



On real estate market transparency: The relationship with ICT trade and investment

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ABSTRACT

The relationship between information and communication technology (ICT) investment, ICT trade, and real estate market transparency is examined in this paper. National-level bi-annual data from a sample of advanced and emerging market economies for the period 2004–2018 underpins this work. The regression analyses suggest greater levels of capital investment in ICT and ICT trade are associated with increased transparency in the real estate market. The effect is more pronounced in emerging economies than in advanced ones. Real estate market transparency is also higher in contexts having less restrictions on foreign real estate investment, coupled with corruption controls. These findings also align with existing literature inferring that countries with common law traditions are often more transparent than those from civil law origins.

1. Introduction

Although the COVID-19 pandemic greatly slowed or halted investment in commercial properties worldwide, the immediate overriding trend is for rising capital allocations in real estate (JLL, 2020). This is reflected in land administration system activity, where initial short-term reductions in transfer requests were swiftly countered by unprecedented land market activity (FAO/UNECE/FIG, 2022). Real estate continues to be one of the world's largest asset class by value and remains a vital part of global investment strategies (JLL, 2020). Consequently, real estate market transparency (*Transparency*, hereafter) is crucial for investors: it is essential for understanding the market's risk dimensions (JLL, 2016, 2020; Newell, 2016, 2021).

There is a widespread acceptance amongst policymakers and land sector specialists that a transparent real estate sector contributes significantly to not only attracting new investment and business activity but also: enables sound long-term governmental planning; supports fair and responsible taxation and enforcement; enhances community well-being, through provision of land tenure security and reduced land disputes; safeguards the business environment; stabilizes environmental

and social conditions; improves the efficiency in building processes; reduces transaction costs; and promotes innovation in the construction industry (JLL, 2014, 2016, 2020; Graafland and Nijhof, 2007; Zakout et al., 2006; Henssen, 2010).

The real estate sector interests a variety of investors ranging from corporations, governments, communities, trusts, pension funds to private individuals. Consequently, its transparency should generate a healthy and honest business environment benefiting all its participants at the national and international levels (JLL, 2020). Despite growing recognition of real estate market transparency, the land sector remains cited as one of the most corrupted in many contexts (Wehrmann, 2008; Wren-Lewis, 2013), with the lack of transaction transparency a key enabling factor. This applies to more developed contexts but is particularly pronounced in developing economies (Papić Brankov and Tanjević, 2013). That said, corruption is not easily defined (Wang and Rosenau, 2001). Subsequently, it is important to note that what is defined as corruption in the global land sector discourse, is often understood as normal business practice in other places.

Regardless, many national governments are increasingly responsive to the negative impacts of an opaque land sector. They develop policy,

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legislative, procedural, or ICT-related interventions (c.f., Akingbade et al., 2012). At the global donor investment level, organizations including Transparency International (Kimeu, 2014), and the World Bank through its 'Ease of Doing Business' initiative (c.f., Deininger and Feder, 2009), have sought to create awareness and regular quantitative reporting of transparency-related land sector indicators at the national level. Perhaps ironically, the 'Doing Business' reports were discontinued in 2021 due to identified 'data irregularities' and 'gaming' of the process by various participants in the real estate sector (Broome, 2022).

Despite perceptions of lack of progress, given the crucial importance of transparency in the local and global real estate markets, there continues to be growing demand for studies on the effect of *transparency* on various activities such as foreign real estate investment, property development, state land management, property occupation, sellers' property pricing strategies, real estate transaction volume, and financial stability (see inter alia Eichholtz et al., 2011; Gholipour, 2013; Gholipour and Masron, 2013; Farzanegan and Gholipour, 2014; Gholipour et al., 2020; JLL, 2006, 2010, 2016; Lieser and Groh, 2014; Newell, 2016, 2021; Burns et al., 2007; Zimmermann, 2008; Bagdai et al., 2012). However, there is still very limited empirical research on determinants of, as opposed to levels of (c.f., Kimeu, 2014), *transparency* across countries and over time (Newell, 2008; Ionaşcu et al., 2019). Moreover, quantitative examinations, from a global perspective, on the relationship between real estate market transparency and investments and trade in ICT are scarce.

Therefore, the aim of this study is to understand how technological advances at a country-level relate to real estate market transparency. This can be a crucial factor and are already heavily explored in terms of methods for systems development, and implementation in the land administration literature (Deininger et al., 2010; Lemmen et al., 2015; McLaren et al., 2018; Hendriks et al., 2019; Bennett et al., 2019). However, less explored, in a robust quantitative sense, are the impacts and outcomes these technological implementations produce for the real estate market.

Before outlining how the intended outcomes are to be achieved, several key constructs are defined. For the purposes of this work, real estate transparency (*Transparency*) is defined as "an open and clearly organized market operating in a legal and regulatory framework that is characterized by a consistent approach" with the enforcement of "rules and regulations" (JLL, 2016). "Respect of private property rights and high ethical and professional standards" are also included in JLL's definition of real estate transparency. *ICT investment* is defined as "capital investment in telecommunications" and "refers to the costs of obtaining ownership of telecommunications equipment and infrastructure (including supporting land and buildings and intellectual and non-tangible property, such as, computer software)". Meanwhile *ICT trade* refers to imports and exports of information and communication technology goods. See Table A2 for the complete definition of variables.

In response to the overarching questions, empirical examination is undertaken to determine whether capital investment in ICT, and higher levels of ICT trade relate to higher *Transparency* – after controlling, as best as possible, for other key economic and institutional determinants. These outcomes also discover if the magnitude and significance of the links between ICT investment, ICT trade and *Transparency* vary in economies at different stages of development. For this purpose, sample countries are categorized into two sub-categories of: i) advanced countries and ii) emerging economies. See Table A1 for the complete list of countries and categorization. Justification of this categorization lies with its alignment to International Monetary Fund (IMF) definitions and classifications: 1) advanced; 2) emerging; and 3) low-income.¹ It needs to be stated that since the sample includes very few group 3 countries,

¹ For specific IMF definitions see: <https://www.imf.org/external/databrowser/datasets/FM#:~:text=The%20country%20classification%20in%20the, revised%20to%20broaden%20country%20coverage>

for purposes of this study, groups 2 and 3 are combined as 'emerging economies'.

This research is highly timely and pertinent: many emerging and advanced economies have recently and significantly increased expenditures on digitalization and information technology: further acceleration was witnessed during the COVID-19 pandemic (FAO/UNECE/FIG, 2022). More broadly, according to Euromonitor International (2021), the world's capital investment in telecommunications has grown in the last decade from about US\$349,810 million (fixed 2020 exchange rates) in 2010 to around US\$421,084 million in 2020, with an average annual growth rate of approximately 2%. This undertaking has in turn enhanced market information, improved transaction processes, expanded efficiency and productivity, stimulated their economic growth, alleviated poverty, increased foreign direct investment, and improved public health outcomes (Gholami et al., 2006; Jha et al., 2016; JLL, 2020; Venkatesh et al., 2020).

ICT trade also accounts for a significant portion of the total goods traded in advanced and emerging economies. According to the World Bank (2021a) (2021b), ICT imports and exports account respectively for approximately 12% and 11% of total goods imported and exported globally over the past decade. This coincides with the growing recognition that a country's productivity can be closely linked to the efficiency of its telecommunications system (van Ark, 2002; van Ark et al., 2003; Nordhaus, 2002; Chavula, 2013). It also presumes that high levels of ICT trade are likely to be soundly correlated with the progress of a reasonably strong ICT system at the macro and organizational levels (Waverman et al., 2011). This is best explained by telecommunication systems essentially responding to a range of changing demands and technology-driven innovative opportunities. These require up-to-date ICT infrastructure and accompanying systems (Adam, 1996; McCormick, 2003; Chavula, 2013).

The study seeks to contribute to the literature in two ways. Firstly, although several researchers use correlation analyses to understand the determinants of *Transparency* (e.g., Newell, 2008; Ionaşcu et al., 2019), to the best of the authors' knowledge, there is a lack of empirical studies on the determinants of *Transparency* across a large sample of countries over time, and by applying multivariate regressions. Secondly, no previous study has examined the link between ICT investment, ICT trade and sub-components of *Transparency*. As is discussed later in the data and methodology section, five sub-components of the *Real Estate Transparency Index* are employed in this work. These are *Performance measurement*, *Market fundamentals*, *Governance of listed vehicles*, *Regulatory and legal*, and *Transaction process* (JLL, 2020).² Therefore, this analysis provides new insights about the role of ICT in enhancing transparency in various aspects of the real estate market.

The article proceeds as follows. Section 2 reviews the relevant literature while Section 3 describes the employed data, chosen variables and estimation method. Section 4 presents the results and Section 5 concludes the paper, summarizing key findings, potential limitations, and further work required.

2. Literature review

In this study, we utilize the comprehensive measure of real estate transparency provided by Jones Lang LaSalle (JLL), a metric widely acknowledged and employed within the field. While JLL does not provide an explicit definition of transparency, they describe a market as highly transparent when it satisfies several criteria. Firstly, a transparent market is characterized by the availability of high-quality fundamental market data. This includes time-series data on property rents for various sectors (such as, office, retail, industrial, and residential spaces) and key

² This index also contains a *Sustainability* component which is not considered in this study because: firstly, its data is only available from 2012; and secondly, there are several missing values for some emerging countries.

performance indicators, such as, the presence of a direct property index. Secondly, detailed information regarding the governance of listed vehicles, including the free float share of the public real estate market, should be readily available. Thirdly, these measures place an emphasis on the accessibility of high-quality information about the transaction process. This involves elements such as the fairness of the bidding process, which should be clearly detailed and understood by all parties involved. Fourthly, the JLL measure underscores the importance of operating within a clear and well-understood regulatory and legal framework. Examples of this criterion include mandatory requirements for lenders to conduct comprehensive real estate appraisals. Lastly, a highly transparent market, according to JLL's criteria, is one that aligns with sustainability targets. This involves components like the existence of a green building financial performance index, indicating the market's emphasis on environmentally conscious and sustainable practices.

These criteria collectively serve to mitigate the potential for information asymmetry within the real estate market. By ensuring broad and equal access to high-quality data, clear transaction processes, and comprehensive regulatory information, the potential for certain actors to possess more or better information than others is reduced. However, while JLL's measure helps to identify markets that promote equitable access to information, the potential for information asymmetry can never be fully eliminated. Factors, for example, imminent legal changes or exclusive insider information can still lead to imbalances, despite a market's overall transparency. As a result, it is generally anticipated that a more transparent real estate sector can attract a greater number of investors in comparison to sectors with less transparency (Gholipour and Masron, 2013).

Technology and infrastructure for telecommunications are believed to be among the most important factors correlated with high levels of transparency in the real estate market as, amongst others, they: firstly, determine the speed of information flow; and secondly, reduce asymmetric information. In this way, they contribute to better performance if the market is characterized as being very economically efficient (JLL, 2022; Ionaşcu and Anghel, 2020).³ This is because trading real estate is a complex process with multiple interventions of various entities. It includes transaction costs, for instance, those specific to search cost/time, legal and administrative costs (including real-estate agent fees, conveyancing or notarial work, surveying and mapping, and government fees, duties and taxes), adjustment costs, financial costs, as well as uncertainty costs (Quigley, 2003). The higher these costs, the poorer the transparency of the real estate market (Lieser and Groh, 2011). ICT development can vastly diminish informational asymmetry and corruption where there are appropriate ICT laws in place (Adam and Fazekas, 2021). Also required are supportive policies relating to institutional accountability, sustainable system financing and maintenance (Bennett et al., 2021a), data access laws, enabling innovation, education and training, and community awareness raising, amongst other aspects (c.f., Framework for Effective Land Administration, endorsed by UNGGIM August 2020; UNGGIM (2020).

Empirical literature on measuring the factors contributing to transparency of real estate markets is quite limited (Newell, 2016; Ionaşcu et al., 2019). Most relevant studies have investigated ICT impacts on corruption in general (Bertot et al., 2010; Kuriyan et al., 2011; Subhajyoti, 2012; Davies and Fumega, 2014; Akingbade et al., 2012). A transparent housing market is seen as one with low or ideally, no levels of corruption, where information can be accessed, and where the market

functions on the basis 'rule of law' and respect for private property law, in a consistent fashion (Triantafyllopoulos, 2006; Ionaşcu et al., 2019). In a recent systematic and comprehensive review of academic and policy literature, Adam and Fazekas (2021) provide detailed insights on the positive and negative outcomes that ICT can generate for anti-corruption strategies. Their review considered the characteristics of six different ICT tools which are commonly used both *against* and *for* corruption.

These ICT-based anti-corruption interventions are: (i) Digital public services (sub-forms of e-governments which involve the use of ICT for the delivery of public services); (ii) Crowdsourcing platforms (primarily used for collecting incidents of petty corruption in the public sector as experienced by a larger group of citizens); (iii) Whistleblowing tools (similar to crowdsourcing, but, gathering more detailed reports related to individuals, whilst presumably protecting the personal data of those individuals, as well as larger and grand corruption cases); (iv) Transparency portals and big data (online platforms mainly publishing information on government operations); (v) Distributed ledger technology and blockchain (decentralized and synchronized databases upheld by a peer-to-peer network), notwithstanding the challenges facing any implementation of substantive scale in the real-estate sector (c.f., Arruñada, 2018); and (vi) Artificial intelligence technologies (learning algorithms that make predictions based on a given set of examples and the obtained relationships can greatly assist policy-making and policy implementation).

Adam and Fazekas (2021) findings highlight that although most studies consider ICT development as a positive force in the fight against corruption, many have largely neglected its potentially negative features, for example, creating new risks and threats, including increasing opportunities for corruption. In other words, it is notable that "ICT is not per se a panacea against corruption, and it can also play into the hands of corrupt officials" (Adam and Fazekas, 2021, p. 12). Hence, one should not presume that the impact of ICT on the market's efficiency will be definitely positive. Another important insight of their study is that any potential benefits ICT may bring in terms of acting as instruments for anti-corruption, relies greatly on extra factors including political structures, infrastructures, legal systems, and social and economic mechanisms. Therefore, policymakers need to cautiously consider: firstly, the misuse risks of ICT systems; and secondly, their suitability for local conditions, cultural backgrounds, and technological skills (Helbig et al., 2009).

Regarding ICT development and its effects on market efficiency, most previous studies focus on ICT's influence on financial markets. Among the earliest studies on the impacts of ICT on the efficiency of such markets, Hobijn and Jovanovic (2001) found that the rise of the ICT revolution in the 1970 s favored the creation of new businesses: many older firms could not implement emerging digital technologies. Therefore, stock prices of incumbents fell steeply and rapidly. Hobijn and Jovanovic (2001) believed that older firms did not have the appropriate awareness and skills, and vested interests and were therefore disadvantaged in adopting new technologies. Gu and Finnerty (2002) analyzed the evolution of the US stock market's efficiency using 103 years of daily data (1896–1998). They argued that significant technological advances in the most recent decades and the growing ability of investors to use and examine relevant information promptly made the market much more efficient. This demonstrates statistically that improved market efficiency was in fact due to reduced autocorrelation. This meant investors could incorporate a previous period's pattern of market behavior into their trading strategies, thanks to ICT and new technologies.

Focusing on the real estate market specifically, most studies have examined the impact of market transparency on real estate-related performance variables (e.g., Eichholtz et al., 2011; Gholipour, 2013; Gholipour and Masron, 2013; Farzanegan and Gholipour, 2014; Gholipour et al., 2020; Newell, 2016, 2021). Of the most recent studies, Ionaşcu et al. (2021) analysed the reaction of housing prices to changes in market transparency using JLL's Global Real Estate Transparency

³ New digital technologies serve the purpose of improving transparency in real estate by offering new solutions to increase the efficiency and productivity of real estate activities (Ionaşcu and Anghel, 2020). For example, the drive to improve productivity and uncover new revenue streams has spurred a rapid increase in the use of real estate technology platforms. The availability of new, high-frequency and more granular data is boosting the transparency of real estate in ways that were unimaginable just a decade ago (JLL, 2022).

Index. Utilizing a biannual panel of 21 European metropolitan areas for the period 2004–2016, they indicated that a diminishing transparency level was linked to rising house prices.

Very few studies have empirically investigated the factors affecting real estate transparency, and specifically, the impact ICT interventions have on it. For instance, using correlation analyses, [Newell \(2008\)](#) and [Ionaşcu et al. \(2019\)](#) assessed the association between transparency and some macroeconomic, social, and/or institutional variables. These studies, however, applied correlation analyses: this approach does not provide results as reliable as panel data regressions. The present study contributes to the literature by providing a detailed analysis of the possible influences of technological advances on real estate market transparency. The chosen sample comprises more than 90 countries including both advanced and emerging economies.

3. Methodology and Data

The overarching research outcomes place the present work within the positivist research paradigm, whereby quantitative statistical methodologies are applied. Specifically, random effects modelling, and analysis are applied, utilizing national level data, as compiled in JLL's *Global Real Estate Transparency Index*, Euromonitor International and the World Bank. Dependent, independent, and control variables, associated with the dataset, along with processing methods, are identified and now disclosed. At the outset, it is important to note that, to the best of the authors' knowledge, the datasets utilized are the most comprehensive in terms of the number of countries included and the number of temporal epochs. Moreover, they understood the need to deliver the best available aggregated estimates with regard to transparency, ICT investment, and ICT trade at the national level.

That said, as subsequently detailed, national level indices, whilst enabling country-level comparisons, necessarily risk smoothing over coarse and complex local settings: extra factors impacting positively and negatively on transparency may not be noticed. The authors therefore encourage this quantitative study and results with this in mind. They certainly do not discount the need for further studies, potentially qualitative in nature, to help validate the findings this work produces. Indeed, they encourage such work. This is not to downplay the novelty and utility in the present work, only to recognize it must be seen rather as a part of a multi-perspective and multi-disciplinary research endeavor.

3.1. Data

Bi-annual data from 96 countries for the years 2004, 2006, 2008, 2010, 2012, 2014, 2016, and 2018 were acquired and utilized. The sample incorporates all countries and years for which data on ICT-related variables and *Transparency* are (at least for one year) obtainable. The above-mentioned years are considered as JLL's *Global Real Estate Transparency Index*, serving as a proxy for real estate market transparency here, and is produced every two years ([JLL, 2020](#)). It should be noted that the panel is unbalanced: observations on explanatory and dependent variables for some years are missing. The sample countries are documented in [Table A1](#) in the Appendix.

3.2. Dependent variable

The dependent variable in this study is real estate market transparency (*Transparency*). To measure this variable, we have utilized a widely used real estate transparency index, namely the Global Real Estate Transparency Index, which is jointly created by JLL and LaSalle

Investment Management.⁴ The JLL composite transparency index (*Transparency-Composite*) is a comprehensive indicator calculated based on six sub-indices: (1) *Performance measurement*, including “direct property indices, listed real estate securities indices, private real estate fund indices, and valuations”; (2) *Market fundamentals*, capturing the availability of market data for various property sub-sectors such as office, retail, industrial, hotels, residential and alternatives; (3) *Governance of listed vehicles*, such as financial disclosure and corporate governance; (4) *Regulatory and Legal* aspects, comprising “real estate tax, land-use planning, building controls, enforceability of contracts, property registration, compulsory purchase and debt regulation”; (5) *Transaction process*, covering “pre-sale information, bidding processes, professional standards of agents, anti-money laundering regulations and occupier services”; and (6) *Sustainability* covering “green building regulations, energy benchmarking, energy efficiency standards, carbon reporting, green leases, financial performance of green buildings, net zero carbon frameworks, health and wellness certifications, resilient building standards, water efficiency standards” ([JLL, 2020](#)). All indices vary on a scale of 1–5. Generally, a country or real estate market with a perfect score of 1 reflects total transparency, whereas a score of 5 means that the country has total real estate opacity. To better facilitate this index's interpretation in this study, the scores are reversed (meaning that 1 indicates total opacity and 5 is the highest level of transparency). [Table A2](#) in the Appendix presents the descriptive statistics of variables.

As mentioned previously, it is important to recognize that there are at least two limitations about the JLL transparency index. Firstly, JLL focuses on commercial real estate transparency when developing its index: residential real estate is not included. This has significant implications: residential real estate may constitute a significant portion of any real estate market with regard to number of transactions and total value of those transfers. Commercial real estate should not, and cannot, generally be taken as a proxy for the real estate market as-a-whole in any given jurisdiction. This is particularly the case in emerging contexts where residential property markets often lack formalized procedures, statutory recording, and may operate as a ‘black market’ in large parts of the country.

Discounting the residential market from the analysis therefore has significant implications when it comes to making whole-of-country generalizations. On this, the World Bank's ‘Doing Business’ reports maintained a similar focus on commercial properties (with reference to cost ‘to register’ and time ‘to register’), and also only focused on properties in more developed urban areas. Its results were routinely misinterpreted to apply to all real estate within a given country context, and for this reason, it has urged caution when reviewing the presented results here. Secondly, JLL did not collect data from every country for the whole period of the present study and subsequently the panel is unbalanced. For more details on the index methodology, see the technical note of Global Real Estate Transparency Index in [JLL \(2020\)](#).

3.3. Variables of interest

The independent variables of interest are ICT investment and ICT trade. *Capital Investment in Telecommunications* (in USD million, fixed 2020 exchange rates) is used as a proxy of ICT investment. This includes both public and private investment in ICT. Data for this variable were obtained from [Euromonitor International \(2021\)](#) and refers to expenditure connected with acquiring ownership of telecommunication equipment infrastructure. This incorporates buildings, supporting land, and intellectual and/or non-tangible property like computer software. Included here are expenditure on initial installations and additions to existing installations. Country size is corrected for by dividing *Capital*

⁴ Over the past decade, the JLL index has been employed by several studies when examining the real estate market's transparency (see inter alia [Newell, 2008](#); [Farzanegan and Gholipour, 2014](#); [Ionaşcu et al., 2021](#)).

Investment in Telecommunications by population so that measures from various countries could be compared.⁵

We acknowledge that in order to capture the impact of ICT investment on real estate market transparency researcher(s) should use the specific ICT investment in real estate sector. Unfortunately, at present, data on ICT investment specifically in the real estate sector across countries and over time is not available, which would not permit the panel data regressions crucial to our study. We chose to use aggregate ICT investment as a proxy because we believe the benefits of ICT investment can quickly spill over to all economic sectors, including real estate, albeit at varying rates. We argue that advances in ICT broadly have a facilitative effect on transparency across sectors, by improving information dissemination, streamlining transactions, and enhancing governance practices. Specifically, in real estate, this may manifest in the form of more sophisticated and accessible digital platforms for property listings, streamlined transaction processes, and improved regulatory oversight.

As a measure of ICT trade, the sum of ICT goods imports (% total goods imports) and ICT goods exports (% of total goods exports) are used. The data for ICT imports and ICT exports are collected from the World Bank (2021a) (2021b). ICT import is defined as ICT-related goods imports, for instance, computers and peripheral or other communication equipment, electronic components, consumer electronics, and other relevant tools which are miscellaneous in character. ICT export is classified as information and communication technology goods that are exported, for example computers and related peripheral or communications-type equipment, consumer electronic goods, and electronic components, and other miscellaneous materials.

In the analysis, both the current and one-period lagged of ICT investment and ICT trade also serve as explanatory variables. The 'one-period lagged' is included as the impact of ICT investments and trade may likely appear subsequent to the investment: the impact of ICT investment and ICT trade can have a delayed effect on *Transparency*. Additionally, 'one-period lagged' may reduce the possible reverse feedback between the explanatory and dependent variables (Farzanegan and Witthuhn, 2017).

3.4. Control variables

Alongside the main variables of interest (ICT investment and ICT trade), control is applied for other plausible determinants of *Transparency* in the estimations including legal origins, national governance indicators, activities in real estate and construction sectors, and the presence of foreign investors (JLL, 2020; JLL, 2016). Whilst these control variables are not considered to be the only other plausible determinants, they are determinants where: i) data is available for the sample countries; ii) constitute an erudite selection of known influencing factors based on land sector literature; and iii) provide a sound first pass for a study of this nature. Below it briefly explains the control variables employed in this study.

3.4.1. Legal origin

Extensive literature underlines the significant influence of legal systems, broadly interpreted as highly persistent systems of social control of economic life, on the development of national accounting, economic and financial systems (La Porta et al., 1998, 2008; Gholipour and Tajaddini, 2017). Notwithstanding the more recently recognized plurality of national legal systems origins and influences, conventionally, from a Western point of view, legal systems are generally classified into two major types of law: (1) civil; and (2) common (Jaggi and Low, 2000) which have their own several sub-traditions – French, German, and

Scandinavian (La Porta et al., 1998). The common law system started in medieval England and is heavily based on laws which were put place on the basis of judges' decisions on specific disputes. Such legal systems were transferred to many nations via conquest and colonization, or for language and political reasons (La Porta et al., 2006). Another legal system is socialist law which is based on the civil law system, with some major modifications and additions from Marxist-Leninist ideology. This has been adopted largely in some of the Eastern European, Asian countries and former Soviet Union republics.

Gray (1988) and La Porta and Lopez-de-Silanes (1998) determined that legal systems directly impact on accounting systems' fundamentals, such as, regulations and standards, financial disclosure as well as capital markets. La Porta et al. (2008) confirmed the strong and pervasive influences of legal origins on various areas of law and regulation and suggested they can have wide-ranging economic and financial consequences. These authors provided evidence that economic outcomes can range from financial development to investments and growth of the unofficial economy. Based on these findings, was the argument that common law is mostly associated with better economic outcomes as was compared to civil law. This was claimed as common law associated with: (1) better investor protection resulting in better access to finance and greater ownership dispersion; (2) less government ownership and regulation leading to better functioning labor markets and fewer unofficial or 'black' economies; and (3) less formalized and more independent judicial systems creating more secure property rights and better contract enforcement situations. As a result, one can argue that these may lead to more transparent business environments in common law countries (La Porta et al., 1998). Hence, studies such as Donkor-Hyiaman and Ghartey (2017) and Gholipour and Tajaddini (2017) argue that the legal system of a nation guides its real estate variables and how well they function. The legal origin's effect on transparency of other markets including the finance industry have been discussed elsewhere (e.g., Akso and Kosedag, 2006; Beck et al., 2003). The legal origin data used in this study are obtained following La Porta et al.'s (2008) categories of common and civil laws, the latter referring to French, German, Scandinavian, and Socialist models while the common law system serves as a base group in the regressions.

3.4.2. Investment freedom and presence of foreign investors

La Porta et al. (2008) argue that globalization boosts competition between countries for foreign direct investment, capital, and generally for business, putting some pressure on countries to embrace and implement effective legal rules and regulations. Consequently, financial liberalization can lead to better transparency and accountability as well as a reduction in adverse selection and moral hazard (Mishkin and Savastano, 2002). Two different proxies for the presence of international investors in the business environment of a country are used: (1) investment freedom; and (2) FDI restrictiveness.

The Index of Economic Freedom devised by Heritage Foundation (2020) is utilized in this study as a proxy for investment freedom. It ranges between zero and 100, with 100 indicating an economically free country with no constraints on the flow of investment capital. Individuals and firms in such contexts are able to move their resources in and out of specific activities, both domestically and internationally, without any restriction. This index takes into account a variety of restrictions which are widely imposed on investment in many countries and deduces points from the ideal score of 100 for each of such restrictions identified in a country's investment system.

For quantifying FDI restrictiveness in the real estate market, the OECD.Stat's (2020) FDI Regulatory Restrictiveness Index is used. This measures the statutory restrictions on foreign direct investment in real estate investment sectors across OECD countries. This index estimates the restrictiveness of a country's FDI rules by examining the four main types of restrictions on FDI which are: foreign equity limits; screening or approval means; limitations on the employment of foreigners as key staff members; and operational restrictions (e.g., limitations on branching,

⁵ It is notable that the Euromonitor International's data and reports are now widely accepted and served many empirical studies in recent years (e.g., Gholipour et al., 2021).

Table 1
Regression results: Determinants of real estate market transparency in the full sample (2004–2018).

Explanatory variables	Dependent variable: <i>Transparency_Composite</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ICT_Investment	0.133 * ** (.030)		0.116 * ** (.031)		0.078 * (.046)		0.058 * (.030)		0.143 * ** (.034)	
ICT_Investment (–1)		0.098 * ** (.029)		0.094 * ** (.030)		0.067 * (.040)		0.045 (.030)		0.115 * ** (.030)
ICT_Trade	0.012 * ** (.002)		0.011 * ** (.002)		0.008 * ** (.002)		0.009 * ** (.002)		0.010 * ** (.002)	
ICT_Trade (–1)		0.009 * ** (.002)		0.009 * ** (.002)		0.003 (.002)		0.008 * ** (.002)		0.008 * ** (.002)
Investment Freedom	0.393 * ** (.112)	0.284 * ** (.097)	0.285 * ** (.126)	0.190 * ** (.111)			0.214 * (.112)	0.138 (.091)		
FDI restrictions					-0.680 * * (.289)	-0.877 * ** (.262)				
Voice & Accountability Index			0.343 * ** (.090)	0.311 * ** (.093)	0.309 * ** (.098)	0.231 * ** (.096)				
Control of Corruption Index							0.474 * ** (.062)	0.475 * ** (.064)		
GVA from real estate & construction	3.032 * ** (.939)	2.341 * * (.933)	1.569 * (.915)	1.437 (.908)	1.390 (.993)	0.867 (.996)	1.523 * (.810)	1.236 (.783)		
Legal Origin_French	-0.498 * ** (.160)	-0.466 * ** (.170)	-0.482 * ** (.142)	-0.458 * ** (.150)	-0.809 * ** (.185)	-0.905 * ** (.179)	-0.355 * ** (.133)	-0.329 * * ** (.135)		
Legal Origin_German	-0.205 (.206)	-0.010 (.210)	-0.275 (.173)	-0.119 (.172)	-0.569 * ** (.211)	-0.456 * * ** (.212)	-0.098 (.158)	0.016 (.156)		
Legal Origin_Scandinavian	0.591 * ** (.167)	0.681 * ** (.170)	0.249 (.173)	0.363 * ** (.182)	-0.137 (.160)	-0.126 (.154)	-0.007 (.155)	0.040 (.160)		
Legal Origin_Socialist	0.024 (.210)	-0.230 (.198)	0.106 (.190)	-0.128 (.190)	-0.920 * ** (.312)	-1.232 * ** (.293)	-0.158 (.189)	-0.309 * (.180)		
Period fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	569	610	569	523	369	330	573	523	580	622
R-sq. (overall)	0.599	0.565	0.674	0.654	0.644	0.608	0.662	0.666	0.303	0.350

Notes: Estimation method: Random-effects GLS regression. Robust standard errors are in parentheses. The asterisks *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. Common law system is used as a base group for legal origin. Highly correlated control variables are not included in the model at the same time. That is why there are 10 specifications (columns 1–10).

capital repatriation and/or land ownership). It is important to note here that the number of observations diminishes when the FDI Regulatory Restrictiveness Index is included in the regression analysis. This is because the data for this index are either not available for some countries or have several missing values.

3.4.3. Economic activities in real estate and construction sectors

In order to control for level of economic activity in the real estate and construction sectors, the sum of gross value added (GVA) in these two sectors is considered: (1) GVA from real estate, renting and business activities to total gross value added; and (2) GVA from construction to total gross value added. Data for these variables are also collected from Euromonitor International. One may expect countries with higher levels of activities in real estate and the construction sector tending to have higher levels of *Transparency*. This is because when there are more activities in a sector the economic agents demand for much clearer and disclosure-related regulations to protect their interests.

3.4.4. Governance indicators

There is broad evidence in the literature that countries with weaker accountability mechanisms and controls of corruption have less-developed markets where the costs of capital are higher (La Porta et al., 1997, 2006; Bhattacharya and Daouk, 2002). *Voice and Accountability Index* and *Control of Corruption Index* are deployed in this study as the country governance proxies. The former captures the perceptions of the extent to which a country's citizens can choose or elect their

government, there is a free media, and people have the right to freedom of association and expression. On the last aspect, this represents the extent to which public power is exercised for private gains, including both minor and maximum forms of corruption, as well as the extent to which elites and private interests “capture” the state. Both measures range from approximately – 2.5–2.5, with higher values corresponding to better governance. The data of these indices are obtained from the *Worldwide Governance Indicators (2021)* of the World Bank. Governance indicators (in particular, the Control of Corruption index) are included as an explanatory variable which to some extent can capture potentially corrupt actions in the real estate market (e.g., rent-seeking from land sector professionals).

3.5. Estimation method

The random effects model with period fixed effects are applied in this study.⁶ The main reason for applying the random effects model is that most of the considered variables in the models do display only very gradual changes over time (e.g., *Transparency* and governance

⁶ The instrumental variables (IV) estimator is not applied in the analyses. This is because the two variables of interest, *ICT_Investment* and *ICT_Trade*, are not seen as endogenous based on the obtained Durbin and Wu–Hausman statistics. The test statistics are found to be insignificant at the 5% level, suggesting that the tested variables (*ICT_Investment* and *ICT_Trade*) must be treated as exogenous. The test results are available upon request.

Table 2
Regression results: Determinants of real estate market transparency in emerging economies (2004–2018).

Explanatory variables	Dependent variable: <i>Transparency_Composite</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ICT_Investment	0.050 ** (.029)		0.051 * (.031)		0.027 (.052)		0.022 (.033)		0.052 * (.031)	
ICT_Investment (-1)		0.046 (.029)		0.042 (.031)		0.013 (.051)		0.018 (.033)		0.056 ** (.028)
ICT_Trade	0.016 *** (.002)		0.015 *** (.002)		0.010 *** (.002)		0.0151 *** (.002)		0.014 *** (.002)	
ICT_Trade (-1)		0.010 *** (.002)		0.010 *** (.002)		0.004 ** (.002)		0.009 *** (.002)		0.009 *** (.002)
Investment Freedom	0.266 *** (.091)	0.154 * (.081)	0.225 ** (.101)	0.127 (.090)			0.197 ** (.093)	0.106 (.079)		
FDI restrictions					-0.304 (.291)	-0.511 ** (.259)				
Voice & Accountability Index			0.130 (.084)	0.146 * (.086)	0.159 (.102)	0.162 (.103)				
Control of Corruption Index							0.233 *** (.082)	0.261 *** (.085)		
GVA from real estate & construction	1.532 * (.925)	0.931 (1.074)	1.059 (.986)	0.289 (1.050)	1.419 (1.265)	0.282 (1.193)	1.170 (.962)	0.415 (1.018)		
Legal Origin_French	-0.350 ** (.153)	-0.298 * (.157)	-0.355 ** (.149)	-0.295 * (.154)	-0.820 *** (.192)	-0.876 *** (.156)	-0.328 ** (.144)	-0.274 * (.146)		
Legal Origin_German	-0.040 (.284)	0.231 (.304)	-0.045 (.263)	0.213 (.270)	-0.563 (.379)	-0.301 (.388)	0.032 (.277)	0.275 (.292)		
Legal Origin_Scandinavian	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted		
Legal Origin_Socialist	-0.223 (.182)	-0.272 (.177)	-0.184 (.175)	-0.317 * (.185)	-1.159 *** (.341)	-1.385 *** (.305)	-0.309 * (.190)	-0.421 ** (.192)		
Period fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	346	382	346	324	186	169	346	324	357	394
R-sq. (overall)	0.352	0.312	0.394	0.352	0.462	0.433	0.362	0.309	0.191	0.189

Notes: Estimation method: Random-effects GLS regression. Robust standard errors are in parentheses. The asterisks *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. The sample period is 2004–2018. For columns 1, 2, 3, 4, 7 and 8, data from 63 countries are used. For columns 5 and 6, the sample country is 34 and for columns 9 and 10 the sample country is 66. Common law system is used as a base group for legal origin.

indicators) which makes use of the fixed effects model as less appealing (Torres-Reyna, 2007). The other advantage of the random effects model over the fixed effects model is that it allows for explanatory variables that remain constant over time (Wooldridge, 2013). Fixed effects estimations eliminate time-constant explanatory variables. Besides, since including legal origin (which is a time-invariant variable) as the key control variable in the analyses is vital, the random effects model is again considered as more appropriate for this research. In addition, the random effects estimator is suitable here as it offers a wider range of control variables included in the estimations, which reduce the likelihood of unobserved effects being correlated with the explanatory variables (Wooldridge, 2013). The empirical model (1) can therefore be presented as:

$$Transparency_{it} = \beta_1 ICT_Investment_{it} + \beta_2 ICT_Trade_{it} + \beta_3 X_{it} + \Omega_t + \alpha + u_{it} + \varepsilon_{it} \quad (1)$$

where *Transparency* represents the composite real estate transparency index; *ICT_Investment* logarithm of capital investment in ICT per capita; *ICT_Trade* denotes the sum of ICT goods imports and exports; *X_{it}* is the vector of control variables; *I = 1, ..., n* stands for the country; *t = 1, ..., t* represents the time period; Ω_t takes into account the period effect; α is constant; u_{it} is the between-country error; and ε_{it} is the within-country error.

The period fixed impacts upon control for factors changing across time, but remain constant across countries, for example, global business cycles. On this issue, it is crucial to control for period effects since many nations in the sample were affected by the Global Financial Crisis (2008–2009). The issue of heteroscedasticity is addressed by utilizing robust standard errors in all estimations.

4. Empirical results

This section presents the regression results for the full sample, emerging economies, and advanced countries in Tables 1, 2 and 3,

respectively. *Transparency_Composite* is used as the dependent variable in these tables. Table 4 provides estimation results for sub-components of the *Transparency_Composite* followed by Table 5 reporting regression results for the impact of ICT import and ICT export on *Transparency_Composite*. To avoid the multi-collinearity⁷ issue, highly correlated control variables are not included in the estimations at the same time. For instance, this was the case for *Voice and Accountability Index* and *Control of Corruption Index* in the full sample with a correlation coefficient of 0.74. Similarly, the current level of ICT investment and ICT trade and their one-period lags are not included in the models simultaneously. Given this, columns 1–10 in Tables 1–3 offer different model specifications that do not include the highly correlated variables in one model.

4.1. Estimation results for the full sample and sub-sample countries

As can be seen from columns 1–10 of Table 1, both *ICT_Investment* and *ICT_Trade* (as well as their one-period lags) have the expected positive association with *Transparency_Composite* and are statistically significant across most specifications. It means that higher levels of capital investment in the ICT sector and ICT exports and imports contribute to better real estate market transparency when the full sample is considered. This outcome was also obtained when various explanatory variables were included. These findings imply that public and private investment in technology platforms and international flows of ICT products are linked to higher real estate market transparency (in particular, it can be suggested that higher ICT investments manifest in increased volume of real estate market data and enhancing market processes), by growing acceptance of proptech platforms, digital tools and ‘big data’ techniques (JLL, 2020). For example, some of the

⁷ A term that refers to correlation among the independent variables in a multiple regression model (Wooldridge, 2013).

Table 3
Regression results: Determinants of real estate market transparency in advanced economies (2004–2018).

Explanatory variables	Dependent variable: <i>Transparency_Composite</i>									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ICT_Investment	-0.069 (.072)		-0.053 (.071)		-0.074 (.088)		-0.080 (.064)	-0.085 ** (.041)	-0.058 (.073)	
ICT_Investment (-1)		-0.052 (.043)		-0.058 (.045)		-0.008 (.060)				-0.036 (.042)
ICT_Trade	-0.001 (.003)		-0.0008 (.002)		0.005 (.004)		-0.001 (.002)	-0.0003 (.003)	-0.0009 (.003)	
ICT_Trade (-1)		0.0001 (.003)		0.0006 (.002)		0.002 (.003)				0.001 (.003)
Investment Freedom	0.261 (.234)	0.154 (.226)	0.314 (.249)	0.200 (.244)			0.269 (.242)	0.226 (.238)		
FDI restrictions					-0.265 (.399)	-0.304 (.328)				
Voice & Accountability Index			0.379 ** (.193)	0.284 * (.170)	0.553 ** (.217)	0.493 ** (.169)				
Control of Corruption Index							0.420 *** (.104)	0.438 *** (.092)		
GVA from real estate & construction	-1.637 * (.969)	-1.239 (.952)	-1.927 (1.104)	-1.329 (1.133)	-0.967 (.976)	-0.469 (1.078)	-1.788 ** (.840)	-1.317 (.858)		
Legal Origin_French	-0.470 (.289)	-0.432 (.281)	-0.481 * (.257)	-0.442 * (.255)	-0.506 * (.282)	-0.471 * (.258)	-0.265 (.243)	-0.219 (.240)		
Legal Origin_German	-0.730 ** (.294)	-0.695 ** (.291)	-0.755 *** (.252)	-0.724 ** (.266)	-0.683 ** (.257)	-0.628 ** (.254)	-0.526 ** (.224)	-0.498 ** (.224)		
Legal Origin_Scandinavian	-0.100 (.235)	-0.099 (.229)	-0.303 (.200)	-0.226 (.207)	-0.344 * (.206)	-0.319 (.194)	-0.366 ** (.167)	-0.355 ** (.165)		
Legal Origin_Socialist	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted	Omitted		
Period fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	223	228	223	199	183	161	223	199	223	228
R-sq. (overall)	0.126	0.137	0.271	0.258	0.332	0.379	0.480	0.494	0.003	0.013

Notes: Estimation method: Random-effects GLS regression. Robust standard errors are in parentheses. The asterisks *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Omitted indicates that the variable is removed from the model. Data for 31 countries are employed. Common law system is used as a base group for legal origin.

Table 4
Regression results: Determinants of sub-components of real estate transparency index in the full sample (2004–2018).

Explanatory variables	DV: <i>Transparency_Performance measurement</i>		DV: <i>Transparency_Market fundamental</i>		DV: <i>Transparency_Governance of listed vehicles</i>		DV: <i>Transparency_Regulatory & legal</i>		DV: <i>Transparency_Transaction process</i>	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
ICT_Investment	0.111 *** (.042)		0.112 ** (.044)		0.177 *** (.060)		0.114 *** (.026)		0.149 *** (.032)	
ICT_Investment (-1)		0.095 *** (.034)		0.071 (.064)		0.061 (.073)		0.088 *** (.026)		0.117 *** (.041)
ICT_Trade	0.013 *** (.003)		0.016 *** (.004)		0.011 *** (.004)		0.010 *** (.002)		0.009 *** (.001)	
ICT_Trade (-1)		0.013 *** (.003)		0.008 ** (.004)		0.008 ** (.004)		0.008 *** (.002)		0.006 *** (.002)
Control variables	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included
Period fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	376	375	376	375	375	373	374	373	376	375
R-sq. (overall)	0.666	0.654	0.611	0.548	0.481	0.436	0.762	0.741	0.698	0.677

Notes: DV is the dependent variable. Notes: Robust standard errors are in parentheses. The asterisks *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. Estimation method: Random-effects GLS regression. Control variables are dummies for legal origins, GVA from real estate & construction, Investment Freedom, and Voice & Accountability Index.

emerging market economies in Africa (e.g., Kenya and Ghana) and South America (e.g., Ecuador) are argued to have improved the transparency of their real estate markets via the digitization of land registries and recording title deeds with blockchain technology⁸ (JLL, 2016). In terms of the magnitude of these two variables of interest, the findings indicate that the coefficient of *ICT_Investment* ($\beta = 0.116$) is much larger than that of *ICT_Trade* ($\beta = 0.011$) (see column 3 of Table 1). Indicated here is that the capital investment in ICT sector has a stronger relationship with

⁸ Note: The significance of these blockchain technologies implementations, in terms of scale and impact, applied in land sector, is debated (c.f., Bennett et al., 2021b).

Transparency_Composite compared to ICT trade.

Regarding the control variables, measures for investment freedom and restriction of foreign real estate investment have the predicted sign and are statistically significant across most specifications (columns 1–8 of Table 1), indicating that real estate market transparency is higher in countries with higher investment freedom and less restrictions on foreign real estate investments. These results are in line with La Porta et al. (2008) who argue that liberalization contributes to market transparency. The results also suggest that there is a robust and positive relationship between national governance indicators (Voice & Accountability Index and Control of Corruption Index) and the *Transparency_Composite* (columns 3–8 of Table 1). This suggests that real estate market transparency is relatively higher in democratic countries

Table 5

Regression results: Determinants of real estate market transparency (ICT Import vs. ICT Export, 2004–2018).

Explanatory variables	Dependent variable: <i>Transparency_Composite</i>											
	Full sample				Advanced economies				Emerging economies			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ICT_Investment	0.115 *		0.110 *		-0.032		-0.088		0.049 *		0.056 *	
	**		**		(.071)		(.074)		(0.029)		(0.032)	
	(.030)		(.032)									
ICT_Investment (-1)		0.093 *		0.098 *		-0.035		-0.057		0.041		0.046
		**		**		(.048)		(.046)		(0.031)		(0.032)
		(.030)		(.031)								
ICT_Import	0.025 *				0.003				0.034 * **			
	**				(.006)				(0.007)			
	(.006)											
ICT_Import (-1)		0.021 *				0.007				0.021 * **		
		**				(.007)				(0.007)		
		(.005)										
ICT_Export			0.015 *				-0.006				0.022 * **	
			**				(.005)				(0.004)	
			(.004)									
ICT_Export (-1)				0.014 *				-0.001				0.015 * **
				**				(.004)				(0.004)
				(.003)								
Control variables	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included	Included
Period fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	578	533	573	526	227	203	227	202	351	330	346	324
R-sq. (overall)	0.684	0.664	0.644	0.633	0.338	0.347	0.272	0.281	0.415	0.363	0.366	0.330

Notes: Robust standard errors are in parentheses. The asterisks * and * ** denote significance at the 10% and 1% levels, respectively. Estimation method: Random-effects GLS regression. Control variables are dummies for legal origins, GVA from real estate & construction, Investment Freedom, and Voice & Accountability Index.

Table A1

List of sample economies.

Advanced economies

Australia, Austria, Belgium, Canada, Czech, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Israel, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Sri Lanka, Tanzania, Thailand, Tunisia, Turkey, United Arab Emirates, Uganda, Ukraine, United Kingdom, USA

Emerging economies

Algeria, Angola, Argentina, Bahamas, Bahrain, Belarus, Botswana, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Croatia, Dominican Republic, Ecuador, Egypt, Ghana, Guatemala, Honduras, Hungary, India, Indonesia, Iran, Iraq, Jamaica, Jordan, Kazakhstan, Kenya, Kuwait, Lebanon, Libya, Malaysia, Mauritius, Mexico, Mongolia, Morocco, Mozambique, Myanmar, Nigeria, Oman, Pakistan, Panama, Peru, Philippines, Poland, Qatar, Romania, Russia, Rwanda, Saudi Arabia, Senegal, Serbia, South Africa, Uruguay, Venezuela, Vietnam, and Zambia

Notes: IMF categorizes countries into three groups: (1) advanced economies, (2) emerging markets, and (3) low-income developing countries. Since we do not have many countries from group 3, we combine groups 2 and 3 as emerging economies.

(with more freedom of the press, freedom of association and public officials are more accountable). As well, the results suggest that improvement in *Transparency* is associated with higher levels of economic activity in real estate and construction sectors, as the coefficient of *GVA from real estate & construction* is positive and statistically significant at least in half of the estimations which include this variable. This is because when there is more activity in a sector, the economic agents (e.g., property developers, property funds) demand more transparent regulation to protect their interests.

Finally, the estimation results indicate that countries adapting *French* legal origins have significantly less *Transparency* compared to the base group of legal origin - common law (columns 1–8 of [Table 1](#)). The authors stress there could be several explanations for this result, however, one possibility is that this could be mainly due to fact that French law is considered less flexible compared to common law: for those countries adopting it, it anecdotally takes longer to devise a new regulation, such as for new technology in the real estate industry. It is worth comparing

this suggestion to rules and regulations relating to the use of Unmanned Aerial Vehicles (UAVs) in the land administration sector in this sector (c. f., [Stöcker et al., 2017](#)). At any rate, the finding lends support to La Porta et al.'s (1996) arguments on business environments being more transparent in common law countries.

The results of regressions for subsample countries (emerging and advanced economies) are presented in [Tables 2 and 3](#). *ICT* trade is an important determinant of *Transparency_Composite* in emerging economies, since the coefficients of *ICT* trade and its one-period lag are statistically significant and positive for these countries in all specifications (columns 1–10 of [Table 2](#)). *ICT* investment in the current period is significantly correlated to *Transparency_Composite* in emerging economies (columns 1, 3 and 9 of [Table 2](#)). On the other hand, for advanced economies, a robust link between *ICT* trade, *ICT* investment and *Transparency_Composite* is not observed across different specifications (columns 1–10 of [Table 3](#)). One possible reason is that *ICT* investment and trade in emerging countries rose faster than high-income economies. For the period 2004–2019, the average *ICT* goods imports (% total goods imports) for High income, Low & middle income, and Upper middle-income economies were, respectively, 11.92%, 13.76% and 16.1% ([World Bank, 2021a](#)). The same pattern is observed for *ICT* goods exports (% of total goods exports). The rates are 10.34%, 14.54% and 17.32%, respectively, for High income, Low & middle income, and Upper middle-income economies ([World Bank, 2021b](#)).

The relationships between five sub-components of *Transparency_Composite* (*Transparency_Performance measurement*, *Transparency_Market fundamental*, *Transparency_Governance of listed vehicles*, *Transparency_Regulatory and legal* and *Transparency_Transaction process*) and *ICT* investment and *ICT* trade are examined, and the results are presented in [Table 4](#). The *ICT_Investment* is positively and significantly associated with all the employed sub-components of *Transparency* at least at the 5% level.

These findings indicate that capital investments in telecommunications equipment and infrastructure in the economies flow on to help improve the quality of information, the real estate market's performance and fundamentals (e.g., updated real estate price indices), make possible firms' financial disclosure, make real estate taxation, land-use planning,

Table A2
Descriptive statistics.

Variables	Definition	Mean	Std. Dev.	Data sources
Transparency_Composite	The JLL composite transparency is a comprehensive tool calculated based on six sub-indices: (1) <i>Performance measurement</i> (2) <i>Market fundamental</i> (3) <i>Governance of listed vehicles</i> (4) <i>Regulatory and Legal</i> (5) <i>Transaction process</i> , and (6) <i>Sustainability</i> . All sub-indices except for <i>Sustainability</i> are considered in the models.	1.985	0.993	Global Real Estate Transparency Index, Jones Lang LaSalle
Transparency_Performance measurement	<i>Performance measurement</i> includes direct property indices, listed real estate securities indices, private real estate fund indices, and valuations.	1.600	1.160	Global Real Estate Transparency Index, Jones Lang LaSalle
Transparency_Market fundamental	<i>Market fundamental</i> comprises sectors including office, retail, industrial, hotels, residential and alternatives.	1.625	1.201	Global Real Estate Transparency Index, Jones Lang LaSalle
Transparency_Governance of listed vehicles	<i>Governance of listed vehicles</i> includes financial disclosure and corporate governance.	2.169	1.409	Global Real Estate Transparency Index, Jones Lang LaSalle
Transparency_Regulatory & legal	<i>Regulatory and Legal</i> which includes real estate taxation, land-use planning, building restrictions, enforceability of contracts, property registration, forced purchase and debt regulation.	2.480	0.918	Global Real Estate Transparency Index, Jones Lang LaSalle
Transparency_Transaction process	<i>Transaction process</i> addresses pre-sale information, bidding processes, agent professionalism, anti-money laundering legislation and occupier services.	2.476	1.017	Global Real Estate Transparency Index, Jones Lang LaSalle
Investment Freedom	There would be no restrictions on the movement of investment money in an economically free country. Individuals and businesses would be able to freely move their resources into and out of specified activities, both within and across national borders. The investment freedom component of the Index of Economic Freedom would give such a country a score of 100. The Index assesses a number of investment limitations that are commonly enforced. For any restriction detected in a country's investment system, points are subtracted from the ideal score of 100.	58.766	22.051	Heritage Foundation (2020)
Voice & Accountability Index	Measures citizens' impressions of their ability to elect their government, as well as their freedom of expression, freedom of association, and access to a free press.	0.133	0.992	Worldwide Governance Indicators (2021)
ICT_Investment per capita	Capital investment in telecommunications refers to the costs of obtaining ownership of telecommunications equipment and infrastructure (including supporting land and buildings and intellectual and non-tangible property such as computer software). These expenses include both new installations and upgrades to existing installations. This variable is measured in USD, with fixed 2020 exchange rates and constant 2020 prices per '000 people.	91,378	111,081	Euromonitor International (2021)
ICT_Import	Refers to information and communication technology goods imports. Computers and peripherals, communication devices, consumer electronic equipment, electronic components, and other information and technology goods are all included.	8.186	6.785	World Bank (2021a)
ICT_Export	Indicates information and communication technology goods exports, consistent with ICT_Import, including computers and peripherals, communication devices, consumer electronic equipment, electronic components, and other information and technology goods.	5.618	9.127	World Bank (2021b)
ICT_Trade	The sum of ICT goods imports (% total goods imports) and ICT goods exports (% of total goods exports).	13.817	15.666	World Bank (2021a); b)
GVA from real estate & construction	The sum of gross value added (GVA) in these two sectors is used to control for changes in economic activity in the real estate and construction sectors: (1) GVA from real estate, renting, and commercial operations to total gross value added; and (2) GVA from construction to total gross value added.	0.201	0.067	Euromonitor International (2021)
Control of Corruption Index	Captures public perceptions of the amount to which public authority or power is used for private gain, including petty and grand corruption, as well as "state capture" by elites and business interests.	0.222	1.058	Worldwide Governance Indicators (2021)
FDI restrictions	Measures statutory barriers to foreign direct investment in 22 different economic sectors. It examines the four basic categories of FDI limitations to determine how restrictive a country's FDI policies are: 1) Foreign equity restrictions; 2) Discriminatory screening or approval methods; 3) Constraints on the employment of foreigners as key people; and 4) Other operational prohibitions, such as restrictions on branching and capital repatriation or foreign-owned company property ownership. Restrictions are rated on a scale of 0 (open) to 1 (closed). The average of sectoral ratings serves to calculate the overall restrictiveness index.	0.218	0.282	OECD.Stat's (2020)

building restrictions, enforceability of contracts, property registration, forced purchase and debt regulation more effective. These investments may also contribute to more efficient and fair transactions in the real estate industry. The results also imply that *ICT_Trade* and one-period lag of this variable are positively and significantly associated with these sub-components (see columns 1–10 of [Table 4](#)).

Finally, separate regressions for ICT import and ICT export are conducted to explore if they wield different impacts on *Transparency_Composite*. [Table 5](#) reports the estimation results. It was observed that both ICT import and ICT export play important roles in

enhancing transparency in the full sample and emerging economies. Furthermore, the impact of ICT import emerges as being stronger than that of ICT export in these economies (see columns 9–12 of [Table 5](#)).

5. Discussion and Conclusions

Real estate markets throughout the world are making rapid advances in terms of their functionality for people and as a primary asset class for investors. Thus, their transparency is increasingly becoming a more valuable barometer for their performance and attractiveness for

corporations, governments, communities, trusts, pension funds to private individuals (JLL, 2020), globally.⁹ In order to respond to this evolving expectation of investors, businesses, and consumers, policy-makers are under increasing pressure to develop strategies and enforce new regulatory frameworks which can improve the real estate market's transparency so they can compete with other asset classes.

Technology is proven to be a contributor to higher market transparency in general, yet real estate markets have had trouble effectively implementing new supportive technology platforms and infrastructures fast enough, and sustainably enough (Baum et al., 2020; JLL, 2020). It is crucial to ensure that any technological advances are carefully managed to avoid disruptions that could erode trust, a critical asset for the real estate industry. Furthermore, the link between technological progress and real estate transparency is not yet evaluated quantitatively in any detail. For this reason, the present study investigated the association between real estate market transparency and two important aspects of aggregate technological advance: country-level investment in ICT and ICT trade levels. Whilst the impacts of the two determining factors are neither limited nor specific to the real estate market, they were justified to act as a proxy for direct ICT investment into that sector.

Based on a panel of 96 countries for the period 2004–2018, the findings confirm that both investment in ICT and trade of ICT goods are directly and significantly linked with real estate market transparency, at least with regard to commercial real estate. Also shown in the regression analyses is that sub-components of real estate market transparency (performance measurement, market fundamental, governance of listed vehicles, regulatory & legal, transaction process) are positively associated with ICT investment and trade. The sub-category analysis revealed that emerging economies indicate a positive and significant association between technological development (ICT investment and trade) and real estate market transparency, while this link was not found to be significant for advanced countries. Panel data analyses suggest that real estate market transparency is poorer in countries with less democratic values, higher levels of corruption, closer to international real estate investors and where the French (civil) law system operates. These results from country-level analyses should not be interpreted as a causal impact of explanatory variables on real estate market transparency: the analyses in this study have not perfectly controlled for local and regional factors within each country that possibly drive real estate market transparency.

These findings have implications for policymakers, particularly in emerging economies, especially if results are generalized to the broader real estate market. Despite recognized historical complexities relating to colonialism and vast cultural differences between countries in this economic bracket, in line with Home's (2021) view that technology advances in geo-spatial technology can assist in overcoming existing market deficiencies. This helps to enjoy the widespread economic and social benefits of real estate market transparency, policymakers need to accelerate capital investment in the ICT sector and expand commerce in ICT products and services with other countries.

Governments may support private investment in the ICT sector by: (1) adopting appropriate regulatory and industry policies to incentivize infrastructure investment; (2) lowering the cost of network infrastructure; and (3) improving collaboration within and between sectors (Hu, 2014). Increased ICT sector activities can have flow-on derivative benefits for the real estate sector, in terms of making skilled ICT capacity and ICT infrastructure available to the land sector. This can include the

creation of real estate sector Public Private Partnerships (PPPs) (García-Morán et al., 2021; Burns et al., 2020); adoption of modern geospatial and database technologies by both government land administration systems and by private sector land sector agents (e.g., notaries, conveyancers, surveyors, and real estate agents) (McLaren et al., 2018), and ensuring sustainable maintenance of those systems (Bennett et al., 2021a).

Furthermore, governments in developing contexts may introduce tax breaks to entice more private sector investment in the ICT industry. These strategies cover more than just sector policy, since investment decisions are influenced by a number of variables, including the roles of financial sector growth and the broader investment climate. They must also include prospective public sector initiatives that might drive ICT adoption in subsectors where the private sector is unlikely to participate on its own.

In terms of ICT trade, governments of emerging economies may further reduce the tariff and non-tariff (e.g., regulations, standards, testing and certification procedures) trade barriers for ICT goods and services. For example, emerging economies tend to impose higher trade restrictions for telecommunication services than advanced economies. According to the OECD's (2020) data on Trade Restrictiveness Index (which takes the value from 0 to 1, where 0 is completely open and 1 is completely closed) for the *Telecome* sector, most emerging economies (e.g., Brazil, South Africa, Indonesia, China, and India) score significantly higher than advanced countries (e.g., Germany, UK, France). As a specific example, in the context of the real estate sector, these findings are further confirmed by Stocker et al. (2017; 2022), who find diffusion of UAV technology for land administration purposes to be greatly impeded by restrictive laws and policies.

It is important to again highlight the limitations of this study. Currently, there are inadequate observations for real estate transparency indices (especially for the sub-components of composite index) for several emerging economies. Some sample countries only have one to two observations covering the period of this study. Whilst there is scarcity of data, including its reliability, for specific indices in developing contexts is hardly a new issue, and is even confirmed in studies relating to measurement of the high-profile UN Sustainable Development Goals (SDGs), where data for only half of the indicators is deemed available (Dang & Serajuddin, 2020), it nonetheless requires disclosure. Furthermore, as stated in Section 3.5, most of the considered variables in the models have demonstrated only very gradual changes over time. These characteristics of the dataset make the application of the Generalized Method of Moments (GMM) estimator challenging as this method takes into account the first-difference of variables before estimations.

Future studies may replicate the present research when more data become available for real estate transparency indices. In addition, complementary country-level qualitative case studies which, for example, include more detailed information about transacted property, e.g., owners and their addresses, purchase prices, land values, land use regulations, planned changes in land use regulations. This would help to unpack and confirm the claims made in this paper, i.e., more nuance around the conditions and nature of successful ICT investments - taking into account institutional arrangements, political settings, geographical contexts, and capacity levels. Additionally, in the present study we use ICT investment in all economic sectors for our analyses. Future research may examine the relationship between ICT investment and real estate transparency by using ICT investment in the real estate sector if the data are available across countries for several years.

Finally, it is important to note that the recent COVID-19 pandemic and its challenges forced many countries to fast-track digitization and technology innovation: the urgency of the pandemic responses, coupled with lock-downs and at-distance working drove the need for accurate and timely administrative data (FAO/UNECE/FIG, 2022). This is because it is critical to keep track of activities in real time, especially in reference to health, mobility, and space usage. Such developments may have positively benefited the real estate industry and consequently, their

⁹ While real estate transparency and ICT integration generally promote fairness and informed decision-making, benefits may vary among social groups. Those with limited ICT access or skills may face challenges. Also, the benefits for local citizens and international investors can differ based on socio-economic and regulatory factors. Transparency could deter practices like land grabbing by ensuring clearer property rights, but the exact impacts are context-dependent. These nuances highlight the importance of inclusive policies in advancing real estate market digitization and transparency.

effect on the market's transparency needs to be investigated in future when more data is available.

Ethical approval

This article does not contain any studies with human participants or animals.

Compliance with Ethical Standards

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Arjomandi Amir: Methodology, Writing – review & editing. **Gholipour Hassan F.:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Software. **Bennett Rohan:** Methodology, Writing – original draft, Writing – review & editing. **Andargoli Amirhossein Eslami:** Writing – review & editing.

Declaration of Competing Interest

none.

Data Availability

Data will be made available on request.

Appendix

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