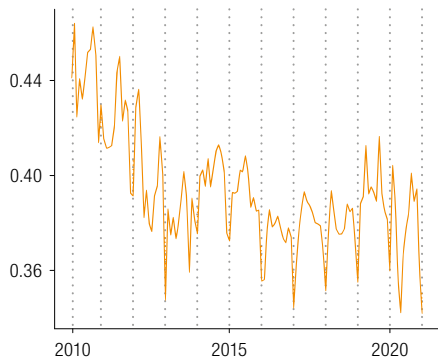
Source: Authors' compilation, based on Google Trends.

Figure 3. Amazon.com: VOI and DOI, 2010–2021

a. Volume of internationalization



b. Degree of internationalization



DOI computer as GINI.

Source: Authors' compilation, based on Google Trends.

A sudden increase in search queries in a location will have the same effect as a decrease in DOI in any distributional measure. Therefore, researchers should use both the volume and degree of internationalization when interpreting these indices.

Another important property of Google Trends data is its extremely fine granularity. Whereas most MNEs report data only on aggregated geographic segments (if data are available), Google Trends allows analysis at the country and state levels. In addition, data are available at a daily or weekly frequency. This allows scholars to better understand the fast-changing dynamics of the international outreach of DMNEs. In figure 1, we show the relative search volume for ChatGPT in Germany, India, Japan, South Africa and the United States. Based on Google search volume, interest in ChatGPT in the United States lead the interest in other countries. However, in mid-January, interest in ChatGPT in these countries picked up and exceeded the interest in the United States. The data also provide two interesting insights into country differences. First, interest in ChatGPT by Japanese Google users was less than that of users in other countries. Second, while interest in Germany, Japan, South Africa, and the United States started declining in May 2023, interest in India still grew in June 2023.

6. Empirical assessment and comparison of the Google Trends DOI

6.1 Data collection and baseline analysis

A meaningful comparison and discussion of differences in various measures of internationalization and how they relate to traditional MNEs and DMNEs requires data from several sources. Consequently, we gather data from several data sets and use these data to compute various measures for the degree of internationalization (see table 3 for descriptive statistics).

For traditional MNEs, we first compute FSTS, FATA, FFTP and share of foreign subsidiaries for S&P500 firms from filings with the United States Securities and Exchange Commission. Second, we are grateful for data provided on the RIMS measure of firm internationalization for 484 MNEs. For the same sample MNEs, we use the globaltrends package to obtain Google Trends DOI and VOI. The three data sets establish a baseline comparison between traditional measures of internationalization and the Google Trends DOI. This comparison reveals a consistently positive but moderate correlation between traditional and Google Trends measures of internationalization.

The correlation across all measures of 0.324 highlights that although the three measures all capture degree of internationalization, they capture different facets of the construct and are not perfectly substitutable. The average correlation between Google Trends DOI and traditional measures (FSTS, FATA, FFTP) is 0.331.

Table 3. Descriptive statistics, MNEs versus DMNEs

Parameter		Observations	Minimum	Mean	Maximum	Standard deviation
Google Trends DOI	MNEs	851	0	0.176	0.498	0.109
	DMNEs	198	0	0.188	0.627	0.125
Foreign assets to total assets	MNEs	851	7.593	67.629	100	21.566
	DMNEs	169	0	33.780	99.811	25.258
Foreign employees to total employees	MNEs	851	1.693	59.503	100	23.611
	DMNEs	n.a.	n.a.	n.a.	n.a.	n.a.
Foreign sales to total sales	MNEs	851	2.995	70.168	100	21.487
	DMNEs	195	3.07	43.415	99.992	24.982
Transnationality Index	MNEs	851	4.314	65.767	99.590	19.172
	DMNEs	n.a.	n.a.	n.a.	n.a.	n.a.

Source: Author's estimations, based on Google Trends and UNCTAD FDI/MEN database.

The average correlation among the traditional measures – FATA, FSTS, and RIMS – is 0.317.⁹ In other words, the Google-based measure of internationalization appears to capture internationalization as reliably (or unreliably) as the other measures. Looking further into individual traditional measures, the Google Trends DOI correlates most strongly with the market-related indexes, FSTS (0.378) and RIMS (0.364).

Third and finally, we obtain the TNI from UNCTAD for the largest 100 MNEs, including the index's subdimensions of FATA, FSTS and FETE. The pattern of correlations in this sample is similar to that in our previous analysis. While the Google Trends DOI measure is significantly correlated with FSTS and the TNI, there is no significant correlation with FETE and FATA.

These comparisons (table 4, figure 4) suggest two findings: Google Trends DOI has a slightly higher correlation (RIMS: 0.364) with the only available internationalization measure that is based on distributional data and not on a simple foreign versus domestic dichotomy such as FSTS (0.293) or FATA (0.161). Second, Google Trends DOI appears more sensitive to sales (FSTS: 0.378) than physical assets (FATA: 0.250).

⁹ This excludes TNI, which is based on FSTS and FATA, and thus naturally correlated with these measures.

Table 4. Bivariate correlations between traditional measures of internationalization and Google DOI for MNEs

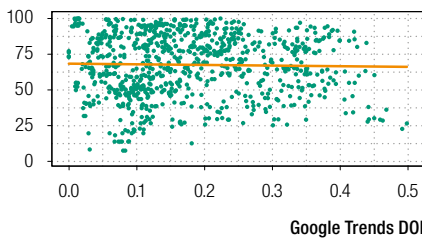
Parameter1	Parameter2	Correlation	p-value	Observations
Google Trends DOI	Foreign sales to total sales	0.291	0.000	851
Google Trends DOI	Foreign sales to total sales	-0.023	1.000	851
Google Trends DOI	Foreign employees to total employees	0.026	1.000	851
Google Trends DOI	Transnationality Index	0.111	0.008	851
Foreign sales to total sales	Foreign assets to total assets	0.599	0.000	851
Foreign sales to total sales	Foreign employees to total employees	0.584	0.000	851
Foreign sales to total sales	Transnationality Index	0.838	0.000	851
Foreign assets to total assets	Foreign employees to total employees	0.664	0.000	851
Foreign assets to total assets	Transnationality Index	0.871	0.000	851
Foreign employees to total employees	Transnationality Index	0.878	0.000	851

Source: Author's estimations, based on Google Trends and UNCTAD FDI/MEN database.

Figure 4. Measures of internationalization for MNEs

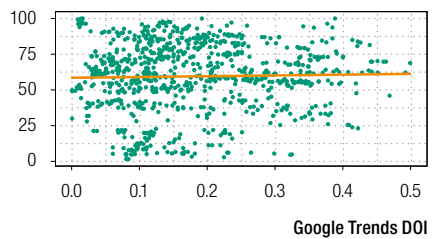
a. Foreign assets to total assets

Transnationality measures



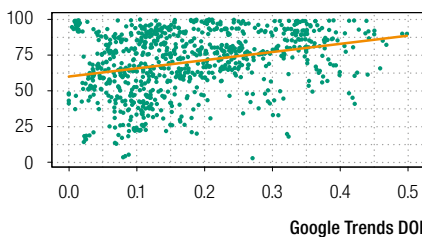
b. Foreign employees to total employees

Transnationality measures



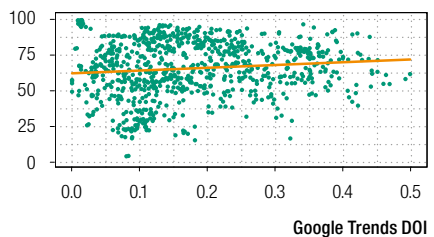
c. Foreign sales to total sales

Transnationality measures



d. Transnationality index

Transnationality measures



Source: Authors' compilation, based on Google Trends and UNCTAD FDI/MEN database.

For digital firms, we obtain internationalization data from UNCTAD for the largest 200 DMNEs. Data are available for only two years, which could result in lower reliability for our correlation analysis (table 5, figure 5). The Google Trends DOI has a low positive correlation (0.076) with FSTS and a negative correlation with FATA (-0.271). This means that the difference between the Google Trends DOI and traditional measures of internationalization is much larger for DMNEs than for MNEs. In the case of DMNEs, the measures appear to assess very different aspects of internationalization. This could have two reasons: (a) traditional measures or the Google Trends DOI are inappropriate for capturing the internationalization of DMNEs, or (b) the two capture complementary aspects of internationalization. In the following section, we outline why we believe that Google Trends DOI can complement the analysis on DMNEs' internationalization process. Nevertheless, we propose that Google Trends DOI and traditional measures should be used jointly because they capture different aspects of the internationalization of DMNEs.

In the previous section, we compared Google Trends DOI with other available indices, data sets and rankings, such as the Top 100 MNE and DMNE list from UNCTAD. In other words, we have relied on other samples rather than using Google Trends to identify and select the most "international" companies. The Google Trends VOI and DOI can monitor the degree of internationalization in real time for many firms, products or persons. As such, they theoretically lend themselves to selecting and ranking of firms. The immense data availability and the ability to survey many firms with little effort certainly benefit researchers. However, researchers should be aware of the biases of Google Trends indexes (e.g. business-facing versus consumer-facing, or B2B versus B2C). These can be acknowledged by (a) creating separated rankings for such biased groups and (b) using an econometrically more sophisticated technique based on regression models that accounts for the characteristics of the country (similar to three- or five-factor models; Fama and French, 1992). It is worth noting that (other forms of) bias also exist when using traditional measures to rank firms by their DOI or VOI. Foreign-to-total measures favour companies from smaller markets, and asset-related measures discriminate against firms with asset-thin business models such as DMNEs (Trentini, 2021). Similarly, sales- or employee-based measures load more heavily on some industries than others.

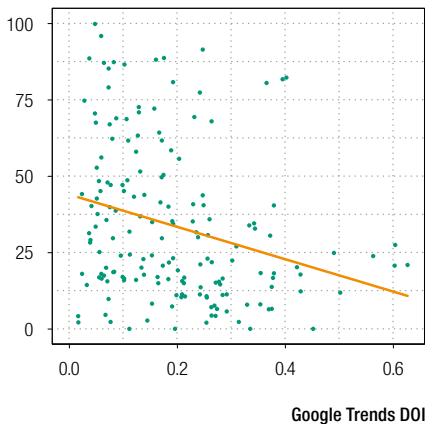
Table 5. Bivariate correlations between traditional measures of internationalization and Google DOI for DMNEs

Parameter1	Parameter2	Correlation	p-value	Observations
Google Trends DOI	Foreign sales to total sales	0.076	0.583	195
Google Trends DOI	Foreign assets to total assets	-0.271	0.001	169
Foreign sales to total sales	Foreign assets to total assets	0.615	0.000	166

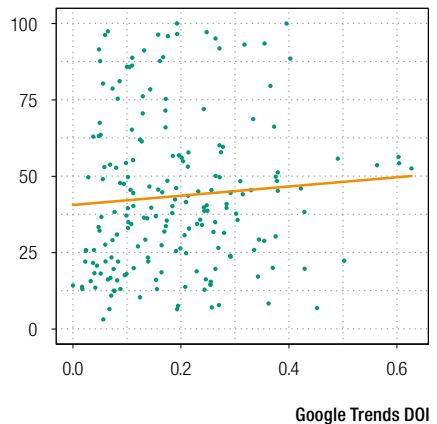
Source: Author's estimations, based on Google Trends and UNCTAD FDI/MEN database.

Figure 5. Comparison of measures of internationalization for DMNEs**a. Foreign assets to total assets**

Transnationality measures

**b. Foreign sales to total sales**

Transnationality measures



Source: Authors' compilation, based on Google Trends and UNCTAD FDI/MEN database.

6.2 Comparing traditional and digital MNEs across internationalization measures

If we compare descriptive statistics for the different internationalization measures for MNEs and DMNEs (table 3), an interesting pattern emerges that coincides with the theoretical differences set out in the previous section. Measured with traditional measures, the average MNE is two times more international in assets (MNE: 68 per cent; DMNE: 34 per cent) and 50 per cent more international in sales than the average DMNE (MNE: 70 per cent; DMNE: 43 per cent).

Applying a Google-based measure, DMNEs are slightly more international than MNEs. The most international company, both digital and traditional, using Google Trends DOI is Alphabet (0.627); the largest traditional company, Samsung Electronics (0.463), has a 26 per cent lower degree of internationalization. Naturally, Google DOI, which is based on companies' global digital footprint, loads more heavily on DMNEs than traditional MNEs.

Applying traditional FATA, Rio Tinto tops the list of traditional MNEs, with 99.8 per cent in foreign assets. Just Eat Takeaway.com, the DMNE with the highest FATA, comes close to 99.8 per cent of foreign assets. Founded in Spain, Rio Tinto lists

and maintains head offices in London and in Melbourne. This makes the distinction between foreign and domestic sales or assets difficult. Furthermore, the complex corporate structure reduces the transparency of cash flows. Rio Tinto is very asset-heavy (\$96.7 billion). At the same time, it is slim on the market side, with more than \$55 billion of revenues coming from only 2,000 customers (Rio Tinto, 2023). On its website, Rio Tinto claims operations in 35 countries, a surprisingly small footprint for the most internationalized traditional MNE. Similarly, Just Eat Takeaway.com maintains a dual listing resulting from a merger between London-based Just Eat and Amsterdam-based Takeaway.com. According to their website, they serve 16 markets plus Australia, Canada, New Zealand and the United States. Though certainly large multinational companies, the two examples highlight the problematic distinction between foreign and domestic that underpins most traditional measures of internationalization. In both cases, a distributional measure of sales or assets that distinguishes the foreign-to-domestic ratio and the distribution across all countries would have rated the two companies much lower in internationalization.

The differences in company rankings in table 6 between Google-based measures and traditional measures reveal further insights. Among traditional measures, Rio Tinto dominates with a TNI of 99 per cent, followed by Anglo American (United Kingdom; 95 per cent), Altice Europe (Netherlands; 93 per cent), Linde (Germany; 92 per cent), and Foxconn/Hon Hai Precision Industries (Taiwan Province of China; 90 per cent). Strikingly, the list does not include a single United States-based company. This is because when applying the FATA, FSTS and FETE measures, companies originating from small countries naturally have higher ratios of foreign business. The ranking of the Google Trends DOI is led by Samsung Electronics (Republic of Korea), Huawei Technologies (China), Vinci (France), Airbus (France) and SAP (United States). Most remarkably, Rio Tinto ranks lowest overall in the Google Trends DOI (table 7). Thus, according to traditional measures, the most internationalized company is the least international in the digital world. Similarly, Altice Europe, third in the TNI ranking, is only two spots from the bottom of the Google Trends DOI ranking. This comparison supports our prior assessment that the Google Trends DOI inhibits less home-country bias but tends to load more heavily on consumer-oriented, asset-light companies.

Turning toward DMNEs in tables 8 and 9, we observe a similar pattern. The Google Trends DOI ranks consumer-facing companies Alphabet, Meta, Netflix, Pinterest (all United States) and Alibaba (China) as the most internationalized firms and iMarketKorea (Republic of Korea), Grupo Televisa (Mexico), Graham Holdings, Roper Technologies and Qurate Retail (all United States) as the least internationalized firms. The traditional measures of FSTS and FATA are led by Just Eat Takeaway.com (FATA) and Delivery Hero (FSTS). Interestingly, Twitter (now X; United States) appears among the least international companies measured in FATA, and Alibaba Group (China) features among the least international companies measured in FSTS.

Table 6. Top five internationalized MNEs by internationalization measure

Measure	Rank	MNE	Value
Google Trends DOI	1	Samsung Electronics	0.463
	2	Huawei Technologies	0.421
	3	Vinci	0.418
	4	Airbus	0.394
	5	SAP	0.381
Foreign assets to total assets	1	Rio Tinto	99.758
	2	British American Tobacco	99.336
	3	Veolia Environnement	96.972
	4	ArcelorMittal	96.633
	5	Anglo American	96.032
Foreign employees to total employees	1	Rio Tinto	99.587
	2	Glencore	97.165
	3	Anglo American	96.825
	4	CK Hutchison	93.000
	5	Altice Europe	91.046
Foreign sales to total sales	1	ArcelorMittal	100
	2	Rio Tinto	99.426
	3	Roche	99.040
	4	Altice Europe	98.349
	5	Hon Hai Precision Industries	97.924
Transnationality Index	1	Rio Tinto	99.590
	2	Anglo American	95.128
	3	Altice Europe	93.481
	4	Linde	92.070
	5	Hon Hai Precision Industries	90.909

Source: Authors' compilation, based on Google Trends and UNCTAD FDI/MEN database.

Table 7. Bottom five internationalized MNEs by internationalization measure

Measure	Rank	MNE	Value
Google Trends DOI	1	Rio Tinto	0.014
	2	Legend Holdings	0.022
	3	Nippon Telegraph & Telephone	0.026
	4	Altice Europe	0.027
	5	Softbank Group	0.036
Foreign assets to total assets	1	State Grid Corporation of China	7.598
	2	Saudi Aramco	12.689
	3	China National Petroleum	21.882
	4	Sinopec	26.010
	5	Samsung Electronics	28.616
Foreign employees to total employees	1	State Grid Corporation of China	1.693
	2	China COSCO Shipping	4.897
	3	China National Offshore Oil	5.233
	4	Sinopec	6.653
	5	China National Petroleum	9.947
Foreign sales to total sales	1	State Grid Corporation of China	3.650
	2	ChemChina	13.061
	3	Sinochem	13.693
	4	China COSCO Shipping	18.091
	5	Nippon Telegraph Telephone	18.687
Transnationality Index	1	State Grid Corporation of China	4.314
	2	Saudi Aramco	15.521
	3	Sinopec	21.590
	4	ChemChina	26.123
	5	China National Petroleum	26.340

Source: Authors' compilation, based on Google Trends and UNCTAD FDI/MEN database.

Thus, traditional measures capture DMNEs' operational footprint whereas the Google DOI and VOI capture firms' digital outreach to users, giving a more forward-looking picture of their operations. The Google trends indexes give an indication of where sales, profits and possibly also assets may be reported in future financial disclosures – if the digital company is in the scope of BEPS Pillar One measures – helping restore taxing rights in those locations.

On an industry level, annex tables A1 and A2 in the online appendix show that for MNEs, aircraft, consumer electronics, textiles, and computer and data processing tend to have higher internationalization scores than FATA. In contrast, FATA ranks food and beverages, metals and metals products, and business services higher. Compared with FSTS, business services score much higher in traditional measures. DMNEs cover only four industries: digital content, digital solutions, e-commerce and Internet platforms. Based on data from the Google Trends DOI, Internet platforms are the most international industry. According to the traditional measures

Table 8. Top five internationalized DMNEs by internationalization measure

Measure	Rank	MNE	Value
Google Trends DOI	1	Alphabet	0.604
	2	Meta Platforms	0.603
	3	Pinterest	0.502
	4	Netflix	0.491
	5	Alibaba Group	0.452
Foreign assets to total assets	1	Just Eat Takeaway.com	99.811
	2	Thomson Reuters	91.408
	3	Wolters Kluwer	88.663
	4	WeWork	88.115
	5	Mercadolibre	87.302
Foreign sales to total sales	1	Delivery Hero	99.992
	2	Spotify Technology	99.938
	3	Amadeus IT Group	97.401
	4	Thomson Reuters	97.110
	5	Micro Focus International	96.532

Source: Authors' compilation, based on Google Trends and UNCTAD FDI/MEN database.

Table 9. Bottom five internationalized DMNEs by internationalization measure

Measure	Rank	MNE	Value
Google Trends DOI	1	iMarketKorea	0.000
	2	Grupo Televisa	0.017
	3	Graham Holdings	0.023
	4	Roper Technologies	0.033
	5	Qurate Retail	0.037
Foreign assets to total assets	1	Akamai Technologies	0.000
	2	Alibaba Group	0.000
	3	Grupo Televisa	2.108
	4	Twitter	2.251
	5	Applovin	2.256
Foreign sales to total sales	1	Naver	3.070
	2	Yandex	6.476
	3	Alibaba Group	6.811
	4	Tencent Holdings	7.032
	5	DiDi Global	7.516

Source: Authors' compilation, based on Google Trends and UNCTAD FDI/MEN database.

of FATA and FSTS, Internet platforms rank last, and e-commerce dominates FATA and FSTS. Summarizing these observations, we conclude that Google-based internationalization measures have these characteristics:

- a. They yield similar results when applied to traditional MNEs. They may, consequently, be used as a complement to traditional measures.
- b. They yield very different, partially contradicting results when applied to DMNEs. Because traditional measures of FATA and FSTS are potentially problematic in asset-thin DMNEs, the Google Trends DOI may be a superior or, at least, valuable complement to traditional measures.
- c. They load more heavily on market-or customer-oriented companies than traditional measures in both MNEs and DMNEs.
- d. They suffer less from home-country bias in both MNEs and DMNEs.

7. Discussion

The Google Trends DOI captures a market- or user-side form of internationalization. As a result, we argue that they more effectively capture DMNEs' internationalization since DMNEs scale their international operations from strategically placed assets in a few countries that do not necessarily match their digital and commercial footprint. In addition, the origin of reported sales for many DMNEs does not necessarily coincide with the true origin of the cash flows or the users.

Beyond the validity of the Google Trends DOI, Google-based data have several practical advantages. Google Trends data are available for every region and country and in a daily format. Contrary to traditional measures that are rarely reported in sufficient granularity to create distribution-based measures of internationalization, in Google Trends complete data are available. The daily granularity allows researchers to capture fast internationalization patterns, often found in DMNEs, such as ChatGPT. It is even possible to capture specific transactions if a company or academic researcher seeks to study a firm's market entry into a specific country.

A second practical strength of the Google Trends DOI is its standardization, achieved by scaling it to a group of reference terms. This means that the internationalization of a company can be compared with the internationalization of non-economic actors whose global impact and internationalization do not manifest through sales, assets or employees. Therein, the Google Trends DOI opens up entirely new applications of internationalization in other disciplines. It can be used to study universities, policy institutions, sports teams and even persons, ideas or ideologies (Aguzzoli et al., 2021).

Despite these advantages in validity when applied to DMNEs and the remarkable opportunities that result from superior data availability, Google Trends data have some weaknesses. For some companies, the Google Trends DOI may suffer from keyword contamination. This happens when the name of a company corresponds to a term that users may use for other purposes (e.g. Tesla, the company, and Tesla, the historical person). The use of search topics in Google Trends can reduce this problem. A second problem results from differences in languages and market share of Google within countries. Because the Google Trends DOI can draw on more than 130 countries to calculate its unweighted distribution, a potential bias from a single country, such as China or the Russian Federation, would not materially affect it. Also, such bias would affect all companies' distributions, thus allowing for an unbiased comparison of companies' degrees of internationalization; however, Chinese or Russian DMNEs might appear "smaller" than their Western counterparts.

The measures allow researchers to triangulate data (Nielsen et al., 2020) to overcome issues in the measurement of internationalization (Verbeke and Forootan, 2012; Verbeke et al., 2009). Therefore, scholars can use Google Trends measures

to operationalize the degree of internationalization independent of the type of value chain activity, entry mode choice and strategic motives for internationalization. Moreover, researchers can separate the dispersion of international operations (i.e. degree of internationalization) from the intensity of international operations (i.e. volume of internationalization).

8. Conclusions and way forward

In this paper we proposed new internationalization measures specifically suited to study the evolution and internationalization process of digital MNEs. The proposed Google Trends DOI and VOI enhance the quality and diversity of internationalization measures in the international business community and offer valuable insights for policymakers that traditional measures may not capture, helping them locate the operations of digital companies. As an open-source software package, globaltrends provides unrestricted access to a rich, novel data source.¹⁰

Google Trends VOI and DOI capture the market- or user-side dimension of a firm's internationalization and give a forward-looking picture of emerging digital champions, providing a useful tool first for selecting the next top 100 DMNEs and then for studying the evolution and internationalization patterns of digital companies. This is important as these new business models are adopted gradually across different economic sectors, impacting and significantly changing international investment patterns and international production networks.

These measures are more capable of tracking the location of DMNEs' digital operations, which is often unrelated to the placement of assets and sales. The market-side characteristics of Google Trends indexes make them a particularly valid instrument for selecting and detecting DMNEs that are potentially in scope for the BEPS Pillar One and – more in general – are useful tools for evidence-based policymaking (e.g. regulatory interventions) in the frame of the digital economy.

Google Trends indexes should complement traditional measures of internationalization such as the TNI and the FDI lightness index, which are better at capturing the physical operations of well-established firms.¹¹ For example, comparing the locations of assets (FATA), employees (FETE) and sales (FSTS) of DMNEs with the locations of users measured with Google DOI can provide interesting insights. If the location of users differs substantially from operations

¹⁰ Using the proposed measures to operationalize internationalization therefore enhances reproducibility, replicability and transparency in international business research (Aguinis et al., 2017; Beugelsdijk et al., 2020).

¹¹ Ideally, researchers also include an additional control for B2B versus B2C to capture systematic biases (Pühr and Müllner, 2021; Trentini et al., 2022).

(i.e. sales, assets and employees), this can indicate tax or regulatory arbitrage by DMNEs. Tracking diverging trends between the TNI and its subindexes and these new Google measures can enable policymakers to address the economic impact of FDI in host economies.

More in general, considering both measures can help policymakers predict how international production networks will evolve and prepare adequate developmental strategies to leverage the new economy. When studying the effects of internationalization on companies, researchers should reflect on the mechanisms that underpin the hypothesized effect and select the more appropriate measure for hypothesis testing and control for other dimensions of internationalization.

The detailed data available on Google Trends opens new avenues of research, for example studying how internationalization affects firms' vulnerability to consumer activism. Google-based measures are more reflective of the international scale of these consumers, capturing companies' exposure to international consumers on a daily basis. Thanks to better ESG disclosures, consumers today are better informed about corporate practices and can be more demanding of corporations. Similarly, the availability of high-frequency data allows researchers to study the reactions of global financial markets to an event (Puhr and Müllner, 2022). In that case, Google Trends measures accurately reflect the companies' worldwide recognition among consumers and investors. Finally, beyond financial and tax relevance, the location of users and the global footprint of DMNEs are relevant for socioeconomic and political issues. DMNEs such as Facebook, Google, Twitter and Youtube have, in the past, played an important role in shaping the sociopolitical dynamics of countries and regions (e.g. the Arab Spring, the Cambridge Analytica exposure, social media restrictions). Studying these sociopolitical effects could widen knowledge about the global impact of DMNEs beyond their economic contribution.

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Appendix

Appendix table A1. Average values for measures of internationalization by industry for MNEs

Industry	Observations	Google Trends DOI	Foreign assets to total assets	Foreign employees to total employees	Foreign sales to total sales	Transnationality Index
Aircraft	17	0.327	64.278	61.770	82.682	69.577
Building materials	16	0.165	84.678	71.583	76.887	77.716
Business services	10	0.062	87.358	90.732	87.098	88.396
Chemicals	21	0.114	85.686	74.544	86.181	82.137
Computer and data processing	23	0.274	72.263	61.028	76.661	69.984
Construction	6	0.160	68.362	58.402	53.779	60.181
Consumer electronics	7	0.326	77.506	70.417	91.557	79.827
Electricity, gas and water	118	0.120	60.959	55.399	58.688	58.349
Finance	7	0.077	14.554	22.396	24.609	20.520
Food and beverages	28	0.149	91.191	83.029	84.881	86.367
Health care services	3	0.221	78.102	51.727	57.770	62.533
Industrial and commercial machinery	16	0.277	79.883	57.881	78.522	72.095
Media	6	0.125	48.286	69.548	40.068	52.634
Metals and metal products	18	0.167	85.526	66.151	87.717	79.798
Mining, quarrying and petroleum	190	0.149	65.682	52.872	65.300	61.285
Motor vehicles	89	0.273	55.285	53.288	76.423	61.665
Pharmaceuticals	61	0.244	71.778	66.622	86.411	74.937
Real estate	2	0.071	66.62	67.495	53.015	62.377
Retail trade	27	0.140	70.773	72.489	65.034	69.432
Telecommunications	97	0.176	66.435	64.288	67.120	65.947
Textiles, clothing and leather	10	0.289	63.512	77.731	89.008	76.750
Tobacco	22	0.103	91.464	61.976	79.221	77.554
Transport and storage	32	0.176	69.306	40.333	72.025	60.555
Wholesale trade	25	0.085	59.807	56.076	46.262	54.048

Source: Authors' compilation, based on Google Trends and UNCTAD FDI/MEN database.

Annex table A2. Average values for measures of internationalization by industry for DMNEs

Industry	Observations	Google Trends DOI	Foreign assets to total assets	Foreign sales to total sales
Digital content	74	0.162	38.717	44.242
Digital solutions	59	0.190	29.811	39.662
E-commerce	39	0.156	42.574	50.887
Internet platforms	26	0.304	17.317	38.050

Source: Authors' compilation, based on Google Trends and UNCTAD FDI/MEN database.