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Online Leisure Activity and Digital Platforms in an Open Economy

Jiheum Yeon
Xiaohan Zhang

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Executive Summary

Digital platforms have become central to modern economies, as consumers increasingly spend leisure time online and platform firms transform user engagement into economic value. This study develops a multi-country, multi-industry open-economy general equilibrium model to analyze how web traffic—measured as visits to platform domains—can be converted into "data capital" through big data and AI algorithms and then used as a non-rival input for production and innovation.

To ground the analysis, we construct a new dataset that links domain-level web traffic to corporate ownership across countries. The evidence reveals sharp cross-country differences in the geographic origin of users. U.S. platforms attract a strongly international audience, with domestic users accounting for less than one-third of visits on average. Chinese platforms are more domestically concentrated, though TikTok stands out as a global exception with a highly international user base. Korean platforms, by contrast, rely overwhelmingly on domestic users, with less than ten percent of traffic originating abroad. Comparing these patterns with international service trade statistics, we find that countries with higher shares of foreign users are systematically more active in exporting online services.

Qualitative analysis provides further insight into user behavior. Consumers allocate more time to a platform when they experience greater content satisfaction, which depends on both technological quality and country-specific content preferences. When the quality of foreign platform content improves, consumers reallocate time away from domestic platforms toward foreign ones. The extent of this shift is influenced by the elasticity of leisure demand, the substitutability across platforms, and the share of time already devoted to foreign platforms.

The general equilibrium model allows us to simulate counterfactual scenarios and evaluate policy-relevant outcomes. Reducing cross-border frictions to foreign content raises welfare in all countries, primarily through the expansion of content variety and the reallocation of consumer time, while leaving the broader industrial structure largely unchanged. Lowering barriers faced by foreign platforms, such as discriminatory digital services taxes, increases platform revenues, encourages consumers to spend more leisure time online, and strengthens investment incentives

for domestic platforms. Although the immediate welfare gains are modest, the longer-run effects on intangible investment and innovation are more significant. Enhancing the productivity of platform R&D generates asymmetric effects by expanding platform activity in the innovating country and reducing it in the non-innovating country, yet global welfare increases because users everywhere benefit from improved content quality and diversity.

Taken together, the findings highlight that the accumulation of web-traffic-based data capital is a central driver of platform growth. Policies that improve access to foreign content, the taxation of digital services, and foster innovation in platform R&D directly influence how consumer time is allocated and how platform firms invest in data-driven growth. For policymakers, the results suggest that lowering barriers to cross-border online activity can deliver substantial welfare gains, that digital taxation should be carefully designed to balance fiscal and innovation objectives, and that investment in platform R&D is essential for competitiveness in the global digital economy.

In sum, this study demonstrates that digital platforms thrive not only on technological progress but also on the ability to accumulate and deploy data capital derived from web traffic. Recognizing the economic role of data capital is crucial for designing effective policies in the digital era, where market access, taxation, and innovation shape the international competitiveness of platform industries.

Keywords: Cross-country time allocation, Online leisure, Digital Platforms, Cross-country services trade, Non-rivalry, Intangible Capital, Zero Prices
JEL Classification: F41, E22, J22, L86

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Contents

Tables

Online Leisure Activity and Digital Platforms in an Open Economy

Jiheum Yeon* and Xiaohan Zhang†

1. Introduction

Digital platforms intermediate a growing share of household leisure time and firm marketing activity across borders. When users spend time online, their attention generates data that platforms transform into content improvements and targeted intermediation services. Because online attention and data travel with minimal physical barriers, these activities naturally span countries, in which household time use is transformed and accumulated as economically productive input to platforms. Motivated by this new technological nature, we develop a macroeconomic model of online leisure and platform production in an open economy using a multi-country, two-sector framework in which cross-country consumer attention is a non-priced, non-rival input that scales digital platforms.

To begin with, we use unique Semrush clickstream data and document systematic differences in the geographic composition of traffic (visitors) across major platforms. We find that Korean domains are highly home-oriented; Chinese domains are domestic on average but more dispersed; and U.S.-incorporated domains are markedly global. Aggregating to destinations, traffic into Korea is mostly domestic, while traffic into China is mixed and traffic into the U.S. is comprised of non-U.S. users. Second, combining these patterns with Trade in Services by Mode of Supply (TISMOS) data (OECD and WTO (2021)), we find that for the countries we study platforms, platforms have lower own-country traffic shares have larger cross-border advertising exports, consistent with the idea that globally oriented platforms accumulate customer capital across borders. These empirical patterns point to cross-country margins in household attention and platform intermediation.

We build a quantitative model to interpret these facts. Households allocate time among work, offline leisure, and a continuum of online varieties hosted at home and abroad. The

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nontraditional (NT) sector ("platforms") operates three product lines: (i) marketing services purchased by the traditional sector, (ii) website quality that raises online utility, and (iii) new data that augments future production. User attention and data capital enter each line as a nonrival input. Cross-border frictions are captured by two wedges: one discounts the enjoyment of foreign content such as policy restrictions or cultural/language barriers (Disdier and Head (2008)), and the other raises the cost of imported platform intermediation (e.g., digital services taxes (KPMG LLP (2025)). In a broad sense, the model captures an idea that the diffusion of the internet and information technology raises international services trade, supporting our use of online audience measures as open-economy margins (e.g., Freund and Weinhold (2004)).

In the model, attention and data capital are scarce resources and economically productive inputs, consistent with recent theory on the economics of data (e.g., Jones and Tonetti (2020); Abis and Veldkamp (2024)). Platforms act as two-sided intermediaries with cross-group network effects (e.g., Rochet and Tirole (2003); Armstrong (2006); Rysman (2009)), where larger user bases raise value. We model the dynamic process in which intangible capital formed as data and online content that retains attraction from a global user base, following McGrattan and Prescott (2010a); McGrattan and Prescott (2010b).

When calibrating the two-country model, we use the Semrush clickstream data, a unique data set that allows us to measure cross-country traffic flows at the domain level. Depreciation rates for intangible assets (brand equity, entertainment and artistic originals, databases) map to brand equity, online content, and data. We parameterize the wedges to reflect observed access frictions and documented ranges for digital services taxation, in which we use the Semrush evidence above to motivate open-economy margins in the NT sector.

Steady-state comparative statics highlight three mechanisms. (i) Easing access to foreign content generates the largest household-side gains. Welfare rises by about 3% in both countries, as households reallocate sharply from offline to online leisure. Sectoral responses are modest: One country's NT investment declines slightly while that in the other country rises, with small changes in value-added shares, underscoring that the main channel is consumer surplus from variety and time reallocation rather than structural change. (ii) Removing digital services taxes on foreign platforms yields smaller direct welfare gains but sharper sectoral effects. NT investment increases by about 5% in both countries, the NT value-added share expands modestly, and imported advertising rises by about 5 p.p. Thus, the reform stimulates capital formation even as intermediation purchases shift abroad. (iii) A leisure-technology TFP improvement in one country produces more muted effects than under previous calibrations. In the innovating country, welfare rises by about 0.7%, with small increases in wages, consumption, and NT investment, alongside a reallocation of time from offline to online leisure. The other country sees virtually no change. Sectoral adjustments are incremental: NT value-added shares shift by only a tenth of a percentage point, and advertising reallocation is minimal. These results suggest an incipient home-market effect, but at a much smaller scale than in prior scenarios.

Taken together, the framework connects household time allocation to international production in digital intermediation and clarifies when policies act chiefly on consumer surplus (market access reforms), when they reorient sectoral activity without large welfare gains (tax reforms), and when technology shocks reshape outcomes but only incrementally at empirically plausible magnitudes. The rest of the paper presents the data and measurement, develops the model, discusses calibration, and reports quantitative experiments on access frictions, digital services taxation, and leisure-technology productivity.

Related Literature. Our analysis connects two strands of work. First, we model user attention as a scarce resource and data as a nonrival input to platform production, building on classic ideas about information-rich environments and more recent theory on data nonrivalry as in Jones and Tonetti (2020). We embed two-sided platforms in an environment in which larger user bases raise platform value and improve services production, following canonical treatments of two-sided markets (e.g., Rochet and Tirole (2003); Armstrong (2006); Rysman (2009); Katz and Shapiro (1985); Bergemann and Bonatti (2011); Athey and Gans (2010)).

Second, we treat advertising, content, and data as forms of intangible capital in an open economy, drawing on the literature that measures and prices intangibles and documents their growing macroeconomic importance (e.g., Corrado et al. (2009); McGrattan and Prescott (2010a); Haskel and Westlake (2017)). In particular, the open-economy margins are motivated by evidence from Semrush clickstream data that allow us to observe cross-country traffic flows. In doing so, we also introduce and interpret wedges in platform production (e.g., digital services tax) and household time allocation that shift cross-country traffic and services flows (OECD (2019); Goldfarb and Tucker (2011)). Finally, viewing content quality and data accumulation as capital links the mechanism to endogenous growth with nonrival inputs, following the long tradition since Romer (1990).

Layout. The structure of this paper is as follows. Section 2 introduces cross-country traffic and remote services trade patterns. Section 3 introduces the quantitative model. Section 4 delivers qualitative insights from a simplified version. Section 5 conducts numerical simulation by quantitatively exploring the roles of cross-border frictions and sectoral efficiency. Section 6 concludes.

2. Data

In this section, we explain how we measure cross-country traffic flows at the domain and destination-country levels, using the list of social media platforms in the United States, China, and South Korea. We also document remote cross-country services trade.

2.1 Cross-country traffic flows

Semrush. Semrush clickstream data refer to the wide range of digital marketing and web analytics information. At the domain level, it includes metrics on website traffic, such as total visits, unique visitors, average visit duration, bounce rate, device type, and traffic sources (e.g., direct, search, referral, and social), as well as detailed keyword analytics for both organic and paid search, backlink profiles, and display advertising data.

We use the geographic distribution of traffic by source location, which is at the country level for all regions in the world. For our analysis, we rely on the country-level geographic distribution data, and aggregate them into the United States of America, China, Korea, and the rest of the world.

To construct bilateral cross-country traffic flows per domain or country, it is necessary to identify the domain's country, which then defines a destination country. This can be done in several steps. Firstly, we need to identify the relationship between domains and a firm. For example, Meta Platforms Inc. runs multiple social media platforms including Facebook, Instagram, and Whatsapp.

This relationship can become substantially more complex when subsidiaries and ultimate owners are involved. For example, some of the most popular social media platforms in China—such as TikTok, Douyin, and Xigua—are owned by ByteDance, a company incorporated in Singapore. ByteDance itself is a subsidiary of Orbit Holdings Ltd., whose country of incorporation is the Cayman Islands, a British Overseas Territory.

We classify domains as Chinese if their ultimate owner is located in the Cayman Islands but they are well known and heavily operated in China. As the examples of TikTok, Douyin, and Xigua illustrate, the Cayman Islands incorporation reflects a special-purpose corporate structure rather than the true operational base. In practice, these platforms function as Chinese social media services.

Table 1 lists each domain with its owner and country of incorporation. It is worth noting that multi-domain ownership is common: ByteDance (tiktok.com; douyin.com, ixigua.com), Meta Platforms, Inc. (facebook.com; instagram.com; whatsapp.com), Alphabet Inc. (blogger.com; youtube.com), X Corp. (twitter.com; x.com), Kakao Corp. (daum.net, kakao.com) and Tencent Holdings Ltd. (qq.com; wechat.com). Second, most platforms use generic *.com* top-level domains regardless of the incorporation country, consistent with global-oriented brand strategies.

Table 1: Domain, Owner, and Country of Incorporation

Domain	Owner	Country
baidu.com	Baidu Inc.	CN
bilibili.com	Bilibili Inc.	CN
blogger.com	Alphabet Inc.	US
daum.net	Kakao Corp.	KR
douban.com	Beijing Douwang Technology Co., Ltd.	CN
douyin.com	ByteDance	CN
douyu.com	DouYu International Holdings	CN
facebook.com	Meta Platforms, Inc.	US
hupu.com	Hupu Inc.	CN
huya.com	Huya Inc.	CN
immomo.com	Hello Group Inc.	CN
instagram.com	Meta Platforms, Inc.	US
ixigua.com	ByteDance	CN
kakao.com	Kakao Corp.	KR
kuaishou.com	Kuaishou Technology	CN
linkedin.com	Microsoft Corporation	US
naver.com	Naver Corporation	KR
pinterest.com	Pinterest, Inc.	US
qq.com	Tencent Holdings Ltd.	CN
quora.com	Quora, Inc.	US
reddit.com	Reddit, Inc.	US
soulapp.cn	Soulgate Inc.	CN
tiktok.com	ByteDance	CN
twitch.tv	Amazon.com, Inc.	US
twitter.com	X Corp.	US
wechat.com	Tencent Holdings Ltd.	CN
weibo.com	Weibo Corporation	CN
whatsapp.com	Meta Platforms, Inc.	US
x.com	X Corp.	US
youtube.com	Alphabet Inc.	US
zhihu.com	Zhihu Inc.	CN

Table 2: Traffic Share by Origin per Domain (2024)

		Origin Country			
Domain	Country	CN	KR	US	ROW
baidu.com	CN	0.82	0.00	0.04	0.14
bilibili.com	CN	0.75	0.00	0.05	0.20
blogger.com	US	0.00	0.02	0.16	0.82
daum.net	KR	0.00	0.93	0.04	0.03
douban.com	CN	0.60	0.00	0.10	0.29
douyin.com	CN	0.73	0.00	0.04	0.22
douyu.com	CN	0.87	0.00	0.03	0.10
facebook.com	US	0.00	0.01	0.21	0.78
hupu.com	CN	0.69	0.00	0.07	0.23
huya.com	CN	0.88	0.01	0.02	0.10
instagram.com	US	0.00	0.02	0.19	0.79
ixigua.com	CN	0.64	0.01	0.06	0.29
kakao.com	KR	0.00	0.93	0.02	0.05
kuaishou.com	CN	0.63	0.01	0.05	0.32
linkedin.com	US	0.00	0.00	0.32	0.68
naver.com	KR	0.00	0.93	0.02	0.04
pinterest.com	US	0.01	0.01	0.31	0.68
quora.com	US	0.00	0.00	0.42	0.58
reddit.com	US	0.00	0.00	0.50	0.49
tiktok.com	CN	0.00	0.01	0.22	0.77
twitch.tv	US	0.00	0.01	0.19	0.79
twitter.com	US	0.00	0.03	0.18	0.78
weibo.com	CN	0.69	0.01	0.05	0.25
whatsapp.com	US	0.00	0.00	0.06	0.93
x.com	US	0.00	0.03	0.20	0.76
youtube.com	US	0.00	0.13	0.14	0.73
zhihu.com	CN	0.80	0.00	0.05	0.15

Table 3: Traffic Share by Origin per Destination Country (2024)

	Origin Country			
Country	CN	KR	US	ROW
CN	0.67	0.00	0.07	0.25
KR	0.00	0.93	0.03	0.04
US	0.00	0.02	0.24	0.74

Table 4: Average Visit Duration by Origin per Domain (2024)

		Origin Country			
Domain	Country	CN	KR	US	ROW
baidu.com	CN	771	550	619	511
bilibili.com	CN	1246	932	1209	790
blogger.com	US	911	521	649	684
daum.net	KR	529	963	1189	622
douban.com	CN	654	594	623	450
douyin.com	CN	573	495	523	514
douyu.com	CN	563	382	539	337
facebook.com	US	1324	735	903	1120
hupu.com	CN	965	622	970	466
huya.com	CN	527	720	516	383
instagram.com	US	910	920	748	902
ixigua.com	CN	982	335	760	524
kakao.com	KR	334	294	464	327
kuaishou.com	CN	1194	615	750	616
linkedin.com	US	906	608	728	707
naver.com	KR	2563	1186	1145	724
pinterest.com	US	1281	790	749	797
quora.com	US	629	418	518	501
reddit.com	US	828	597	820	681
tiktok.com	CN	1276	513	575	670
twitch.tv	US	784	549	817	698
twitter.com	US	886	669	714	718
weibo.com	CN	835	921	876	417
whatsapp.com	US	1831	926	1443	1381
x.com	US	710	776	776	775
youtube.com	US	1351	1582	1366	1633
zhihu.com	CN	722	624	722	469

Table 5: Average Visit Duration by Origin per Destination Country (2024)

	Origin Country			
Country	CN	KR	US	ROW
CN	859	609	724	512
KR	1142	814	933	557
US	1029	758	853	883

Traffic share. Table 2 documents substantial cross-platform heterogeneity in the geographic composition of audiences. Korean platforms are the most home-oriented—daum.net, kakao.com, and naver.com each draw 93% of visits from Korea—leading to an average own-country share of 0.93 across KR domains. Chinese platforms are domestically tilted on average (mean own-country share = 0.68) but exhibit notable dispersion: some are highly domestic (e.g., huya.com = 0.88, douyu.com = 0.87), whereas tiktok.com is almost entirely international (CN = 0.00; ROW = 0.77; US = 0.22). By contrast, US-incorporated platforms are markedly global (mean US share = 0.24), with wide within-group variation—reddit.com reaches 0.50 in the US, while whatsapp.com and blogger.com record just 0.06 and 0.16, respectively; facebook.com's US share is 0.21 with most traffic from ROW. Overall, own-country reliance is highest for KR domains, substantial but mixed for CN domains, and lowest for US domains.

Table 3 summarizes global traffic composition by destination country. Traffic into Korea is overwhelmingly domestic (KR origin share = 0.93), while China also exhibits a strong domestic tilt (CN = 0.67) alongside a sizable international component (ROW = 0.25, US = 0.07). In contrast, the United States is predominantly served by foreign users (ROW = 0.74) with a relatively small domestic share (US = 0.24), indicating a much more global audience. Taken together, these aggregates mirror the platform-level patterns—high home orientation into KR, mixed domestic and international exposure into CN, and pronounced global orientation into the US.

Average visit duration. Tables 4 and 5 together present the patterns of average visit duration by origin country, disaggregated at both the domain and destination-country levels. A striking observation from these tables is the absence of a clear home-oriented pattern in visit length. While one might expect visitors to spend markedly longer time on platforms or websites originating from their own country—reflecting linguistic familiarity, cultural proximity, or habitual usage—the data do not reveal such systematic dominance. For instance, Chinese, Korean, and U.S. users all spend comparable amounts of time on both domestic and foreign platforms once they visit them. Although there are domain-specific variations, these differences do not translate into a general pattern of home bias in the duration dimension.

This lack of a home-oriented duration pattern implies that the intensive margin of online engagement—how long users stay once they have entered a site—is relatively neutral across origins. In other words, conditional on a visit taking place, the amount of time a user spends on a given website does not depend strongly on whether that site is domestic or foreign. Even for globally prominent platforms such as YouTube, Instagram, or TikTok, the differences in average visit length across origin countries are modest. This pattern suggests that once content is accessed, its ability to retain user attention operates largely independently of nationality. The engagement mechanisms—algorithms, interface design, and the universality of online entertainment or information—seem to transcend borders.

Instead, what differentiates cross-border traffic flows appears to lie much more in the

extensive margin—that is, in whether users visit a given platform at all. Cross-border asymmetries in traffic shares and reach reflect substantial differences in accessibility, regulation, and local preference structures, but once a visit occurs, the intensity of usage converges across countries. This points to an interpretation in which digital globalization manifests primarily through the spread and penetration of platforms (the extensive margin), while the duration of interaction (the intensive margin) exhibits limited localization effects. In short, these results emphasize that the global digital landscape is characterized less by who stays longer on domestic versus foreign platforms, and more by who chooses to visit in the first place. The extensive margin thus plays a much more decisive role in shaping the geography of online attention and the formation of cross-border digital linkages than the intensive margin of visit duration.

2.2 Cross-country online services flows

We use the Trade in Services by Mode of Supply (TISMOS) dataset, which allocates international services activity to the four modes. TISMOS provides values of exports and imports by origin-destination and service item. The four modes are: Mode 1 (cross-border supply)—the service is delivered remotely across borders (e.g., cloud advertising, software); Mode 2 (consumption abroad)—the consumer travels to the supplier's economy (e.g., tourism, overseas education); Mode 3 (commercial presence)—services supplied through a foreign affiliate established in the consumer's economy (proxied by affiliate sales); and Mode 4 (presence of natural persons)—services supplied via the temporary movement of workers (proxied by compensation-of-employees and related components). We use Mode 1, which measures cross-border remote supply.

Table 6 summarizes the export distribution of SJ22, Mode 1 activity by origin in 2022. In TISMOS, SJ22 is *Advertising, market research, and public opinion polling.* The US share is 0.11 and is the largest, followed by China at 0.09. The share of Korea is relatively small, 0.01. Using TISMOS and Semrush, we document a negative cross-country relationship between the SJ22 category in TISMOS and countries' own-country traffic shares from Semrush: economies that rank higher in SJ22 exports tend to rank lower in domestic traffic share rankings, indicating that their leading platforms attract a more international audience. This pattern is consistent with the mechanism that globally oriented platforms accumulate and exports. In what follows, we develop a multi-country model that captures this cross-border nature of non-traditional platform technology.

Table 6: Global Shares by Origin for SJ22, Mode 1: Cross-Border Supply (2022)

Origin	Destination	Share
ROW	World	0.80
US	World	0.11
CN	World	0.09
KR	World	0.01

3. The Model

In this section, we present the multi-country general-equilibrium model that captures the facts in Section 2. The key idea is that user activity on websites, whether from domestic or global visitors, accumulates at the domain level and is converted by platform operators into intangible capital.

Treating user time as a productive, non-priced input aligns with viewing attention and data as jointly scaling platform outputs (Jones and Tonetti (2020)). Feedback between users and advertisers is central to pricing and allocation in our intermediation block (see (Rochet and Tirole, 2003); Armstrong (2006)). Because this accumulation is intrinsically cross-border, it then contributes to firms' global expansion through the supply of online leisure technology and marketing services.

We then use a simplified version of the setup to build intuition for the model's qualitative properties, which essentially captures the interaction among consumers, platforms, and the traditional sector in an open economy due to the cross-border nature of platform technology.

Time is discrete and runs forever, $t = 1, 2, \cdots$. In each period t, there are S countries indexed by $i \in \{1, ..., S\}$ populated by the measure of households N_{it}. Consumers demand a variety of online and offline leisure activity, where online activity is conducted through websites operated in the home or foreign country.

In each country, two types of technologies are available: traditional and non-traditional technology. A firm operating traditional technology produces a tradable good that is used for consumption and investment in physical capital. A firm operating non-traditional technology ("digital platform") runs a website that is indexed by $\omega \in \Omega_j = [0, 1]$ and accessible from *both* home and foreign consumers. Specifically, each digital platform operates three product lines: (1) the quality of the website that provides a platform for online leisure activity, (2) the marketing services demanded by the traditional sector, and (3) the new data used as input to operate these three product lines. Markets in both traditional and non-traditional sectors are perfectly competitive.

Preferences. In each country i in period t, the stand-in household with population N_{it} derives utility from a per-capita consumption good c_{it} as well as online and offline leisure goods $\{l_{1it}, \{l_{2it}(\omega)\}\}_{i,\omega\in\Omega}$. Preferences are symmetric across countries. Specifically, l_{1it} denotes the time spent on offline activity *within* a country i and $l_{2it}(\omega)$ is the time spent online through website $\omega \in \Omega_j = [0, 1]$ operated *across* countries $j = 1, \cdots, S$. The stand-in household maximizes their lifetime utility:

$$\sum_{t=0}^{\infty} \beta^t \left\{ \log c_{it} + \psi\, v\left(l_{1it}, \{l_{2it}(\omega)\}; \{\theta_t(\omega)\}, \left\{\tau^{\theta}_{ijt}\right\}\right)\right\}$$

where ψ is preference intensity of leisure good, and $v(\cdot)$ is an aggregator of a variety of

leisure activity. Extending the closed-economy framework of Aguiar et al. (2021) to an open economy context, let $v(\cdot)$ be of the following functional form:

$$\frac{\eta}{\eta-1}\left[l_{1it}^{\frac{\eta-1}{\eta}}+\left(\sum_{j=1}^{S}\int_{\omega\in\Omega_j}\left(\tau_{ijt}^{\theta}\theta_t(\omega)\right)^{\frac{1}{\rho}}l_{2it}(\omega)^{\frac{\rho-1}{\rho}}\,\mathrm{d}\omega\right)^{\frac{\rho}{\rho-1}\frac{\eta-1}{\eta}}\right]$$

where η is the demand elasticity of aggregate leisure and ρ is the substitution elasticity of online leisure activity. The distinction from the Aguiar et al. (2021) framework is that in an open economy, leisure activity takes place across countries because consumers are able to access a domain based in either the home or foreign countries.

$\{\theta_t(\omega)\}_\omega$ is a set of technology shifters that represents the quality of the websites of digital platforms that are operated across countries. It is endogenously determined that each digital platform ω invests in improving its content to retain the attention of consumers worldwide. $\left\{\tau_{ijt}^{\theta}\right\}$ is country-level preferential shifters where $\tau_{ijt}^{\theta}\leq 1$ with equality when $j=i$. This term captures a reduced degree of enjoyment when consumers access a website from abroad, due to factors such as cultural differences, language barriers, or government censorship of foreign websites. For example, $\tau_{ijt}^{\theta}=0$ with $j\neq i$ implies that online leisure activity is carried out only through the *domestic* website. This distinct mobility is due to the digital technology that surpasses physical barriers.[1]

The stand-in household is subject to budget and time constraints where consumption c_{it} is financed by labor income and financial income. The household is endowed with one unit of time to allocate between work and leisure. h_{it} is labor input, b_{it} is the holdings of debt for which the households pay interest at rate r_t, and $\pi_{it}=\int_{\omega\in\Omega_i}\pi_{it}(\omega)\,\mathrm{d}\omega+\pi_{it}^{y}$ are dividends from both firms with traditional and non-traditional technologies. The constraints are:

$$\begin{aligned}c_{it}+b_{it+1}-(1+r_t)\,b_{it}\leq& w_{it}h_{it}+\pi_{it}\\ 1\geq& h_{it}+l_{it},\quad \text{where}\quad l_{it}\equiv l_{1it}+\sum_{j=1}^{S}\int_{\omega\in\Omega_j}l_{2it}(\omega)\end{aligned}$$

where w_{it} and r_t are wage and interest rates, l_{it} is the total time spent on offline and online activity. The Inada conditions hold with the preferences, so non-negativity constraints for consumption, hours worked, and leisure always hold and are positive in equilibrium.

It can be shown that the representative household in country i allocates its online time across website-country pairs through the following optimality condition:

[1] In the standard international trade (e.g., Eaton and Kortum (2002)) and international macroeconomic models (e.g., Backus et al. (1992); Karabarbounis (2014)), labor and leisure time inputs are assumed to be immobile. In the presence of digital technology, *online* leisure activity is not limited to a specific country.

$$l_{2it}(\omega) = \frac{\tau^{\theta}_{ijt}\theta_t(\omega)}{\Theta_{it}} l_{2it}, \forall \omega \in \Omega_j, \forall j \in S, \tag{1}$$

where $l_{2it} \equiv \sum_{j=1}^{S} \int_{\omega \in \Omega_j} l_{2it}(\omega)\, \mathrm{d}\omega$ and $\Theta_{it} \equiv \sum_{j=1}^{S} \tau^{\theta}_{ijt} \int_{\omega \in \Omega_j} \theta_t(\omega)\, \mathrm{d}\omega$. This optimality condition implies that the demand for online activity at domain ω reflects its relative attractiveness that is a composite of preferential and technological factors. The household allocates its total leisure time l_{it} between online and offline:

$$l_{2it} = \Theta_{it}^{\frac{\eta-1}{\rho-1}} l_{1it}. \tag{2}$$

where the household trades off offline time l_{1it} against online time l_{2it}, given the country-level composite of taste and technological shifters. The higher the taste and/or technology shifter, the greater fraction of time is allocated to online activity.

Non-traditional technology. The non-traditional sector in country i is populated by a continuum of digital platforms indexed by $\omega \in \Omega_j$. Each platform ω operates three product lines: (1) marketing services x^a, (2) website quality x^{θ}, and (3) flow of new data x^d using as input physical capital k, data capital d, labor h, and online leisure time $l_2(\omega)$ spent by consumers from all over the world. Following the approach of McGrattan and Prescott (2010a) and McGrattan and Prescott (2010b), product lines use data capital d as a form of *nonrival* input throughout the *all* production lines. The production technologies are:

$$x^a_{it}(\omega) = z^a_{it}(\omega) \left[\left(k^a_{it}(\omega)\right)^{\alpha_{1i}} \left(d_{it}(\omega)\right)^{\alpha_{2i}} \left(h^a_{it}(\omega)\right)^{1-\alpha_{1i}-\alpha_{2i}} \right]^{\mu} \left[\sum_j N_{jt} l_{2jt}(\omega) \right]^{1-\mu} \tag{3}$$

$$x^{\theta}_{it}(\omega) = z^{\theta}_{it}(\omega) \left[\left(k^{\theta}_{it}(\omega)\right)^{\alpha_{1i}} \left(d_{it}(\omega)\right)^{\alpha_{2i}} \left(h^{\theta}_{it}(\omega)\right)^{1-\alpha_{1i}-\alpha_{2i}} \right]^{\mu} \left[\sum_j N_{jt} l_{2jt}(\omega) \right]^{1-\mu} \tag{4}$$

$$x^d_{it}(\omega) = z^d_{it}(\omega) \left[\left(k^d_{it}(\omega)\right)^{\alpha_{1i}} \left(d_{it}(\omega)\right)^{\alpha_{2i}} \left(h^d_{it}(\omega)\right)^{1-\alpha_{1i}-\alpha_{2i}} \right]^{\mu} \left[\sum_j N_{jt} l_{2jt}(\omega) \right]^{1-\mu} \tag{5}$$

where α_{1i} and α_{2i} denote the output elasticities of physical and data capital, respectively, and μ captures the degree of network effects.

Note that each platform utilizes the online leisure time accumulated at its website ω as a nonrival input, which is specified in equation (1). The production functions of the platform's product lines increase with the total online leisure time spent online at website ω aggregated across countries $j = 1, \cdots, S$, $\sum_j N_{jt} l_{2jt}(\omega)$. This feature is in contrast to a closed economy where platforms based in country i would rely solely on browsing time generated domestically. Each platform maximizes its firm value by selling marketing services to both domestic and foreign traditional sectors and hiring labor and investing in physical capital:

$$\sum_{t=0}^{\infty} m_{it} \left[\sum_{j=1}^{S} (1 - \tau^a_{jit}) q_{ajt}(\omega)\, x_{ajt}(\omega) - w_{it} \left[h_{at}(\omega) + h_{dt}(\omega) + h_{\theta t}(\omega) \right] - x_{kt}(\omega) \right]$$

where m_{it} is the producer discount factor specified as the Arrow-Debreu price from the budget constraint of the representative household, q_{ajt} is the prices of marketing services. The terms are the dividend of each platform, $\pi_{it}(\omega)$. $\left\{\tau^a_{ijt}\right\}$ denotes country-level wedges when purchasing marketing services from different countries, with $\tau^a_{ijt} = 0$ and equality when $j = i$. These wedges capture the relative costs when imported marketing services are used (e.g., digital service tax). This also mirrors the policy discussion on taxing the digitalized economy and allocating taxing rights (e.g., OECD (2019); KPMG LLP (2025)).

The digital platforms are subject to the production technologies described above by equations (3), (4), and (5), as well as the dynamic laws of motion for those products through depreciation and investment, described below by equations (6), (7), and (8):

$$k_{it+1}(\omega) = (1-\delta_k)\, k_{it}(\omega) + x^k_{it}(\omega) \tag{6}$$

$$d_{it+1}(\omega) = (1-\delta_d)\, d_{it}(\omega) + x^d_{it}(\omega) \tag{7}$$

$$\theta_{it+1}(\omega) = (1-\delta_\theta)\, \theta_{it}(\omega) + x^\theta_{it}(\omega) \tag{8}$$

where δ_k, δ_θ and δ_d are depreciation rates, and $x^k_{it}(\omega)$, $x^d_{it}(\omega)$, and $x^\theta_{it}(\omega)$ are investments for physical capital, website quality, and data capital, respectively. Digital platforms accumulate physical capital k and *nonrival* intangible capital d, and enhance the quality of their online domains to continue to attract online consumers.

Traditional technology. There is a representative firm in the traditional sector that produces a traditional good y_{it} by using brand equity capital a_{it}, physical capital k_{it}, and labor input h_{it} subject to a country- and sector-specific efficiency factor z^y_{it}:

$$y_{it} = z^y_{it} \left(a_{it}\right)^{\phi_i} \left(\left(k_{it}\right)^{\gamma_i} \left(h_{it}\right)^{1-\gamma_i}\right)^{1-\phi_i} \tag{9}$$

where ϕ_i and γ_i denote the output elasticities of brand equity capital and physical capital, respectively. This specification postulates that advertising and marketing services are informative and contribute to the production of the traditional good, in line with the macroeconomic approach of digital services (e.g., Rachel (2020); Greenwood et al. (2024)).

The representative firm in the traditional sector in country i maximizes its firm value by purchasing marketing services from both domestic and foreign platforms, and by employing labor and investing in physical capital domestically:

$$\sum_{t=0}^{\infty} m_{it} \left[y_{it} - w_{it} h_{yit} - \sum_{j=1}^{S} \int_{\omega \in \Omega_j} q_{aijt}(\omega)\, x_{aijt}(\omega)\, d\omega - x_{kit} \right]$$

The traditional-sector firm is subject to the production technology described by equation (9) as well as the dynamic laws for physical capital k and brand equity capital a:

$$a_{it+1} = (1-\delta_a)\, a_{it} + x^a_{it}$$
$$k_{it+1} = (1-\delta_k)\, k_{it} + x^k_{it}$$

where δ_a and δ_k are the depreciation rates and x_{it}^a and x_{it}^k are investments in brand equity and physical capital, respectively.

We model imperfect substitution among marketing services purchased from different countries. Specifically, we use a standard Armington-style aggregator at the country level (Armington (1969)):

$$x_{it}^a = \left[\sum_{j=1}^{S} \left(x_{ijt}^a\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

where $x_{ijt}^a = \int_{\omega\in\Omega_j} x_{ijt}^a(\omega)\, d\omega$, and σ is the elasticity of substitution. From the viewpoint of the traditional sector firm, firm-specific marketing services from a country are perfect substitutes, while country-level marketing services are not.

Market clearing. As the traditional-sector good is tradable, the traditional-sector good market clears across countries:

$$\sum_{i=1}^{S}\left[N_{it}c_{it} + x_{it}^k + \int_{\omega\in\Omega_j} x_{it}^k(\omega)\,\mathrm{d}\omega\right] = \sum_{i=1}^{S} y_{it}.$$

The marketing services produced by platforms across countries are demanded by traditional-sector firms across countries. The clearing condition for marketing services is

$$\sum_{i=1}^{S}\left[\sum_{j=1}^{S}\left(\int_{\omega\in\Omega_j} x_{ijt}^a(\omega)\, d\omega\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} = \sum_{i=1}^{S} x_{it}^a.$$

The financial markets are integrated across countries, and the world financial market clearing states that the debt holdings of the countries sum up to zero. Namely,

$$\sum_{i=1}^{S} N_{it}b_{it} = 0.$$

The immobile labor input market clears within each country i. For each country $i = 1, \cdots, S$, the market clearing condition states that

$$N_{it}\left(1 - l_{1it} - \int_{\omega\in\Omega_j} l_{2ijt}(\omega)\,\mathrm{d}\omega\right) = \int_{\omega\in\Omega_j} h_{it}(\omega)\,\mathrm{d}\omega + h_{it}^y.$$

Discussion. In a closed economy—equivalent to $\tau_{ijt}^\theta = 0$ and $\tau_{ijt}^a = 1$ for all $j \neq i$—consumers cannot access foreign websites and are limited to browsing domestic websites operated by digital platforms in their home country. Consequently, this leads to $l_{2jt}(\omega) = 0$ for all $j \neq i$. By contrast, in an open economy—equivalent to $\tau_{ijt}^\theta > 0$ and $\tau_{ijt}^a < 1$ for some $j \neq i$—user engagement is not confined to national boundaries and extends beyond national borders. As online connectivity enables households to access websites in other countries, the

resulting traffic data are accrued by foreign digital platforms. This cross-border exchange of digital attention and content gives rise to an *open-economy margin* that extends beyond conventional market size effects. In addition to accessing foreign goods markets, digital platforms gain exposure to a broader user base from which they collect customer data. These user interactions are then leveraged to accumulate intangible capital and used as productive input to operate product lines. Due to the absence of explicit prices, the allocation of consumer attention functions as an implicit barter system, whereby attention is exchanged for digital content without explicit market valuation.

4. Qualitative properties

To give some intuitions, we simplify the fully-fledged model in Section 3 to a simple two-period, partial-equilibrium version to characterize the demand and supply sides around the platform technology.

On the demand side, the key feature is that households allocate time/attention based on utility benefits from viewing a website. We derive the household's shadow value of time and its relationship with website quality and preferential bias. Using the derivations, we show how quality improvements reallocate time and interact with saving decisions.

On the supply side, the key feature is that user attention serves as a productive input for firms with non-traditional technology. Therefore, we derive the shadow price of investment goods that is produced using household online time and show how this shadow price of the investment goods, in turn, determined by the opportunity cost of attention.

4.1 Households

To understand the demand for leisure from the household and how it interacts with the quality of the website, we analyze the optimization problem of the household in a two-period environment $t = 0, 1$. In this partial-equilibrium setting, households take as given leisure technology θ, wage and interest rates r, w, and the initial level of assets A_0.

$$
\begin{aligned}
&\max \sum_{t=0,1} \left[\log c_{it} + \psi \frac{\eta}{\eta - 1} \left\{ l_{1i}^{\frac{\eta-1}{\eta}} + \left[\sum_{j \in S} \int_{\omega \in \Omega_j} \left(\tau_{ij} \theta(\omega) \right)^{\frac{1}{\rho}} l_{2i}(\omega)^{\frac{\rho-1}{\rho}} \, \mathrm{d}\omega \right]^{\frac{\rho}{\rho-1}\frac{\eta-1}{\eta}} \right\} \right] \\
&\quad s.t. \\
&\qquad c_t + A_{t+1} \leq w_t (1 - L_{it}) + (1 + r_t) A_t, \\
&(\xi) \quad l_{1it} + \sum_{j=1}^{S} \int_{\omega \in \Omega_j} l_{2it}(\omega) \leq l_{it}, \\
&\qquad A_0 \geq 0, A_1 \in (-\infty, +\infty) \text{ given.}
\end{aligned}
$$

Frisch demand for leisure. We first show that within a period the time allocation decisions are intra-temporal, and multi-stage time allocation is solved through the static subproblem: (1) between market work and total leisure; (2) within total leisure, between offline and online; (3) online leisure time is distributed across websites. Let ξ be the Lagrangian multiplier attached to the time constraint in the dynamic problem. Without loss of generality, let total leisure time in the static subproblem be fixed at the total leisure time in the dynamic problem, then the allocation of leisure in the static subproblem coincides with the allocation of leisure in the dynamic problem. This is equivalent to setting $\hat{\xi} = \xi \psi^{-1}$.

$$\max \sum_{t=0,1} \left[\log c_{it} + \psi \frac{\eta}{\eta - 1} \left\{ l_{1i}^{\frac{\eta-1}{\eta}} + \left[\sum_{j \in S} \int_{\omega \in \Omega_j} \left(\tau_{ij} \theta \left(\omega \right) \right)^{\frac{1}{\rho}} l_{2i} \left(\omega \right)^{\frac{\rho-1}{\rho}} \mathrm{d}\omega \right]^{\frac{\rho}{\rho-1} \frac{\eta-1}{\eta}} \right\} \right]$$

s.t.

$$\left(\hat{\xi} \right) \quad l_{1i} + \sum_{j=1}^{S} \int_{\omega \in \Omega_j} l_{2i} \left(\omega \right) \mathrm{d}\omega \leq l_i.$$

This follows from separability between offline and online leisure: comparing the first-order conditions of the dynamic and static problems yields identical intra-temporal allocation rules. Since leisure is separable across online and offline components, the allocation of online leisure across websites can be determined independently of offline leisure, conditional on a fixed total amount of online leisure.

Let $\theta_j \equiv \int_{\omega \in \Omega_j} \theta \left(\omega \right) \mathrm{d}\omega$ denote the average quality of online content provided by the platform from country j and let $l_{2ij} \equiv \int_{\Omega_j} l_{2i} \left(\omega \right) \mathrm{d}\omega$ denote the total leisure time that households in country i spend on that platform from country j. Define the perceived quality as $\theta_{ij} \equiv \tau_{ij} \theta_j$, i.e., the composite quality of country-j websites to households in country i. At the optimum, the composite of online leisure time can be characterized as follows:

$$\left[\sum_{j \in S} \int_{\omega \in \Omega_j} \left(\tau_{ij} \theta \left(\omega \right) \right)^{\frac{1}{\rho}} l_{2i} \left(\omega \right)^{\frac{\rho-1}{\rho}} \mathrm{d}\omega \right]^{\frac{\rho}{\rho-1}} = \left[\sum_{j \in S} \theta_{ij}^{\frac{1}{\rho}} \left(l_{2ij} \right)^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}} \tag{10}$$

Note that the household's allocation of leisure time across across countries follows an Armington structure, which is commonly seen in standard trade models. We show that the properties implied by the CES demand hold as in the demand for leisure.

First, the relative share of time spent on any two country-specific varieties is proportional to the relative perceived qualities. Namely,

$$\frac{l_{2ij}}{l_{2ij'}} = \frac{\theta_{ij}}{\theta_{ij'}}. \tag{11}$$

The cross elasticity of leisure demand for country-j with respect to perceived quality of country-j' website is proportional to the share of time spent on country-j' website:

$$\frac{\partial l_{2ij}}{\partial \theta_{ij'}} \frac{\theta_{ij'}}{l_{2ij}} = \frac{1}{\rho - 1} \frac{l_{2ij'}}{l_{2i}}. \tag{12}$$

For $\rho > 1$, the cross elasticity is strictly negative and origins are gross substitutes, in which the magnitude of elasticity scales with time share of country-j' website. Thus, for two functionally similar platforms based in different countries (e.g., WhatsApp in the US and WeChat in China), an increase in platform's perceived quality in one country shifts time away from the other country. By contrast, for $\rho < 1$ the origins are gross complements.

We turn to analyzing the Frisch demand for leisure, which holds the marginal utility of wealth constant. Let $\Theta_i \equiv \sum_{j \in S} \theta_{ij}$ denote the aggregate perceived quality of leisure technology available to country i, and $\hat{\Theta}_i \equiv \Theta_i^{\frac{1}{\rho-1}}$.

With the household optimally distributing its browsing time across countries, country-i's total online leisure is $l_{2i} \equiv \sum_{j=1}^{S} l_{2ij}$. Time allocation between online and offline is:

$$\begin{aligned} \max_{l_{1i}, l_{2i}} \quad & \frac{\eta}{\eta - 1} \left\{ l_{1i}^{\frac{\eta-1}{\eta}} + \left(\widehat{\Theta}_i \, l_{2i} \right)^{\frac{\eta-1}{\eta}} \right\} \\ s.t. \quad & l_{1i} + l_{2i} \leq l_i. \end{aligned} \tag{13}$$

At the optimum, total leisure is a function of the quality of online leisure technology, the elasticity of leisure, and the marginal value of time:

$$l_i = \left(1 + \hat{\Theta}_i^{\eta-1} \right) \hat{\xi}^{-\eta} \tag{14}$$

Let $\mathrm{v}\left(l_i, \Theta_i\right)$ denote the value of the static subproblem. Its partial derivative with respect to total leisure l_i is the shadow value of leisure, $\mathrm{v}_l\left(l_i, \Theta_i\right) = \hat{\xi} = \left(1 + \hat{\Theta}_i^{\eta-1} \right)^{1/\eta} l_i^{-1/\eta}$.

For each $\left(\hat{\Theta}_i, \hat{\xi} \right)$ there is a strictly monotonic mapping between l and $\mathrm{v}_l\left(l_i, \Theta_i\right)$, which simply reflects the convexity of the static subproblem. Differentiating equation (14) with respect to total leisure time l is

$$\frac{\partial \ln \mathrm{v}_l}{\partial \ln l} = -\frac{1}{\eta} < 0$$

Since equilibrium hours worked are $h_i = 1 - l_i$, Frisch elasticity of labor supply is $\eta l_i / \left(1 - l_i\right)$, which implies that a higher number of Frisch elasticity of leisure leads to a higher number of Frisch elasticity of labor supply.

How does $\hat{\Theta}_i$ affect the shadow price of leisure? Holding total leisure l_i fixed, a higher online leisure technology $\hat{\Theta}_i$ shifts the the marginal value of time, which depends on the share of leisure time devoted to online activity. To see this, note that

$$\frac{\partial \ln \mathrm{v}_l}{\partial \ln \hat{\Theta}_i} = \frac{l_{2i}}{l_i} \left(\frac{\eta - 1}{\eta} \right) \tag{15}$$

Thus, a change in the perceived quality of country-j website shifts household's total leisure demand in country i:

$$\frac{\partial \ln l_i}{\partial \ln \theta_{ij}} = \frac{\partial \ln l_i}{\partial \ln \mathrm{v}_l} \frac{\partial \ln \mathrm{v}_l}{\partial \ln \hat{\Theta}_i} \frac{\partial \ln \hat{\Theta}_i}{\partial \ln \theta_{ij}} = -\frac{\eta - 1}{\rho - 1} \frac{l_{2ij}}{l_i} \tag{16}$$

Hicksian demand for leisure. In the previous section, the analysis held the marginal utility of wealth fixed. When Θ changes, however, households change the composition leisure and consumption, which in turn alters income and the marginal utility of wealth. Building

on the preceding results from the static subproblem, the dynamic subproblem is:

$$\begin{aligned} \max_{\{c_{it},\, l_{it},\, A_{i,t+1}\}_{t=0}^{1}} \quad & \sum_{t=0}^{1} \left[\log c_{it} + \psi \, \frac{\eta}{\eta - 1} \big(1 + \widehat{\Theta}_{it}^{\eta-1}\big)^{\frac{1}{\eta}} l_{it}^{\frac{\eta-1}{\eta}} \right] \\ s.t. \quad & c_{it} + A_{i,t+1} \;\leq\; w_t \big(1 - l_{it}\big) + (1 + r_t) A_{it}, \\ & A_{i0} \text{ given.} \end{aligned} \tag{17}$$

In the dynamic subproblem, we relax constant marginal utility and examine how contemporaneous and anticipated changes in Θ alter leisure allocation and how asset holdings mediate this response. In particular, we show the following two statements. Proofs are relegated to Appendix A.

Proposition 1 (**Hicksian Demand for Leisure**). *(a) if an increase in $\hat{\Theta}_1$ is unanticipated, the household spends more leisure and consumes less in period 2; (b) if an increase in $\hat{\Theta}_1$ is anticipated at $t = 0$, the household consumes less in both periods, spends leisure less and save more in period 1, and spends leisure more in period 2.*

Proof. See Appendix A.3. □

4.2 Firms

In this subsection, we derive the shadow price of the investment goods that a firm produces using leisure time as input. When a competitive firm produces its own investment goods, decision at the margin is equivalent to purchasing the same investment goods on a competitive market operated by other firms with the same technology. Hence, at the optimum, the shadow price is equal to the competitive price at which the firm buys the investment goods from others and is equal to the marginal cost of production.

To illustrate how using leisure as an input in the production of investment goods affects their pricing, we present a simplified version of the firm's problem from the full model, keeping all other elements textbook-standard except that producing investment goods requires leisure as an input. We abstract from nonrivalry across production lines of a firm, because it is orthogonal to the mechanism by which leisure-based investment goods are priced.

Shadow price of investment goods. In this section, we turn to infinite-horizon problem of a firm. The output of a firm is produced according to the following technology using $h_t(\omega)$ which denotes labor and $k_t(\omega)$ is capital, where capital is subject to the law of motion

$$y_t(\omega) = k_t(\omega)^{\alpha} h_t(\omega)^{1-\alpha}, \quad \alpha \in (0, 1)$$

where capital accumulation follows the law of motion in which investment and undepreciated capital form the next period's stock

$$k_{t+1}(\omega) = (1-\delta)\, k_t(\omega) + x_t(\omega). \tag{18}$$

The firm runs a production line to produce its own investment goods, which is produced by the following technology.

$$x_t(\omega) = z_{xt} h_{xt}(\omega)^{\mu} l_{2t}(\omega)^{1-\mu}, \quad \mu \in [0,1]$$

where $h_{xt}(\omega)$ denotes labor and $l_{2t}(\omega)$ is household leisure time exclusively channeled towards the firm. All markets are competitive, and the firm takes the output price, the wage rate, and the interest rate, $\{p_t, w_t, r_t\}$, as given.

Let $\frac{1}{(1+r_t)^t} q_{xt}(\omega)$ be the Lagrangian multiplier associated to the constraint of equation (18). $q_{xt}(\omega)$ is the current shadow price of investment goods produced in t. The competitive firm produces its own investment goods and sells to itself at $q_{xt}(\omega)$,

$$\max \sum_{t=0}^{\infty} \frac{1}{(1+r_t)^t} \Bigg\{ p_t y_t(\omega) - \underbrace{q_{xt}(\omega)\, x_t(\omega)}_{\text{cost of purchasing}} + \underbrace{q_{xt}(\omega)\, x_t(\omega)}_{\text{revenue from selling}} - w_t \left[h_t(\omega) + h_{xt}(\omega) + h_{\theta t}(\omega) \right] \Bigg\}$$

$$s.t.$$

$$\left(\frac{1}{(1+r_t)^t} q_{xt}(\omega) \right) \quad x_t(\omega) = z_{xt} h_{xt}(\omega)^{\mu} l_{2t}(\omega)^{1-\mu}$$

$$\left(\frac{1}{(1+r_t)^t} q_{kt}(\omega) \right) \quad k_{t+1}(\omega) = (1-\delta)\, k_t(\omega) + x_t(\omega)$$

$$k_0(\omega) > 0 \text{ given}$$

When the firm has no impact on how much leisure it can attract, $l_{2t}(\omega)$ is exogenous to the firm. If $\mu \in (0,1)$, then the production technology for $x_t(\omega)$ only uses labor as input and exhibits decreasing returns to scale.[2] At the optimum, $q_{xt}(\omega)$ equals the wage divided by the marginal product of labor, i.e., the marginal cost of producing $x_t(\omega)$:

$$q_{xt} = \frac{w_t}{\mu z_{xt} l_{2t}^{1-\mu} h_{xt}^{\mu-1}}$$

The firm accumulates interim profit because the marginal cost of $x_t(\omega)$ is higher than its average cost. Denote by $V(k_0)$ the value of the firm at $t=0$, $V(k_0) = q_{k,-1} k_0 + (1-\mu) \sum_{t=0}^{\infty} q_{kt} x_t$, where the second term is the inter-margin profit.

[2] When $\mu = 0$, the law of motion of $k_t(\omega)$ is exogenous to the firm. The marginal value is related to the firm through the marginal value of capital.

When the amount of leisure as input is not purely exogenous to the firm, the shadow price of investment goods reflects the value of marginal products of all types of costly effort undertaken by the firm to produce an additional unit of $x_t(\omega)$. Let the optimal rule of household's time use be inherited from the previous analysis, and, for simplicity, assume (i) the technology producing website quality is linear and only use labor as an input; and (ii) the quality fully depreciates in each period. We augment the above optimization problem with two more constraints,

$$l_{2t}(\omega) = \theta_t(\omega) \frac{1}{\Theta_t} l_t$$
$$\theta_t(\omega) = z_{\theta t}(\omega) h_{\theta t}(\omega)$$

Substituting these expressions into the problem yields $x_t = \bar{z}_t h_{xt}^{\mu} h_{\theta t}^{1-\mu}$, where $\bar{z}_t \equiv z_{xt} z_{\theta t}^{1-\mu} l_t^{1-\mu} \in$ The resulting technology for x_t exhibits constant return to scale in $(h_{xt}, h_{\theta t})$, at the optimum, the first-order conditions equate factor prices to marginal products

$$q_{xt} = \frac{w_t}{\bar{z}_t} \mu^{-\mu} (1-\mu)^{-(1-\mu)} \tag{19}$$

and, by L'Hôpital's rule

$$\lim_{\mu \to 0^+} q_{xt} = \frac{w_t}{\bar{z}_t}$$

In other words, if website traffic is the sole input into investment-good production, its shadow price equals the marginal cost of producing the quality level needed to attract the optimal level of traffic to their websites. The degree of attracting any given traffic volume depends on the preferences of the household for leisure and the overall quality of websites.

From equation (19), it can be shown that the shadow price of investment goods produced using traffic as input decreases as the total amount of leisure attention spent at websites increases.

Intuitively, user traffic generated from households' leisure attention is a productive input in the firm's "investment-good" technology. The shadow price of that investment good equals its marginal cost; because traffic raises the technology's effective productivity, more traffic lowers the marginal cost of producing each unit of investment. Lower investment costs, in turn, make it optimal for the firm to accumulate more capital—since investment becomes next period's capital stock—thereby raising future output and profits. Put differently, higher perceived quality attracts more attention, attention makes investment cheaper, and cheaper investment supports faster capital formation.

5. Numerical Simulation

5.1 Parameterization

In this section, we characterize the impacts of wedges and productivity shocks in the non-traditional (NT) sector by analyzing comparative statics between steady states. We parameterize with two countries. In particular, we illustrate how we use Semrush data to back out the degree of home bias of each country. That is, the world consists of two countries, Korea and the U.S. indexed by KR and US, respectively. We begin by introducing the baseline parameterization of the model, which serves as a reference point for all subsequent experiments. Table 7 summarizes key statistics in this baseline.

For the depreciation rate of intangible capital, we use the estimates in Corrado et al. (2024). In particular, we use their estimates for depreciation of brand equity (a), stock of online content (θ), and stock of data and algorithm (d), respectively.

For the Frisch elasticity of leisure, we use the estimates in Aguiar et al. (2021) for recreational computer use. Across the population subgroups with whom they conducted the estimation, η ranges from 1.5 to 2.4. We choose the lower bound, because, as Aguiar et al. (2021) noted, their estimates imply high elasticity of labor supply. With η taking lower value, the implied elasticity of labor supply comes closer to values in standard macro models.

Recall that the wedge $\tau_{ij}^{\theta} \in [0,1]$ captures the discount applied to foreign websites, either due to policy restriction on access or to cultural and language barriers. We use the wedge $\tau_{ij}^{a} \in [0,1)$ to capture the digital service tax announced in many countries including France, Austria, Colombia, etc. According to a survey conducted by KPMG LLP (2025) on digital service tax across countries, as a value-added tax it typically resides in the range of 5% to 10%. To illustrate the change associated with the elimination of the wedges, we pick τ_{ij}^{a} at its upper bound.

To illustrate the properties of the model when there is exogenous change in the wedges and TFP, for simplicity, we do comparative statics in a world composed of two symmetric countries. In particular, we set $N_i = 1$, for both countries, i.e., the two countries have the same relative size of population.

In what follows, we suppress the second subindex of τ_{ij}^{θ} and denote by τ_i^{θ} the degree of bias against foreign websites, $i = K, U$. We back out τ_i^{θ} by inverting the households' optimal rule of allocating leisure time between online and offline activities and between domestic and foreign websites. Specifically,

$$\frac{l_{2K}}{l_{1K}} = (\theta_K + \tau_K \theta_U)^{\frac{\eta-1}{\rho-1}}$$
$$\frac{l_{2U}}{l_{1U}} = (\theta_U + \tau_U \theta_K)^{\frac{\eta-1}{\rho-1}}$$

$$\frac{l_{2KK}}{l_{2K}} = \frac{\theta_K}{\theta_K + \tau_K \theta_U}$$
$$\frac{l_{2UU}}{l_{2U}} = \frac{\theta_U}{\theta_U + \tau_U \theta_K}$$

From American Time Use Survey, the ratio of online leisure time and the other leisure time is 0.019. Assume Korean households follow the same pattern. With values of ρ and η chosen, we have

$$\theta_K + \tau_K \theta_U = \left(\frac{l_{2K}}{l_{1K}}\right)^{\frac{\rho-1}{\eta-1}} = (0.019)^6$$
$$\theta_U + \tau_U \theta_K = \left(\frac{l_{2U}}{l_{1U}}\right)^{\frac{\rho-1}{\eta-1}} = (0.019)^6$$

Using Semrush data, we find that American and Korean households spend 98% and 87% of online leisure time browsing domestic websites, respectively. Absent from any home bias, the perceived quality of a website is the same between countries and the households in each country should divide their online leisure time between domestic and foreign websites in exactly the same pattern. That Korean households spend a higher fraction of online leisure time on foreign websites indicates that Korean households are less biased against foreign websites. Combining this information with the time allocation between online and offline leisure activities, we have

$$\theta_K = \frac{l_{2KK}}{l_{2K}} (\theta_K + \tau_K \theta_U) = \underbrace{0.87}_{\frac{l_{2KK}}{l_{2K}}} \times (0.019)^6$$
$$\theta_U = \frac{l_{2UU}}{l_{2U}} (\theta_U + \tau_U \theta_K) = \underbrace{0.98}_{\frac{l_{2UU}}{l_{2U}}} \times (0.019)^6$$

and

$$\tau_K = \frac{0.13}{0.98} = 0.065$$
$$\tau_U = \frac{0.02}{0.87} = 0.023$$

From these calibrated values, we conduct numerical simulation. Overall, reductions in τ_{ij}^{θ} capture policies or cultural shifts that expand households' access to foreign content. Lowering τ_{ij}^{a} represents the removal of fiscal barriers to digital platforms, affecting both sectoral investment and international intermediation. Finally, increasing $z_{\theta i}$, the TFP of leisure technology, models an exogenous productivity shock that raises the quality of online content available to households in a given country. By comparing steady states across these parameter changes, we obtain a set of clean predictions about how households and production decisions shift across traditional and nontraditional sectors.

Table 7: Model Parameters, Definitions, Values, and Sources

Parameter	**Definition**	**Value**	**Source / Notes**
Technology			
ϕ	Share of brand equity in sector T	0.08	Share of expenditure on online advertisin
$(1-\phi)\gamma$	Share of tangible capital in sector T	0.33	Capital-to-GDP ratio
δ_a	Depreciation rate of brand equity	0.55	Corrado et al. (2024)
δ_k	Depreciation rate of tangible capital	0.06	Standard value
$\mu\alpha_1$	Share of tangible capital in sector NT	0.12	Capital share in sector NT
$\mu\alpha_2$	Share of data in sector NT	0.48	Labor share in sector NT
$1-\mu$	Share of traffic in sector NT	0.20	Authors' choice
δ_θ	Depreciation rate of online content	0.20	Corrado et al. (2024)
δ_d	Depreciation rate data capital	0.32	Corrado et al. (2024)
z_y	TFP of sector T	1	Authors' choice
z_a	TFP of sector NT, marketing service	1	Authors' choice
z_d	TFP of sector NT, data	1	Authors' choice
z_θ	TFP of sector NT, online content	1	Authors' choice
σ	Elasticity of substitution across ads services	5	Authors' choice
Preferences			
β	Discount factor	0.96	Interest rate of 10-year Treasury Bill
ψ	Disutility of labor	4.8	Share of hours worked in time endowmen
η	Frisch elasticity of leisure	1.5	Aguiar et al. (2021)
ρ	Elasticity of substitution across websites	4	Authors' choice
Wedges			
$\tau_K^\theta, \tau_U^\theta$	Restriction on foreign websites	0.065; 0.023	Semrush, ATUS
τ_K^a, τ_U^a	Tax rate on foreign digital services	0.100; 0.100	KPMG LLP (2025)

5.2 Quantitative exploration

Table 8: Household Outcomes of Policy Experiments (% change)

	Wage (%△)	Welfare (%△)	Consumption (%△)	Household Time Use		
				Hours Worked	Offline	Online
1. Elimination of restriction towards foreign leisure technology ($\tau_{ij}^{\theta} = 1$)						
Country 1	0.26	3	0.25	0.02	-5.2	5.8
Country 2	0.29	3	0.30	-0.02	-5.3	6.0
2. Elimination of digital service tax on foreign platforms ($\tau_{ij}^{a} = 0$)						
Country 1	0.39	0.15	0.3	0.2	-0.3	0.16
Country 2	0.42	0.15	0.3	0.2	-0.3	0.14
3. Increase in TFP of leisure technology in Country 1 ($z_{\theta} = 1.15$)						
Country 1	0.04	0.670	0.040	-0.009	-1.20	1.300
Country 2	0.02	0.005	0.018	0.009	-0.01	0.002

Table 9: Sectoral Outcomes of Policy Experiments

	Investment in NT			Online Ads		Size of NT Sector
	Data	Content	Tangible	Total	Imported	Value Added
1. Elimination of restriction towards foreign leisure technology ($\tau_{ij}^{\theta} = 1$)						
Country 1	-1.6	-1.6	-1.6	0.39	0.94	-0.25
Country 2	2.0	2.0	2.0	0.16	-0.95	0.25
2. Elimination of digital service tax on foreign platforms ($\tau_{ij}^{a} = 0$)						
Country 1	5	5	5	0.3	5	0.60
Country 2	5	5	5	0.4	5	0.57
3. Increase in TFP of leisure technology in Country 1 ($z_{\theta} = 1.15$)						
Country 1	0.86	0.86	0.86	-0.020	-0.4	0.113
Country 2	-0.84	-0.84	-0.84	0.081	0.4	-0.114

In Table 8, eliminating restrictions on foreign leisure technologies (setting $\tau_{ij}^{\theta} = 1$) raises welfare by about 3% in both countries, with modest increases in wages and consumption (around 0.25–0.30%). Hours worked are essentially unchanged, while offline leisure falls sharply (around 5%) and online leisure rises by nearly 6%. On the production side (Table 9), the effects are reallocation-driven rather than expansionary: Country 1's non-traditional investment contracts slightly (–1.6%) and its sectoral value-added share falls marginally, while Country 2 experiences symmetric increases in nontraditional investment (+2.0%) and a small rise in value added. Advertising volumes increase modestly in both

countries, with opposite movements in import shares. Overall, easing access to foreign online content mainly delivers large consumer-side benefits—through variety expansion and time reallocation—without significant restructuring of sectoral aggregates, consistent with time-based and choice-experiment valuations (e.g., Goolsbee and Klenow (2006); Brynjolfsson et al. (2019a); Brynjolfsson et al. (2019b)).

Removing the digital services tax on foreign platforms ($\tau_{ij}^{a} = 0$) produces smaller household gains but sharper sectoral movements. Wages and consumption increase by about 0.3–0.4%, and welfare rises slightly (0.15%), with negligible changes in time allocation. The production side responds more strongly: nontraditional investment rises by about 5% in both countries, and the nontraditional sector's value-added share grows by around 0.6 p.p. in Country 1 and 0.57 p.p. in Country 2. Advertising expands modestly overall, but the imported share increases markedly (about 5 p.p.), reflecting a stronger reliance on foreign platforms. Thus, while households see limited direct welfare gains, cheaper access to platform services stimulates nontraditional capital formation, even as intermediation purchases shift abroad.

By contrast, a 15% productivity improvement in leisure technology ($z_\theta = 1.15$) in Country 1 generates asymmetric but relatively modest effects compared to earlier calibrations, which effectively normalizes Country 1's z_θ to one. In Country 1, welfare rises by 0.67%, with small increases in wages and consumption (around 0.04%), hours worked slightly declining, and a reallocation of time from offline (–1.2%) to online leisure (+1.3%). Country 2 experiences almost no welfare change (0.005%) and negligible macroeconomic responses. Sectorally, Country 1's nontraditional investment rises by about 0.9%, its value-added share increases slightly (+0.11 p.p.), and advertising contracts minimally. Country 2 displays mirror-image declines in nontraditional investment and value added, with a small increase in advertising. Taken together, these results point to an incipient home-market effect: productivity leadership draws incremental activity toward the innovating country, though the magnitudes are far smaller than in the earlier calibration.

Overall, the three experiments highlight distinct mechanisms. Market-access reforms (removing τ_{ij}^{θ}) primarily generate large consumer surplus via love-of-variety effects and leisure reallocation, while sectoral aggregates remain mostly stable. Tax policy targeting foreign platforms (removing τ_{ij}^{a}) shifts intermediation toward foreign providers but simultaneously encourages domestic nontraditional capital formation. Productivity improvements in leisure technology reshape sectoral outcomes asymmetrically, but on a smaller scale than before. Quantitatively, percentage changes refer to levels (wages, consumption, welfare, investment, and total advertising), whereas percentage-point changes apply to shares (imported ads and nontraditional value added), as reported in Table 9.

5.3 Robustness checks

Table 10: Household Outcomes: Robustness checks (% change)

	Wage (%△)	Welfare (%△)	Consumption (%△)	Household Time Use		
				Hours Worked	Offline	Online
1. When $\rho = 4 \to 3$						
Country 1	-0.14	-1.4	-0.14	0	-2.5	-2.8
Country 2	-0.14	-1.4	-0.14	0	-2.5	-2.8
2. When $\sigma = 5 \to 4$						
Country 1	0.009	0.020	0.005	0.008	-0.040	0.040
Country 2	0.001	-0.008	-0.007	0.018	-0.000	-0.018

Table 11: Sectoral Outcomes: Robustness checks

	Investment in NT			Online Ads		Size of NT Sector
	Data	Content	Tangible	Total	Imported	Value Added
1. When $\rho = 4 \to 3$						
Country 1	0.70	0.70	0.70	-0.03	-2.8	0.095
Country 2	-0.19	-0.19	-0.19	0.03	-2.4	-0.028
2. When $\sigma = 5 \to 4$						
Country 1	0.70	0.70	0.70	-0.03	-2.8	0.095
Country 2	-0.19	-0.19	-0.19	0.03	-2.4	-0.028

Table 10 and Table 11 report results from robustness checks when considering different values of the elasticity of substitution across websites (ρ) and the elasticity of substitution across advertising services (σ), respectively. When ρ is lowered from 4 to 3, both countries experience nearly identical changes: wages and consumption fall slightly (by about 0.14 percent), welfare declines more noticeably (by about 1.4 percent), and households shift time away from offline and online leisure (around 2.5–2.8 percent decreases), while hours worked remain unchanged. At the sectoral outcomes, this parameter change mainly affects the advertising side, reducing imported online ads by about 2.4–2.8 percent, whereas investment in non-tradable intangibles and sectoral value added remain almost unchanged.

In contrast, reducing σ from 5 to 4 produces much smaller effects. Household outcomes show negligible movements, with changes close to zero and in some cases of opposite sign across countries, indicating limited sensitivity to this elasticity. Similarly, sectoral outcomes are essentially unchanged, with investment in data, content, and tangible capital, as well as the size of the nontraditional sector, remaining virtually identical to the baseline. Taken together, though the quantitative effects when considering different values of the parameters are modest, these robustness checks suggest that our main results are more sensitive to assumptions about substitution across websites than across advertising services.

6. Conclusion

This paper develops a multi-country framework that links household online leisure to global digital platforms, combining new evidence on cross-border web traffic with international trade in digital advertising services. By modeling user attention as a nonrival input and embedding platforms in a two-sector open economy, we provide a unified lens to interpret how international audiences translate into intangible capital and cross-border marketing exports.

Our quantitative experiments reveal three distinct margins. Market-access reforms, such as easing restrictions on foreign content, mainly generate large consumer-surplus gains by expanding variety and reallocating time toward online leisure, with little sectoral restructuring. Tax reforms targeting digital platforms produce only modest direct welfare effects but reorient intermediation patterns and stimulate intangible investment, illustrating how fiscal wedges shift the geography of platform activity. Technology shocks, such as productivity improvements in leisure technologies, create asymmetric home-market effects.

Together, these findings underscore the importance of household time use as a channel connecting digital platforms to global value chains. They also clarify the conditions under which policies primarily affect consumer welfare versus production structures, and they highlight how technology leadership in leisure services may gradually reinforce domestic platform advantages. Future work should extend this pilot framework to richer cross-country heterogeneity, transitional dynamics, and micro-level substitution patterns, thereby deepening our understanding of how digital platforms reorganize economic activity across borders.

Appendix

A Derivations and Proofs

A.1 Derivations of Equations (1) and (2)

For l_{2i}, the household in country i chooses a schedule of online leisure time $\{l_{2i}(\omega)\}_{\omega\in\Omega_j}$ by solving the following static subproblem:

$$\max \left[\sum_{j\in S}\int_{\omega\in\Omega_j}\left(\tau_{ij}\theta(\omega)\right)^{\frac{1}{\rho}} l_{2i}(\omega)^{\frac{\rho-1}{\rho}}\,\mathrm{d}\omega\right]^{\frac{\rho}{\rho-1}}$$
$$\text{s.t.}\ \sum_{j\in S}\int_{\Omega_j} l_{2i}(\omega)\,\mathrm{d}\omega \le l_{2i}$$

The first-order conditions with respect to $\{l_{2i}(\omega)\}_{\omega\in\Omega_j}$ and $\{l_{2i}(\omega')\}_{\omega'\in\Omega_{j'}}$ imply the following

$$\frac{l_{2i}(\omega)}{l_{2i}(\omega')} = \frac{\tau_{ij}\theta(\omega)}{\tau_{ij'}\theta(\omega')}$$

Define

$$\kappa \equiv \frac{l_{2i}(\omega)}{\tau_{ij}\theta(\omega)} = \frac{l_{2i}(\omega')}{\tau_{ij'}\theta(\omega')} \tag{20}$$

We have $\kappa\tau_{ij}\theta(\omega) = l_{2i}(\omega)$ and $\kappa\tau_{ij'}\theta(\omega') = l_{2i}(\omega')$ Integrating both sides of $\kappa\tau_{ij}\theta(\omega) = l_{2i}(\omega)$ with respect to $\omega\in\Omega_j$ and both sides of $\kappa\tau_{ij'}\theta(\omega') = l_{2i}(\omega')$ with respect to $\omega'\in\Omega_{j'}$ leads to:

$$\kappa \equiv \frac{l_{2ij}}{\theta_{ij}} = \frac{l_{2ij'}}{\theta_{ij'}},$$

where $\theta_{ij}\equiv\tau_{ij}\int_{\omega\in\Omega_j}\theta(\omega)\,\mathrm{d}\omega$. Equation (11) follows immediately. For each $i\in S$, sum both sides of $\kappa\theta_{ij} = l_{2ij}$ across j to find

$$\kappa = \frac{l_{2i}}{\Theta_i}, \tag{21}$$

where l_{2i} and Θ_i are defined in the paper. By substituting Equation (21) into Equation (20). we obtain Equation (1) in the paper.

A.2 Derivations and Proofs of Section 4

Define the cross-elasticity of leisure time on one website l_{2ij} with respect to the quality of another website $\theta_{2ij'}$:

$$\begin{aligned}\frac{\partial l_{2ij}}{\partial \theta_{ij'}}\frac{\theta_{ij'}}{l_{2ij}} &= \frac{\partial \ln l_{2ij}}{\partial \ln \Theta_i}\frac{\partial \ln \Theta_i}{\partial \ln \theta_{ij'}} \\ &= \frac{1}{\rho-1}\Theta_i^{\frac{1}{\rho-1}-1}\frac{\theta_{ij'}}{\hat{\Theta}_i} \\ &= \frac{1}{\rho-1}\frac{\theta_{ij'}}{\Theta_i} \\ &= \frac{1}{\rho-1}\frac{l_{2ij'}}{l_{2i}}\end{aligned}$$

We have the utility benefits of the online leisure

$$\begin{aligned}\left\{\sum_{j\in S}\left(\tau_{ij}\theta_j\right)^{\frac{1}{\rho}}\left(l_{2ij}\right)^{\frac{\rho-1}{\rho}}\right\}^{\frac{\rho}{\rho-1}} &= \left\{\sum_{j\in S}\left(\tau_{ij}\theta_j\right)^{\frac{1}{\rho}}\left(\kappa\tau_{ij}\theta_j\right)^{\frac{\rho-1}{\rho}}\right\}^{\frac{\rho}{\rho-1}} \\ &= \kappa\left\{\underbrace{\sum_{j\in S}\tau_{ij}\theta_j}_{\equiv\Theta_i}\right\}^{\frac{\rho}{\rho-1}} \\ &= \kappa\Theta_i^{\frac{\rho}{\rho-1}} \\ &= \frac{l_{2i}}{\Theta_i}\Theta_i^{\frac{\rho}{\rho-1}} \\ &= \Theta_i^{\frac{1}{\rho-1}}l_{2i}\end{aligned}$$

Define $\hat{\Theta}_i \equiv \Theta_i^{\frac{1}{\rho-1}}$. Now, let us consider the division of time between online and offline leisure time. The FOC implies that

$$l_{1i} = \hat{\xi}^{-\eta} \tag{22}$$

$$l_{2i} = \hat{\Theta}_i^{\eta-1}\hat{\xi}^{-\eta} \tag{23}$$

Divide Equation (23) by (22) to obtain Equation (2) in the paper.

$$
\begin{aligned}
l_i &= \left(1+\hat{\Theta}_i^{\eta-1}\right)\hat{\xi}^{-\eta} \\
\iff \hat{\xi}^{\eta} &= \left(1+\hat{\Theta}_i^{\eta-1}\right) l_i^{-1} \\
\iff \hat{\xi} &= \left(1+\hat{\Theta}_i^{\eta-1}\right)^{\frac{1}{\eta}} l_i^{-\frac{1}{\eta}}
\end{aligned}
$$

Recall $\mathrm{v}_l\left(l,\hat{\Theta}\right)=\hat{\xi}$,

$$
\frac{\partial \ln \mathrm{v}_l}{\partial \ln l} = -\frac{1}{\eta}
$$

Derivation of the Frisch elasticity of labor supply

$$
\begin{aligned}
\frac{\partial \ln H}{\partial \ln \mathrm{v}_L} &= \frac{\partial H}{\partial \mathrm{v}_L}\frac{\mathrm{v}_L}{H} \\
&= -\frac{\partial L}{\partial \mathrm{v}_L}\frac{\mathrm{v}_L}{1-L} \\
&= -\frac{\partial L}{\partial \mathrm{v}_L}\frac{\mathrm{v}_L}{L}\frac{L}{1-L} \\
&= -\frac{\partial \ln L}{\partial \ln \mathrm{v}_L}\frac{L}{1-L} \\
&= \eta\frac{L}{1-L} > 0
\end{aligned}
$$

Derivation of equation:

$$
\begin{aligned}
\frac{\partial \ln \mathrm{v}_L}{\partial \ln \hat{\Theta}} &= \frac{\partial \mathrm{v}_L}{\partial \hat{\Theta}}\frac{1}{\mathrm{v}_L}\hat{\Theta}_i \\
&= \frac{1}{\eta}\left(1+\hat{\Theta}^{\eta-1}\right)^{\frac{1}{\eta}-1} L^{-\frac{1}{\eta}}(\eta-1)\hat{\Theta}^{\eta-2}\frac{1}{\left(1+\hat{\Theta}^{\eta-1}\right)^{\frac{1}{\eta}} L^{-\frac{1}{\eta}}}\hat{\Theta}_i \\
&= \frac{\eta-1}{\eta}\underbrace{\frac{\hat{\Theta}^{\eta-1}}{1+\hat{\Theta}^{\eta-1}}}_{\equiv s,\text{the share of leisure spent online}} \\
&= \frac{s(\eta-1)}{\eta} > 0
\end{aligned}
$$

Derivation of equation:

$$\begin{aligned}
\frac{\partial \ln L}{\partial \ln \tau_{12}} &= \frac{\partial \ln L}{\partial \ln \hat{\Theta}_1} \frac{\partial \ln \hat{\Theta}_1}{\partial \ln \tau_{12}} \\
&= \frac{\partial \ln L}{\partial \ln \hat{\Theta}_1} \underbrace{\frac{1}{\rho - 1} \Theta^{\frac{1}{\rho-1}-1} \theta_2 \frac{\tau_{12}}{\hat{\Theta}_1}}_{\frac{\partial \ln \hat{\Theta}_1}{\partial \ln \tau_{12}}} \\
&= \frac{\partial \ln L}{\partial \ln \mathrm{v}_L} \frac{\partial \ln \mathrm{v}_L}{\partial \ln \hat{\Theta}_1} \underbrace{\frac{1}{\rho - 1} \hat{\Theta} \frac{\theta_2}{\Theta_1} \frac{\tau_{12}}{\hat{\Theta}_1}}_{\frac{\partial \ln \hat{\Theta}_1}{\partial \ln \tau_{12}}} \\
&= \frac{\partial \ln L}{\partial \ln \mathrm{v}_L} \frac{\partial \ln \mathrm{v}_L}{\partial \ln \hat{\Theta}_1} \underbrace{\frac{1}{\rho - 1} \frac{\tau_{12}\theta_2}{\Theta_1}}_{\frac{\partial \ln \hat{\Theta}_1}{\partial \ln \tau_{12}}} \\
&= -\eta \frac{s\left(\eta - 1\right)}{\eta} \frac{1}{\rho - 1} \frac{\tau_{12}\theta_2}{\Theta_1} \\
&= -s\left(\eta - 1\right) \frac{1}{\rho - 1} \underbrace{\frac{\tau_{12}\theta_2}{\Theta_1}}_{\in(0,1)}
\end{aligned}$$

$$\begin{aligned}
\frac{\partial \ln \left(l_{2i}/l_i\right)}{\partial \ln \tau_{12}} &= \frac{\left(\eta - 1\right) \hat{\Theta}^{\eta-2}}{\left(1 + \hat{\Theta}^{\eta-1}\right)^2} \frac{\hat{\Theta}}{\frac{\hat{\Theta}^{\eta-1}}{1+\hat{\Theta}^{\eta-1}}} \frac{1}{\rho - 1} \frac{\tau_{12}\theta_2}{\Theta_1} \\
&= \frac{1}{1 + \hat{\Theta}^{\eta-1}} \frac{\eta - 1}{\rho - 1} \frac{\tau_{12}\theta_2}{\Theta_1} \\
&= \frac{1}{1 + \hat{\Theta}^{\eta-1}} \frac{\eta - 1}{\rho - 1} \frac{\tau_{12}\theta_2}{\Theta_1}
\end{aligned}$$

A.3 Proof of Proposition 1

(1) We solve backwardly, in the second period,

$$\max \log\left(c_t\right) + \psi \frac{\left(1 + \hat{\Theta}_t^{\eta-1}\right)^{1/\eta}}{1 - 1/\eta} l_t^{1-1/\eta}$$

s.t.

$$(\mu) \qquad c_t + A_{t+1} \leq w_t\left(1 - l_t\right) + \left(1 + r_t\right) A_t$$

The FOCs w.r.t. c_{it} and l_{it}

$$[c_{it}] \qquad \frac{1}{c_{it}} = \mu$$

$$[l_{it}] \qquad \psi \left(1 + \hat{\Theta}_{it}^{\eta-1}\right)^{1/\eta} l_{it}^{-\frac{1}{\eta}} = \mu w_t$$

Combine with the budget constraint to find,

$$w_1 \psi^{-1} \left(1 + \hat{\Theta}_1^{\eta-1}\right)^{-1/\eta} l_1^{\frac{1}{\eta}} + \bar{A}_2 = w_1 (1 - l_1) + (1 + r_t) A_1$$

To study the impact of an unexpected change in Θ , we treat the asset position A_1 as pre-determined. Differentiate equation w.r.t. $\hat{\Theta}_t$ to find,

$$\begin{aligned} \frac{\partial \ln l_1}{\partial \ln \hat{\Theta}_1} &= (\eta - 1) \frac{\psi^{-1} \left(1 + \hat{\Theta}_1^{\eta-1}\right)^{-1/\eta} l_1^{\frac{1}{\eta}-1}}{\left[\psi^{-1} \left(1 + \hat{\Theta}_1^{\eta-1}\right)^{-1/\eta} l_1^{\frac{1}{\eta}-1} + \eta\right]} \frac{\hat{\Theta}_1^{\eta-1}}{\left(1 + \hat{\Theta}_1^{\eta-1}\right)} \\ &> 0 \end{aligned}$$

Since $c_1 = w\psi^{-1}\left(1+\hat{\Theta}_t^{\eta-1}\right)^{-1/\eta} l_t^{\frac{1}{\eta}}$,

$$\begin{aligned}
\frac{\partial c_1}{\partial \hat{\Theta}_1} &= (-1/\eta)\, w_1\psi^{-1}\left(1+\hat{\Theta}_1^{\eta-1}\right)^{-1/\eta-1}(\eta-1)\,\hat{\Theta}_1^{\eta-2} l_1^{\frac{1}{\eta}} + w_1\psi^{-1}\left(1+\hat{\Theta}_1^{\eta-1}\right)^{-1/\eta}\left(\frac{1}{\eta}\right) l_1^{\frac{1}{\eta}-1}\frac{\partial l_1}{\partial \hat{\Theta}_1} \\
&= (-1/\eta)\,\frac{(\eta-1)\,\hat{\Theta}_1^{\eta-2}}{\left(1+\hat{\Theta}_1^{\eta-1}\right)} w_1\psi^{-1}\left(1+\hat{\Theta}_1^{\eta-1}\right)^{-1/\eta} l_1^{\frac{1}{\eta}} + w_1\psi^{-1}\left(1+\hat{\Theta}_1^{\eta-1}\right)^{-1/\eta} l_1^{\frac{1}{\eta}}\frac{\partial l_1}{\partial \hat{\Theta}_1}\left(\frac{1}{\eta l_1}\right) \\
\frac{\partial c_1}{\partial \hat{\Theta}_1}\frac{\hat{\Theta}_1}{c_1} &= (-1/\eta)\left\{\frac{(\eta-1)\,\hat{\Theta}_1^{\eta-1}}{\left(1+\hat{\Theta}_1^{\eta-1}\right)} - \frac{\partial l_1}{\partial \hat{\Theta}_1}\left(\frac{\hat{\Theta}_1}{l_1}\right)\right\} \\
&= (-1/\eta)\left\{\frac{(\eta-1)\,\hat{\Theta}_1^{\eta-1}}{\left(1+\hat{\Theta}_1^{\eta-1}\right)} - (\eta-1)\,\frac{\psi^{-1}\left(1+\hat{\Theta}_1^{\eta-1}\right)^{-1/\eta} l_1^{\frac{1}{\eta}-1}}{\left[\psi^{-1}\left(1+\hat{\Theta}_1^{\eta-1}\right)^{-1/\eta} l_1^{\frac{1}{\eta}-1}+\eta\right]}\frac{\hat{\Theta}_1^{\eta-1}}{\left(1+\hat{\Theta}_1^{\eta-1}\right)}\right\} \\
&= (-1/\eta)\left\{1 - \frac{\psi^{-1}\left(1+\hat{\Theta}_1^{\eta-1}\right)^{-1/\eta} l_1^{\frac{1}{\eta}-1}}{\left[\psi^{-1}\left(1+\hat{\Theta}_1^{\eta-1}\right)^{-1/\eta} l_1^{\frac{1}{\eta}-1}+\eta\right]}\right\} \\
&= (-1/\eta)\left\{\frac{\eta}{\left[\psi^{-1}\left(1+\hat{\Theta}_1^{\eta-1}\right)^{-1/\eta} l_1^{\frac{1}{\eta}-1}+\eta\right]}\right\} \\
&= -\frac{1}{\left[\psi^{-1}\left(1+\hat{\Theta}_1^{\eta-1}\right)^{-1/\eta} l_1^{\frac{1}{\eta}-1}+\eta\right]} \\
&< 0
\end{aligned}$$

(2) To study the impact of anticipated change of Θ_t , we solve the household problem with the consolidated budget constraint,

$$\max\left[\log(c_{i0}) + \psi\frac{1}{1-\frac{1}{\eta}}\left(1+\Theta_{i0}^{\frac{\eta-1}{\rho-1}}\right)^{\frac{1}{\eta}} l_{1i0}^{\frac{\eta-1}{\eta}}\right] + \left[\log(c_{i1}) + \psi\frac{1}{1-\frac{1}{\eta}}\left(1+\Theta_{i1}^{\frac{\eta-1}{\rho-1}}\right)^{\frac{1}{\eta}} l_{1it}^{\frac{\eta-1}{\eta}}\right]$$

$$c_0 + \frac{c_1}{(1+r_1)} + \frac{A_2}{(1+r_1)} \leq w_0 h_0 + \frac{w_1 h_1}{(1+r_1)} + (1+r_0)\,A_0$$

The FOCs w.r.t. c_{it} and l_{it}

$$[c_{it}] \qquad \frac{1}{c_{it}} = \mu$$

$$[l_{it}] \qquad \psi \left(1 + \hat{\Theta}_{it}^{\eta-1}\right)^{1/\eta} l_{it}^{-\frac{1}{\eta}} = \mu w_t$$

Combine with the budget constraint to find,

$$w_1 \psi^{-1} \left(1 + \hat{\Theta}_1^{\eta-1}\right)^{-1/\eta} l_1^{\frac{1}{\eta}} + \bar{A}_2 = w_1 (1 - l_1) + (1 + r_t) A_1$$

To study the impact of an unexpected change in Θ , we treat the asset position A_1 as pre-determined. Differentiate equation w.r.t. $\hat{\Theta}_t$ to find,

$$\frac{\partial \ln l_1}{\partial \ln \hat{\Theta}_1} = (\eta - 1) \frac{\psi^{-1} \left(1 + \hat{\Theta}_1^{\eta-1}\right)^{-1/\eta} l_1^{\frac{1}{\eta}-1}}{\left[\psi^{-1} \left(1 + \hat{\Theta}_1^{\eta-1}\right)^{-1/\eta} l_1^{\frac{1}{\eta}-1} + \eta\right]} \frac{\hat{\Theta}_1^{\eta-1}}{\left(1 + \hat{\Theta}_1^{\eta-1}\right)}$$

$$> 0$$

The FOCs are

$$
\begin{aligned}
[\partial_{c_0}] \quad & \frac{1}{c_{i0}} = \lambda \\
[\partial_{c_1}] \quad & \frac{1}{c_{i1}} = \lambda \frac{1}{1+r_1} \\
[\partial_{l_0}] \quad & \psi \left(1 + \Theta_0^{\frac{\eta-1}{\rho-1}}\right)^{\frac{1}{\eta}} l_0^{-\frac{1}{\eta}} = \lambda w_0 \\
[\partial_{l_1}] \quad & \psi \left(1 + \Theta_1^{\frac{\eta-1}{\rho-1}}\right)^{\frac{1}{\eta}} l_1^{-\frac{1}{\eta}} = \lambda w_1 \frac{1}{1+r_1}
\end{aligned}
$$

Substitute into the budget constraint, we have the following equation that pins down λ,

$$
\begin{aligned}
\frac{1}{\lambda} + \frac{1}{\lambda} + \frac{A_2}{(1+r_1)} &= w_0 \left[1 - (\lambda w_0)^{-\eta} \psi^{\eta} \left(1 + \Theta_0^{\frac{\eta-1}{\rho-1}}\right)\right] \\
&\quad + \frac{w_1}{1+r_1} \left[1 - (\lambda w_1)^{-\eta} (1+r_1)^{\eta} (\beta\psi)^{\eta} \left(1 + \Theta_1^{\frac{\eta-1}{\rho-1}}\right)\right] + (1+r_0) A_0 \\
\frac{2}{\lambda} &= \left[w_0 + w_1 + (1+r_0) A_0 - \frac{A_2}{(1+r_1)}\right] \\
&\quad - \lambda^{-\eta} \psi^{\eta} \left[w_0^{1-\eta} \left(1 + \hat{\Theta}_0^{\eta-1}\right) + \left(\frac{w_1}{1+r_1}\right)^{1-\eta} \left(1 + \hat{\Theta}_1^{\eta-1}\right)\right]
\end{aligned}
$$

Differentiate both sides w.r.t. $\hat{\Theta}_1$,

$$
\begin{aligned}
-\frac{2}{\lambda^2} \frac{\partial \lambda}{\partial \hat{\Theta}_1} &= \eta \lambda^{-\eta-1} \frac{\partial \lambda}{\partial \hat{\Theta}_1} \psi^{\eta} \left[w_0^{1-\eta} \left(1 + \hat{\Theta}_0^{\eta-1}\right) + \left(\frac{w_1}{1+r_1}\right)^{1-\eta} \left(1 + \hat{\Theta}_1^{\eta-1}\right)\right] \\
&\quad - \lambda^{-\eta} \psi^{\eta} \left(\frac{w_1}{1+r_1}\right)^{1-\eta} (\eta - 1) \hat{\Theta}_1^{\eta-2}
\end{aligned}
$$

Multiply both sides by $\lambda\hat{\Theta}_1$,

$$\begin{aligned}
-2\frac{\partial\lambda}{\partial\hat{\Theta}_1}\frac{\hat{\Theta}_1}{\lambda} =& \eta\lambda^{1-\eta}\psi^{\eta}\left[w_0^{1-\eta}\left(1+\hat{\Theta}_0^{\eta-1}\right)+\left(\frac{w_1}{1+r_1}\right)^{1-\eta}\left(1+\hat{\Theta}_1^{\eta-1}\right)\right]\frac{\partial\lambda}{\partial\Theta}\frac{\hat{\Theta}_1}{\lambda} \\
& -\lambda^{1-\eta}\psi^{\eta}\left(\frac{w_1}{1+r_1}\right)^{1-\eta}(\eta-1)\hat{\Theta}_1^{\eta-1} \\
\lambda^{1-\eta}\psi^{\eta}\left(\frac{w_1}{1+r_1}\right)^{1-\eta}(\eta-1)\hat{\Theta}_1^{\eta-1} =& \left\{\eta\lambda^{1-\eta}\psi^{\eta}\left[w_0^{1-\eta}\left(1+\hat{\Theta}_0^{\eta-1}\right)+\left(\frac{w_1}{1+r_1}\right)^{1-\eta}\left(1+\hat{\Theta}_1^{\eta-1}\right)\right]+2\right\}\frac{\partial\lambda}{\partial\hat{\Theta}_1}\frac{\hat{\Theta}_1}{\lambda} \\
\frac{\partial\ln\lambda}{\partial\ln\hat{\Theta}_1} =& \frac{\lambda^{1-\eta}\psi^{\eta}\left(\frac{w_1}{1+r_1}\right)^{1-\eta}(\eta-1)\hat{\Theta}_1^{\eta-1}}{\eta\lambda^{1-\eta}\psi^{\eta}\left[w_0^{1-\eta}\left(1+\hat{\Theta}_0^{\eta-1}\right)+\left(\frac{w_1}{1+r_1}\right)^{1-\eta}\left(1+\hat{\Theta}_1^{\eta-1}\right)\right]+2} \\
=& \frac{\lambda(\eta-1)\left(\frac{w_1}{1+r_1}\right)\underbrace{\psi^{\eta}\left(\frac{\lambda w_1}{1+r_1}\right)^{-\eta}\hat{\Theta}_1^{\eta-1}}_{l_{2,1}}}{\eta\lambda\left[w_0\underbrace{\psi^{\eta}(\lambda w_0)^{-\eta}\left(1+\hat{\Theta}_0^{\eta-1}\right)}_{l_{2,0}}+\frac{w_1}{1+r_1}\underbrace{\psi^{\eta}\left(\frac{\lambda w_1}{1+r_1}\right)^{-\eta}\left(1+\hat{\Theta}_1^{\eta-1}\right)}_{l_{2,1}}\right]+2} \\
=& \frac{\lambda(\eta-1)\left(\frac{w_1}{1+r_1}\right)l_{2,1}}{\eta\lambda\left[w_0 l_{2,0}+\frac{w_1 l_{2,1}}{1+r_1}\right]+2} \\
>& 0
\end{aligned}$$

where in the second last line, we use what is implied from the FOCs

$$\begin{aligned}
l_0 &= (\lambda w_0)^{-\eta}\psi^{\eta}\left(1+\hat{\Theta}_0^{\eta-1}\right) \\
l_1 &= \left(\frac{\lambda w_1}{1+r_1}\right)^{-\eta}\psi^{\eta}\left(1+\hat{\Theta}_1^{\eta-1}\right)
\end{aligned}$$

$$\frac{l_{2,t}}{l_t} = \frac{\hat{\Theta}_t^{\eta-1}}{1+\hat{\Theta}_t^{\eta-1}}$$

From the FOCs,

$$\frac{\partial \ln c_0}{\partial \ln \lambda} < 0$$
$$\frac{\partial \ln c_1}{\partial \ln \lambda} < 0$$
$$\frac{\partial \ln l_0}{\partial \ln \lambda} = -\eta < 0$$

Then

$$\frac{\partial \ln c_0}{\partial \ln \hat{\Theta}_1} = \frac{\partial \ln c_0}{\partial \ln \lambda} \frac{\partial \ln \lambda}{\partial \ln \hat{\Theta}_1} < 0$$
$$\frac{\partial \ln c_1}{\partial \ln \hat{\Theta}_1} = \frac{\partial \ln c_1}{\partial \ln \lambda} \frac{\partial \ln \lambda}{\partial \ln \hat{\Theta}_1} < 0$$
$$\frac{\partial \ln l_0}{\partial \ln \hat{\Theta}_1} = \frac{\partial \ln l_0}{\partial \ln \lambda} \frac{\partial \ln \lambda}{\partial \ln \hat{\Theta}_1} < 0$$

Therefore, when $\hat{\Theta}$ increases, λ increases, and the households consume less in both periods and work more in the first period. Hence the households have more savings at the end of the first period. Next we show that the households enjoy more leisure in the second period. From the FOC w.r.t. l_1,

$$l_1 = \left(\frac{\lambda w_1}{1+r_1}\right)^{-\eta} \psi^{\eta} \left(1 + \Theta_1^{\frac{\eta-1}{\rho-1}}\right)$$

Differentiate both sides w.r.t. $\hat{\Theta}_1$,

$$\begin{aligned}
\frac{\partial l_1}{\partial \hat{\Theta}_1} =& \left(\frac{\lambda w_1}{1+r_1}\right)^{-\eta} \psi^{\eta}\left(1+\hat{\Theta}_1^{\eta-1}\right)\left\{-\eta\frac{1}{\lambda}\frac{\partial \lambda}{\partial \hat{\Theta}_1}+\frac{1}{1+\hat{\Theta}_1^{\eta-1}}(\eta-1)\hat{\Theta}_1^{\eta-2}\right\} \\
\text{factor out } \frac{1}{\hat{\Theta}},=& \left(\frac{\lambda w_1}{1+r_1}\right)^{-\eta} \psi^{\eta}\left(1+\hat{\Theta}_1^{\eta-1}\right)\frac{1}{\hat{\Theta}}\left\{-\eta\frac{\partial \lambda}{\partial \hat{\Theta}_1}\frac{\hat{\Theta}}{\lambda}+(\eta-1)\frac{\hat{\Theta}_1^{\eta-1}}{1+\hat{\Theta}_1^{\eta-1}}\right\} \\
=& \left(\frac{\lambda w_1}{1+r_1}\right)^{-\eta} \psi^{\eta}\left(1+\hat{\Theta}_1^{\eta-1}\right)\frac{1}{\hat{\Theta}}\times \\
& \left\{-\eta\frac{\lambda(\eta-1)\left(\frac{w_1}{1+r_1}\right)\psi^{\eta}\left(\frac{\lambda w_1}{1+r_1}\right)^{-\eta}\hat{\Theta}_1^{\eta-1}}{\left\{\eta\lambda\left[w_0\psi^{\eta}(\lambda w_0)^{-\eta}\left(1+\hat{\Theta}_0^{\eta-1}\right)+\frac{w_1}{1+r_1}\psi^{\eta}\left(\frac{\lambda w_1}{1+r_1}\right)^{-\eta}\left(1+\hat{\Theta}_1^{\eta-1}\right)\right]+2\right\}}\right. \\
& \left.+(\eta-1)\frac{\hat{\Theta}_1^{\eta-1}}{1+\hat{\Theta}_1^{\eta-1}}\right. \\
\text{factor out } \frac{(\eta-1)\hat{\Theta}_1^{\eta-1}}{1+\hat{\Theta}_1^{\eta-1}},=& \underbrace{\left(\frac{\lambda w_1}{1+r_1}\right)^{-\eta} \psi^{\eta}\left(1+\hat{\Theta}_1^{\eta-1}\right)}_{l_1}\frac{1}{\hat{\Theta}}(\eta-1)\frac{\hat{\Theta}_1^{\eta-1}}{1+\hat{\Theta}_1^{\eta-1}} \\
& \times\left\{-\eta\frac{\lambda\left(\frac{w_1}{1+r_1}\right)\psi^{\eta}\left(\frac{\lambda w_1}{1+r_1}\right)^{-\eta}\left(1+\hat{\Theta}_1^{\eta-1}\right)}{\left\{\eta\lambda\left[w_0\psi^{\eta}(\lambda w_0)^{-\eta}\left(1+\hat{\Theta}_0^{\eta-1}\right)+\frac{w_1}{1+r_1}\psi^{\eta}\left(\frac{\lambda w_1}{1+r_1}\right)^{-\eta}\left(1+\hat{\Theta}_1^{\eta-1}\right)\right]+2\right\}}+1\right\} \\
=& \frac{l_1}{\hat{\Theta}}(\eta-1)\frac{\hat{\Theta}_1^{\eta-1}}{1+\hat{\Theta}_1^{\eta-1}}\left\{-\eta\frac{\lambda\left(\frac{w_1 l_1}{1+r_1}\right)}{\left\{\eta\lambda\left[w_0 l_0+\frac{w_1 l_1}{1+r_1}\right]+2\right\}}+1\right\}
\end{aligned}$$

Multiply both sides by $\left(\frac{l_1}{\hat{\Theta}}\right)^{-1}$,

$$\frac{\partial \ln l_1}{\partial \ln \hat{\Theta}_1} = (\eta-1)\frac{\hat{\Theta}_1^{\eta-1}}{1+\hat{\Theta}_1^{\eta-1}}\left\{-\eta\frac{\lambda\left(\frac{w_1 l_1}{1+r_1}\right)}{\left\{\eta\lambda\left[w_0 l_0+\frac{w_1 l_1}{1+r_1}\right]+2\right\}}+1\right\}$$

Since

$$\begin{aligned}
-\eta\frac{\lambda\left(\frac{w_1 l_1}{1+r_1}\right)}{\left\{\eta\lambda\left[w_0 l_0+\frac{w_1 l_1}{1+r_1}\right]+2\right\}} &> -\eta\frac{\lambda\left(\frac{w_1 l_1}{1+r_1}\right)}{\eta\lambda\left[w_0 l_0+\frac{w_1 l_1}{1+r_1}\right]} = -\frac{\frac{w_1 l_1}{1+r_1}}{w_0 l_0+\frac{w_1 l_1}{1+r_1}} \\
-\eta\frac{\lambda\left(\frac{w_1 l_1}{1+r_1}\right)}{\left\{\eta\lambda\left[w_0 l_0+\frac{w_1 l_1}{1+r_1}\right]+2\right\}}+1 &> \frac{w_0 l_0}{w_0 l_0+\frac{w_1 l_1}{1+r_1}},
\end{aligned}$$

we have

$$\begin{aligned}
\frac{\partial \ln l_1}{\partial \ln \hat{\Theta}_1} &> (\eta-1)\frac{\hat{\Theta}_1^{\eta-1}}{1+\hat{\Theta}_1^{\eta-1}}\frac{w_0 l_0}{w_0 l_0+\frac{w_1 l_1}{1+r_1}} \\
&> 0
\end{aligned}$$

So the households enjoy more leisure in the second period.

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국문요약

본 연구에서는 플랫폼 기업이 온라인 활동에서 발생하는 웹 트래픽(방문)을 내부 알고리즘(빅데이터, 인공지능 등)을 통해 데이터 자본으로 전환하고, 이를 비경합적 요소로 활용하는 다국가·다산업 개방경제 일반균형 모형을 제시한다. 웹 트래픽과 기업 소유 정보를 연결하여 구축한 데이터에 따르면, 국가별 대표 플랫폼 기업 도메인에 축적되는 트래픽의 발원지는 국가마다 뚜렷한 차이를 보였다. 미국 도메인의 경우 자국 발원 트래픽은 평균 3분의 1 이하에 불과했으며, 중국은 국제적 사용자층을 보유한 TikTok을 제외하면 약 3분의 2가 해외에서 유입되었다. 반면 한국 도메인의 경우 해외 발원 트래픽은 10% 미만으로 나타났다. 이러한 결과를 초국적 서비스 데이터와 비교한 결과, 해외 이용자 비중이 높은 국가일수록 온라인 서비스 수출 규모가 큰 것으로 확인되었다.

정성적 분석 결과, 소비자는 플랫폼 기업이 운영하는 웹사이트 콘텐츠에 대한 만족도가 높을수록 더 많은 시간을 해당 사이트에 배분하였다. 만족도는 웹사이트의 기술력과 국가별 콘텐츠 선호에 의해 결정되었으며, 외국 플랫폼 콘텐츠가 발전하면 자국 플랫폼에 대한 시간 배분은 줄어들고 외국 플랫폼에서 더 오래 머무는 경향이 나타났다. 이때 대체 정도는 여가 수요 탄력성, 플랫폼 간 대체 탄력성, 그리고 외국 플랫폼에 이미 배분된 시간 비중에 의해 영향을 받았다.

모형 시뮬레이션 결과, 해외 콘텐츠에 대한 마찰이 완화될 경우 양국 모두에서 후생이 상승하였으며, 이는 콘텐츠 다양성 확대와 시간 재배분 효과에 기인한 것으로 나타났다. 산업 구조 변화는 제한적이었으나, 해외 플랫폼과의 마찰 완화는 플랫폼 기업 수익 확대, 소비자의 온라인 여가시간 증가, 국내 플랫폼에 대한 투자 유인 강화로 이어졌다. 또한 플랫폼 콘텐츠 연구개발의 생산성이 상승할 경우, 혁신 국가에서는 플랫폼 생산이 활성화되었으나 비혁신 국가는 상대적으로 불리한 영향을 받았다. 그럼에도 양국 모두 후생은 상승하였다. 이러한 분석 결과는 웹 트래픽 기반 데이터 자본의 축적이 플랫폼 기업 성장의 핵심적 요인임을 시사한다.

핵심용어: 국가 간 시간배분, 온라인 여가 활동, 디지털 플랫폼, 국가 간 서비스 무역, 비경합성, 무형 자산

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저서 및 논문

『무역이 국내 노동 재배치에 미친 영향과 정책 시사점』(공저, 2024)
"Dynamics of U.S. Tax Progressivity: A Quantile Approach" (공저, 2025) 외

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