Intangible Capital Around the World

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Abstract

We estimate the value of intangible capital around the world through the valuation approach of a neoclassical model of investment with two heterogeneous types of capital inputs: physical capital and intangible capital. Using data on public listed firms across 77 countries, we infer the importance of intangible capital for the firm's market value in each country. We find that intangible capital accounts for over half of firms' market value globally, with significant cross-country heterogeneity. To understand the drivers of intangible capital accumulation we explore the variation in the economic and legal environment across countries. We find that economic development, intellectual property protection, and financial market factors—especially the cost of financing—significantly influence the cross-country variation in the value of intangible capital.

Key Words: Valuation, Neoclassical Investment, Structural Estimation, Intangible Capital

JEL Classification: D21, D22, E22, E24, G12, G32

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1 Introduction

How much does intangible capital contribute to a firm's market value? And what are the economic drivers of intangible capital accumulation? To address these questions, we use cross-country variation in the economic and legal environment and a neoclassical model of investment with two inputs—physical capital (e.g., plants and machinery) and intangible capital (e.g., brand name, stock of knowledge). To quantify the relative importance of intangible capital for firm value across the world, we estimate the model using data from a large set of publicly traded firms in 77 countries spanning the period from 2000 to 2020. We find that, while there is substantial cross-country heterogeneity, intangible capital is consistently a crucial determinant of firm value, accounting for over 50% of a firm's market value in the past decade. In addition, the importance of intangible capital in each country is closely linked to country characteristics. We show that economic development, intellectual property protection, and financial market factors—especially the cost of financing—significantly influence the cross-country variation in the value of intangible capital. Taken together, our findings show that intangible capital is a key driver of firm value, and its accumulation is strongly influenced by a country's economic and institutional environment.

We use a generalized neoclassical model of investment to decompose the market value of a firm between physical and intangible capital. In the model, changing the quantity of the capital inputs is costly, which we capture through standard adjustment cost functions. The market value of the firm is contingent on the shadow price and the quantity of each installed input. These shadow prices capture the replacement cost of the input and can be easily estimated from investment data once we specify an adjustment costs function. If both the operating profit and the adjustment costs functions exhibit homogeneity of degree one, the market value of each input is the product of the input's shadow price and the corresponding stock variable. Consequently, the total market value of the firm becomes the sum of the market values of all inputs. This additive characteristic facilitates a straightforward computation of each input's contribution to the firm's overall value.

We estimate the model using data from a large cross section of publicly traded firms around the world. To measure the firm-level stocks of each capital input, we use accounting information data of listed companies from the Compustat (North America and Global) database. For physical capital, the data is readily available from the firm's balance sheet. For intangible capital, we follow

Eisfeldt and Papanikolaou (2013) and Peters and Taylor (2017), to construct firm-level measures of intangible stock using accounting data related to Selling, General and Administrative (SG&A) expenses, in each country. Corrado, Hulten, and Sichel (2009) use the capitalized expense in R&D, software, advertising, employee training to measure the aggregate amount of intangible capital in United States. For measuring the intangible capital at the firm-level, Lev and Radhakrishnan (2005) document SG&A serves as a comprehensive measure of investment expense of intangible capital, encompassing multiple facets. It reflects the value of skilled labor force (capturing training costs), knowledge capital (often including R&D expenditures), brand capital (accounting for advertising expenses), and other operational expenses. We employ the perpetual inventory method to aggregate these expenditures, enabling us to derive the capital stocks for intangible capital.

To estimate the model we minimize the difference between observed and model-generated valuation ratios, specifically the market value of equity plus net debt-to-book value of capital stocks. We estimate adjustment cost parameters for both physical and intangible capital at the individual country and regional levels. For large equity markets, we estimate country specific adjustment cost parameters. These are 17 countries including all major economies in the world. For other countries, we adopt a strategy of pooling these nations into the geographic areas based on United Nations statistics criteria, and estimate region-specific adjustment parameters. In total, our analysis covers 77 countries, whose the listed companies represent 34% of world GDP and 11% of global value added. Due to data availability most of our analysis focus on the last 15 years, the start date varies per country, mostly starting in the mid 2000 and ends in 2020. Leveraging the estimated adjustment cost parameters, we apply our model to decompose the value of firms into physical and intangible capital for each of these countries.

Our main empirical findings can be summarized as follows. First, we show that neoclassical model of investment with two heterogenous capital inputs aligns well with the data across diverse economies. In major markets where country-specific parameters are estimated, the model effectively accounts for both time-series and cross-sectional variations in valuation ratios across portfolios. In the worldwide, the cross-country time-series R^2 stands at 55%, while the cross-sectional R^2 reaches 88%. The model exhibits robust explanatory power, across sub-samples of continents. In Asia, the time-series R^2 is 56% and a cross-sectional R^2 of 88%. In Europe, the time-series R^2 is 41% and a cross-sectional R^2 of 83%. In Americas, the time-series R^2 is 70% and a cross-sectional R^2 of 94%. Including intangible capital and allowing for heterogeneity in the capital inputs, the neoclassical model successfully explains the variation of firm valuation across the world.

Second, we find that the estimated adjustment cost of intangible capital varies across countries and that this heterogeneity is important for capturing firm value. Examining larger equity markets, the physical capital adjustment cost parameter varies from 0.42 for Japan to 7.08 for the USA. Across the countries and regions, the average parameter is 3.68 and a standard deviation of 1.86. For Germany, the UK, and India, the estimated parameters hover around this average, registering values of 4.64, 5.42, and 4.41, respectively. In contrast, the intangible capital adjustment cost parameter displays greater variability, ranging from 2.63 for Japan to 32.67 for China. The cross-country average stands at 11.60, with a standard deviation of 6.22. The USA, UK, and Canada align closely with this average, featuring estimated values of 16.84, 9.14, and 12.07, respectively.

Third, our findings show that intangible capital significantly contributes to the market value of firms across all countries. Utilizing the estimated parameters of geography-specific and capital-specific adjustment costs, we calculate the market share of intangible capital for each firm and each time point. In the country-specific estimation, the cross country average value of intangible capital represents 54.92% of the firm's market value. Importantly, there exists substantial heterogeneity in the market share of intangible capital, ranging from 70.26% in China to 35.60% in South Korea. Apart from China, the top five countries with the highest intangible market shares include the USA (67.38%), the UK (64.37%), France (64.93%), and Hong Kong (59.31%).

Finally, for all countries that the model directly estimates the specific coefficient, the cost of adjusting intangible capital is higher than the cost of adjusting physical capital. In the worldwide, the adjustment cost of intangible capital is twice as large as that of physical capital, where the market share of intangible capital 54.92% surpasses book value 31.45%. Collectively, these findings underscore the pivotal role of intangible capital as a key input in the production and value creation for firms worldwide.

Our results highlight the significance of geographical variation in adjustment costs for understanding differences in market value among firms and their inputs across countries. To investigate the key country characteristics that drive these cross-country differences we investigate six dimensions of country-level characteristics that may influence adjustment costs: (1) Protection of Intellectual Property Rights, (2) Employment Contract Protection, (3) Ease of Contract Enforcement, (4) Cost of Financing, (5) Protection of Investor Rights, and (6) Economic Development. We model adjustment costs as a function of these characteristics and re-estimate the neoclassical investment model using this specification. This approach allows us to leverage the heterogeneity of smaller economies within regions, as well as time series variations in firm value and investment rates, to accurately identify the significance of country characteristics. Our findings indicate that the model in which adjustment costs depend on country characteristics fits the data well for all regions except Africa, closely aligning with the parameters in benchmark model.

The extended model translates the cross-country difference in status of institutional infrastructure and financial market development into the amount of capital valuation directly impacted. The marginal compensation value for the under-development of institutional infrastructure and financial market is estimated. Our analysis shows that economic development and financial market factors, particularly the protection of intellectual property rights and the cost of financing, play significant roles in the cross-country variation of intangible capital value, while similar factors affect physical capital but to a lesser extent. The variation in intellectual property rights protection contributes to 0.14 standard deviation in value of intangible capital. The variation in cost of financing contributes to 0.34 standard deviation in intangible capital, while it is 0.13 for the value of physical capital. Overall, these results emphasize the critical interplay between country characteristics and the valuation of both physical and intangible capital across different economic contexts.

Related Literature. Our research is closely aligned with the extensive literature on valuation and production-based asset pricing, with a specific focus on the role of intangible capital. (Hall, 2001) discusses the valuation of securities is overly high compared to the price of installed capital in late 1990s. The omitted intangible capital provides a candidate explanation. (Belo et al., 2022) provides a decomposition of the value of North American firms, considering physical capital, labor, and two types of intangibles—brand capital and knowledge capital. (Crouzet and Eberly, 2021) explains the quantitative tension between physical-capital investment rate and the firm valuation, using the adjustment cost estimates from (Belo et al., 2022) to decompose the long-run evolution of firm valuation. (Peters and Taylor, 2017) incorporate organization capital for the total book capital, adjust the measure for the Tobin's Q, and to explain the total firm investment. (Eisfeldt and Papanikolaou, 2013) show that firms with more organization capital are riskier than firms with less organization capital. (Eisfeldt, Kim, and Papanikolaou, 2020) and (Gulen et al., 2022) include intangible capital for Value factor. Adjusted measure of firm valuation ratio improves the asset pricing factor models. (Hansen, Heaton, and Li, 2012) study the risk characteristics of intangible capital. In international macro-finance, research on the cross-section of equity valuation is emerging. To our knowledge, our paper is the first attempt for quantifying market value of intangible capital in global economy. We find that adjustment cost of intangible capital is larger than that of physical capital in most countries. Furthermore, our cross-country analysis allows us to study the importance of country's fundamental characteristics in driving the importance of each input in the firm's market value.

Our research adds to the extensive literature on cross-country difference of valuation (firm average Q) and investment. What determines the firm value in a country? La Porta et al. (2002) investigate the ownership of the large listed firms in different countries, document that block shareholder impedes the corporate governance and erodes corporate value. The higher firm valuation is the result of the higher cash-flow growth benefiting from the investor protection. McLean, Zhang, and Zhao (2012) extend the investment-Q regression, document the investment is more sensitive to firm value, in countries with better investor protection. Aforementioned research only considers the homogeneous capital, but intangible capital is crucial for modern corporation. Acharya, Baghai, and Subramanian (2014) specifically focus on the effect of employee protection over firm innovation productivity. Patent application and economic importance measured by citation increases after a state in the U.S. adopted the Wrongful Discharge Laws. Calcagnini, Ferrando, and Giombini (2014) document firm valuation tends to be lower in economies with stronger protection of employment contract.

High firm value is often interpreted as high growth of capital and the corresponding dividend growth. Our research clarifies the sophisticated interplay between firm valuation and investment. Conditional on the same future path of profitability and revenue growth, the firm value also relies on the exact dynamic of capital adjustment cost. This can hardly be delineated by the textbook dividend-growth model where the economic uncertainty is ignored, while the general Neo-Classical dynamic investment model derives the robust prediction over the firm value. Despite the rich literature in describing how the firm profit can be affected by the legislation system in protecting patents, little is known for the difficulty in implementing the investment, which is quantified by the intangible capital adjustment cost in this paper. High investment rates reflect the expectation of high cash flow growth or the low discount rate, while the sensitivity of firm value to investment rate elicits the adjustment cost, conveys the shadow price of capital. We utilize the model of adjustment cost function that are determined by the institutional development in multiple aspects, to disentangle the joint effects over capital value from the institution of intellectual property right, employee contract protection, the shareholder right, the efficacy of contract enforcement, the fairness of financial market, and the economic development.

Our results highlight the significance of country-specific characteristics, such as patent protection, and bank profitability, in assessing the value of various inputs. Using a dynamic general equilibrium model, Antill et al. (2023) quantify the extent how plaintiff rights in the litigation influences innovation. Strengthening protection to incumbent patent increases the monopoly rent and the firm value, but discourage the innovation of new entrant. Similarly, Crouzet et al. (2022a) argue that stronger property rights can hinder growth by limiting access to intangible capital. Our empirical examination indicates that countries with stronger patent protections experience lower adjustment costs for intangible capital, which, when keeping investment levels constant, leads to a reduced value of that capital. In Petersen and Rajan (1994); Hauswald and Marquez (2006), cost of funding depends on the information rent and the power of bank in loan market negotiation. We find that bank's profitability, reflecting the firm's cost of financing, significantly increases the cost of investing in intangible capital. La Porta, Lopez-de Silanes, and Shleifer (1999); La Porta et al. (2002) raise the concern whether corporation value is eroded due to the under-development of financial market and weak shareholder protection. We show that the neoclassical model of investment with two capital inputs explains the firm valuation well. This indicates the manager's valuation is aligned to the market valuation in most countries, with the exception of China and Japan. Our estimation confirms that the firm value is largely contributed by the intangible capital. Status of country in intellectual property protection and cost of financing explain cross-country variation in firm value, while the effect from shareholder rights is less pronounced.

Our work also talks to the recent literature of modern corporate sector in international finance. (Karabarbounis and Neiman, 2014) document the declining labor share of income in national accounting data, both in the United States and globally. (Chen, Karabarbounis, and Neiman, 2017) investigated the increasing corporate saving in the private corporate sector. (Falato et al., 2022) provide an explanation for the simultaneous shift toward the intangible capital and the corporate saving. (Altomonte et al., 2021) claim that the frictions in intangible investments can lead to the dispersion of markup at firm-level. Our work investigates the role of capital market environment in the valuation of intangible capital, by quantifying the difficulty of intangible capital investment for countries. High valuation of intangible capital can be the result of its high shadow price.

The remainder of the paper is structured as follows: Section 2 presents the model, while Section 3 introduces the functional forms and outlines the estimation procedure. Section 4 details the data used. Section 5 discusses the contribution of intangible capital to firm value and the cross-country difference in cost of investing intangible capital. Section 6 examines the heterogeneity of economic and institutional environment in countries, models the cost parameters as a function of country fundamentals. Section 7 addresses various robustness checks, and finally, Section 8 concludes the paper. Additional results and robustness analyses can be found in the Appendix.

2 The Model of the Firm

We consider a neoclassical model of the firm as in (Belo et al., 2022)(we use the consistent notation with Belo et al. (2022) whenever possible) with several quasi-fixed inputs. Time is discrete and the horizon is infinite. Firms choose costlessly adjustable inputs (e.g., materials, energy) each period, while taking their prices as given, to maximize operating profits (revenues minus the expenditures on these inputs). Because we treat intangible capital as quasi-fixed inputs, investments in intangible capital is excluded from our definition of operating profits. Then, taking these operating profits as given, firms optimally choose the physical and intangible capital investments, and debt to maximize their market value of equity.

To save on notation, we denote a firm's i set of capital as $\boldsymbol{K_{it}}$ (variables in bold represent a vector). This set includes the physical capital stock (K^P_{it}) and the intangible capital stock (K^I_{it}). Similarly, we denote a firm's i set of investments in the inputs at time t, as $\boldsymbol{I_{it}}$. This set includes the investment in physical capital (I^P_{it}) and the investment in intangible capital (I^I_{it}).

The law of motion of the firm's capital inputs is given by:

$$K^P_{it+1} = I^P_{it} + (1 - \delta^P_{it})K^P_{it} \tag{1}$$

$$K^I_{it+1} = I^I_{it} + (1 - \delta^I_{it})K^I_{it} \tag{2}$$

where δ^P_{it} and δ^I_{it} are the exogenous depreciation rates of physical and intangible capital, respectively.

2.1 Technology

The operating profit function for firm i at time t is $\Pi_{it} \equiv \Pi(\boldsymbol{K_{it}}, \boldsymbol{X_{it}})$, in which $\boldsymbol{X_{it}}$ denotes a vector of exogenous aggregate and firm-specific shocks. Firms incur adjustment costs when investing. The adjustment costs function is denoted $C_{it} \equiv C(\boldsymbol{I_{it}}, \boldsymbol{K_{it}})$. This function is increasing and convex in investment, and decreasing in the capital stocks. For physical and intangible capital inputs these costs include, for example, planning and installation costs, and costs related with production being temporarily interrupted. We assume that the firm's operating profit function and adjustment costs function are both homogeneous of degree one and we specify the functional forms in the empirical section below.

2.2 Taxable Profits and Firm's Payouts

Firms can issue debt to finance their operations.[1] At the beginning of time t, firm i issues an amount of debt, denoted B_{it+1}, which must be repaid at the beginning of time $t+1$. r^B_{it} denotes the gross corporate bond return on B_{it}.

We can write taxable corporate profits, denoted TCP, as operating profits minus intangible capital investments (which are expensed), physical capital depreciation, adjustment costs, and

[1] We include debt in the model to better fit the data, but for parsimonious reasons we keep the financing side of the firm as simple as possible.

interest expense:

$$TCP_{it} = \Pi_{it} - I_{it}^{I} - \delta_{it}^{P} K_{it}^{P} - C_{it}.$$

Thus, adjustment costs are expensed, consistent with treating them as foregone operating profits.

Let τ_{it} be the corporate tax rate. The firm' payout, denoted D, is then given by:[2]

$$D_{it} \equiv (1-\tau_t)[\Pi_{it} - C_{it} - I_{it}^{I}] - I_{it}^{P} + B_{it+1} - r_{it}^{B} B_{it} + \tau_t \delta_{it}^{P} K_{it}^{P} + \tau_t (r_{it}^{B} - 1) B_{it}, \tag{3}$$

in which $\tau_t \delta_{it}^{P} K_{it}^{P}$ is the depreciation tax shield, and $\tau_t(r_{it}^{B} - 1)B_{it}$ is the interest tax shield.

2.3 Equity Value

Firm i takes the stochastic discount factor, denoted $M_{t+\triangle t}$, from period t to $\triangle t$ as given when maximizing its cum-dividend market value of equity:

$$V_{it} \equiv \max_{\{\mathbf{I}_{it+\triangle t}, \mathbf{K}_{it+\triangle t+1}, B_{it+\triangle t+1}\}_{\triangle t=0}^{\infty}} E_t \left[\sum_{\triangle t=0}^{\infty} M_{t+\triangle t} D_{it+\triangle t} \right], \tag{4}$$

subject to a transversality condition given by $\lim_{T\to\infty} E_t[M_{t+T} B_{it+T+1}] = 0$, and the laws of motion for the capital inputs given by equations (1).

Let $P_{it} \equiv V_{it} - D_{it}$ be the ex-dividend equity value. In the online appendix we show that, given the homogeneity of degree one of the operating profit and adjustment costs functions, the firm's value maximization implies that:

$$P_{it} + B_{it+1} = q_{it}^{P} K_{it+1}^{P} + q_{it}^{I} K_{it+1}^{I}, \tag{5}$$

in which

$$q_{it}^{P} \equiv 1 + (1-\tau_t)\partial C_{it}/\partial I_{it}^{P} \tag{6}$$

$$q_{it}^{I} \equiv (1-\tau_t)\left[1 + \partial C_{it}/\partial I_{it}^{I}\right] \tag{7}$$

[2] Note that physical capital investment and intangible capital investments are treated differently given the different accounting rules. Investment in physical capital is spread out over time and expensed as depreciation, while the intangible capital costs are mostly treated as expenses at the time that they occur.

and $\partial C_{it}/\partial x$ denotes the first derivative of the adjustment costs function with respect to variable x, q_{it}^P, and q_{it}^I measure the shadow prices of physical capital and intangible capital, respectively (the Lagrange multipliers of equations (1) to (2)). The valuation equation (5) is simply an extension of (Hayashi, 1982)'s result to a multi-factor inputs setting. Note that there is subtle difference between the shadow price of the two inputs, which comes from the different tax treatment of the inputs.

According to equation (5) the firm's market value is given by the sum of the value of the firm's installed capital inputs. This additive feature allows us to compute the fraction of firm value that is attributed to each input (henceforth referred simply as "input-shares") in a straightforward manner as follows:

$$\mu_{it}^P = \frac{q_{it}^P K_{it+1}^P}{q_{it}^P K_{it+1}^P + q_{it}^I K_{it+1}^I} \tag{8}$$

$$\mu_{it}^I = \frac{q_{it}^I K_{it+1}^I}{q_{it}^P K_{it+1}^P + q_{it}^I K_{it+1}^I} \tag{9}$$

The fundamental goal of the empirical analysis is to characterize these input-shares, including their variation across countries and over time.

3 Estimation Methodology

In this section we specify the functional forms and describe the estimation procedure. In subsection 3.1 we discuss the functional forms used to model adjustment costs which define the specification of firm equity value. In subsection 3.2 we describe the estimation procedure used that focuses on using portfolios to minimize the idiosyncratic noise in the data, and the definition of country and regions that we use to estimate the model.

3.1 Functional Forms

The valuation equation (5) only requires the specification of the adjustment costs function, not of the operating profit function. We consider the following quadratic adjustment costs function:

$$C_{it} = \frac{\theta_{P,c(i)}}{2}\left(\frac{I_{it}^P}{K_{it}^P}\right)^2 K_{it}^P + \frac{\theta_{I,c(i)}}{2}\left(\frac{I_{it}^I}{K_{it}^I}\right)^2 K_{it}^I, \tag{10}$$

in which $\theta_{P,c(i)}, \theta_{I,c(i)} > 0$ are the parameters that control the magnitude of the adjustment costs of each input. The subscript $c(i)$ is the country (or region as we describe below) of firm's i headquarters. Accordingly, in the baseline of the model, we let the adjustment cost parameters to vary across countries to capture the cross-country differences in the market environment for physical capital and intangible capital investment. These variation might arise due to differences in the judicial system, culture, regulation of financial sector, among other.[3] We then examine the determinants of this variation in detail in section 6 below.

This functional form implies that the shadow prices of the capital inputs can be inferred from firm-level data on investment, capital stocks, and taxes, and are given by:

$$q_{it}^{P} \equiv 1 + (1-\tau_{t,c(i)})\theta_{P,c(i)}\left(\frac{I_{it}^{P}}{K_{it}^{P}}\right) \tag{11}$$

$$q_{it}^{I} \equiv (1-\tau_{t,c(i)})\left[1 + \theta_{I,c(i)}\left(\frac{I_{it}^{I}}{K_{it}^{I}}\right)\right] \tag{12}$$

We adopt a simple quadratic adjustment cost specification for parsimonious reasons and to avoid parameter proliferation. There are several implicit assumptions in our simple specification, such as using gross flows, smooth, convex and symmetric adjustment costs. See (Belo et al., 2022) for a discussion of these assumptions.

Denote the firm's total (effective) dollar amount of capital inputs (physical capital stock and intangible capital stock) as $A_{it} = K_{it}^{I} + K_{it}^{P}$. Accordingly, we write a firm's valuation ratio (VR_{it}

[3]Capital adjustment cost captures the flexibility in implementing the investment plan. The resource reallocation, internal coordination within the corporation is costly, but not directly reported in the firm cashflow statement.For example, in a country where the business secret is easily leaked to competing firms, firm is unwilling to invest, in the fear or being copied by the cohort firms. When there is new demand for the vehicle-design or cost optimization in assembly, despite the future profit flow is lucrative from the investment action, the concern of being copied by competitors, the expectation of coping competitors in the later round, would push the producers simultaneously postpone or taper the effort in launching the new design/investment. Though one doesn't see the direct payment to installing the new design, the manager and the in-house engineers all spent quite a lot of time in monitoring the industry and contemplating the decision of allocating the investment budget.

The development of financial market has the similarly important role for capital adjustment cost. Take the example of an electricity vehicle producer. Kicking off the new product line of algorithm-supported auto-driving system requires large initial signup payment to newly recruited engineers and scientist who are expert in this new field. When the firm doesn't have enough liquidity at hand, the expansion decision into the auto-driving system might be postponed, due to the long time required by approving the new loan or raising the new fund from the shareholder. On the contrary, a new assembly line of electricity battery is more tangible, the firm can use financial-lease to obtain the timely funding. These are typical examples for how the cost of financing affects the adjustment cost of capital investment, and how it asymmetrically affects the implementation cost of intangible capital and physical capital.

$\equiv (P_{it} + B_{it+1}) / A_{it+1})$ as:

$$VR_{it} = q_{it}^{P} \frac{K_{it+1}^{P}}{A_{it+1}} + q_{it}^{I} \frac{K_{it+1}^{I}}{A_{it+1}}. \tag{13}$$

3.2 Estimation Procedure

We estimate the model separately in each country (or region, as explained below). Hence, to save notation, in this section we omit the country/region subscript in the model parameters.

The valuation equation (5) links firm value to the value of its capital inputs. The left-hand side (LHS) of equation (13) can be directly measured in the data from equity price and debt data (and measures of the capital stocks, which we discuss below). The right hand side (RHS) of equation (13) is the predicted valuation ratio from the model, which we will denote as $\widehat{VR}_{it}$, and depends on firm-level real variables and model parameters.

Equation (13) establishes an exact relationship between a firm's observed valuation ratio and its model-implied valuation ratio at each time-period. However, due to the noise in firm-level data and the sensitivity of their moments to entry and exit and missing observations, using equation (13) and firm-level data to directly estimate the model parameters is challenging. Therefore, we follow the same methodology as (Belo et al., 2022) and estimate portfolio-level moments. The portfolio estimation methodology targets the cross-sectional mean at the portfolio level and aligning the realized time series of portfolio-level valuation ratios with the model's predictions, provide robust estimates.

We proceed as follows. In theory, at each point in time, any cross-sectional moment of the observed firm-level valuation ratios in the LHS of equation (13) should be equal to any corresponding cross-sectional moment of the model-implied firm-level valuation ratios in the RHS of equation (13). Accordingly, in each country, for each portfolio j and for each year t, we compute the cross-sectional mean observed and model-implied valuation ratios ($\overline{VR}_{jt}$ and $\widehat{\overline{VR}}_{jt}$, respectively) of the firms in the portfolio as follows:

$$\overline{VR}_{jt} = \sum_{i} \frac{VR_{it}}{N_{jt}}$$

$$\widehat{\overline{VR}}_{jt}\left(\Theta\right)=\sum_{i}\frac{\widehat{VR}_{it}}{N_{jt}}\ ,\ i\in \text{portfolio } j,$$

where Θ represents the vector of structural parameters in a given country, $\Theta = [\theta_P, \theta_I]$, and N_{jt} is the number of firms in portfolio j at time t. We target cross-sectional mean valuation ratios because these moments capture the economic behavior of a typical (average) firm in the economy, which is what the theoretical model is designed to study.

We then proceed under the standard assumption that the portfolio-level valuation ratio moments are observed with error by the econometrician:

$$\overline{VR}_{jt}=\widehat{\overline{VR}}_{jt}\left(\Theta\right)+\varepsilon_{jt}, \tag{14}$$

where ε captures measurement error in the portfolio-level moments.[4] Based on equation (14), in each country, we then estimate the model parameters by minimizing the squared distance between the portfolio-level observed and model-implied valuation ratio moments at each point in time:

$$\widehat{\Theta}=\arg\min_{\Theta}\frac{1}{TN}\sum_{t=1}^{T}\sum_{j=1}^{N}\left(\overline{VR}_{jt}-\widehat{\overline{VR}}_{jt}\left(\Theta\right)\right)^{2}, \tag{15}$$

where T is the number of years in the sample, and N is the number of portfolios. An attractive feature of our estimation approach is that it corresponds to a simple linear ordinary least squares (OLS) estimation of (modified) portfolio-level average valuation ratios on portfolio-level averages of firm-characteristics. To show this, define the following variables, $\overline{VR}^{M}_{jt} = \frac{1}{N_{jt}}\sum_{i\in j}\frac{\left(P_{jt}+B_{jt+1}-K^{P}_{jt+1}-(1-\tau_t)K^{I}_{jt+1}\right)}{A_{jt+1}}$ as the modified (M) valuation ratio, and $\overline{IPA}_{jt} = \frac{1}{N_{jt}}\sum_{i\in j}(1-\tau_t)\frac{I^{P}_{it}}{K^{P}_{it}}\frac{K^{P}_{it+1}}{A_{it+1}}$, and $\overline{IKA}_{jt} = \frac{1}{N_{jt}}\sum_{i\in j}(1-\tau_t)\frac{I^{I}_{it}}{K^{K}_{it}}\frac{K^{I}_{it+1}}{A_{it+1}}$. We can then write equation (14) as:

$$\overline{VR}^{M}_{jt}=\theta_P\overline{IPA}_{jt}+\theta_I\overline{IKA}_{jt}+\varepsilon_{jt} \tag{16}$$

which establishes a linear relation between the portfolio-level modified valuation ratio and portfolio-level characteristics. Thus, our objective function in (15) corresponds to a simple linear OLS

[4] Mismeasured components of the valuation ratio such as the market value of debt and the capital inputs can be better observed by firms than by econometrician. Furthermore, the intrinsic value of equity can temporarily diverge from the market value of equity.

regression of equation (16).

3.3 Geographic Areas and Portfolio Sorts

As noted above, the estimation is performed at the portfolio-level and separately for each country or region.

Geographic Areas. To link a firm to a country, we use the firm's headquarter.[5] Ideally, we would like to estimate the model separately for all the countries in the sample. This approach is not possible, however, as the number of firms and observations is too small in some countries. In these cases, we combine multiple countries from a similar geographic area into a region.

Specifically, we define large equity markets as those country having data for at least 200 firms in the time-series average during the sample period, and medium equity market as the country with at least 100 firm. We estimate the model for the economies with large-size equity market, and the rest of area in each continent separately.

In the continent of *Asia*, countries (or territories) China, Hong Kong, India, Indonesia, Japan, Malaysia, Singapore, South Korea, Taiwan, Thailand have large-size equity markets, under this criterion. In the remaining area of Asia, Israel, Pakistan, Turkey, Vietnam have the medium-size equity markets. Small-size countries are: Southern Asia (Bangladesh, Sri Lanka), South-Eastern Asia (Philippines), Western Asia (United Arab Emirates, Bahrain, Cyprus, Jordan, Kuwait, Oman, Palestine, Qatar, Saudi Arabia).

In the continent of *Europe*, France, Germany, Poland, United Kingdom, are economies with the large number of listed companies. In the remaining area of Europe, Greece, Italy, Sweden, Switzerland have the medium-size equity market. Small-size countries are: *Southern Europe* (Spain, Croatia, Malta, Serbia, Slovenia), *Eastern Europe* (Bulgaria, Hungary, Romania, Russia, Ukraine), *Northern Europe* (Denmark, Estonia, Finland, Ireland, Iceland, Lithuania, Latvia, Norway), *Western Europe* (Austria, Belgium, Luxembourg, Netherlands, Portugal).

In the continent of *Americas*, Canada, United States of America are large economies. In the remaining area of Americas, Brazil has the medium-size equity market. Small-size countries are: *Latin America and the Caribbean* (Argentina, Chile, Colombia, Cayman Island, Jamaica, Mexico,

[5]For robustness check, we also consider defining the location of firm as its residing country of incorporation. The result are similar.

Peru).

We estimate the adjustment cost parameters for each country and remaining regions separately. This procedure avoids double-accounting of observations. In *Oceania*, we don't have valid observations of listed firms locating in this continent after the large economy Australia is selected out. In *Africa*, South Africa is has the largest equity market and falls under the medium-sized equity market category in our global classification. Other small-size countries in Africa include *Northern Africa* ountries (Morocco and Tunisia) and *Sub-Saharan African countries* (Cote D'ivoire, Kenya, Mauritius, Nigeria).

In summary, we use a simple classification of four regions: *Rest of Asia*, *Rest of Europe*, *Latin America*, and *Africa*. The Oceania sample for estimation includes only one large economy, Australia. Hence, our analysis covers 77 countries across five continents. We estimate the parameters specific to 21 different geographic areas: 17 countries with large equity markets, and four regions– *Rest of Asia*, *Rest of Europe*, *Latin America*, and *Africa*.[6]

Portfolio sorts. For each one of 21 geographic areas, we form two sets of portfolios sorted on the following variables: $\left(\frac{I_{it}^P}{K_{it}^P}\right)\left(\frac{K_{it+1}^P}{A_{it+1}}\right)$, $\left(\frac{I_{it}^I}{K_{it}^I}\right)\left(\frac{K_{it+1}^I}{A_{it+1}}\right)$. Sorting on these variables generates a large dispersion in the explanatory variables which helps for the identification of the model parameters. (In the online appendix, we show that the model results are across different sorting variables.) We then follow Fama and French (1993) in constructing the portfolios. Specifically, we sort all firms in each year t into ten portfolios based on the deciles of the sorting variable of each firm for the fiscal year ending in $t-1$. The portfolios are re-balanced at the end of each year. This procedure gives a total of 20 portfolios in each country or region.

4 Data

In this section, we provide a general description of the data. Additional details about the data sources and the harmonization of measures are available in the Section F of the appendix.

[6]Distribution of the 21 geographic areas in the five continents are: *Asia* (China, Hong Kong, India, Indonesia, Israel, Japan, Malaysia, Singapore, South Korea, Taiwan, Thailand, *Rest of Asia*), *Europe* (France, Germany, Poland, United Kingdom, *Rest of Europe*), *Americas* (Canada, United States of America, *Latin America*), *Oceania* and *Africa*.

We construct firm-level measures of market value, input investment, and stock using the financial reports of publicly traded firms in each country. For firms in the United States and Canada, we collect annual balance sheet information from Compustat North America Annual Fundamentals and stock price data from the Compustat-CRSP linked dataset. For firms in other countries, we gather annual information from Compustat Global Annual Fundamentals and stock prices from Compustat Global Security Daily.

We set the currency as the U.S. dollar for all countries. The frequency is annual and varies by country. We deflate the variables using the country-specific consumer price index.[7] We set the starting-year as the year when the country has sufficient firm-year observations. For major economies, the data spans 2000-2020 (see Table 1 for individual country samples). The online appendix (Table C.1) reports the starting year for each country or region. The sub-samples of countries in Asia start around 2000, while those for main countries in Europe and Africa start around 2006.[8]. The full records for listed companies in North America date back further; however, for estimation to be comparable to other countries worldwide, we use the sample for Canada and the United States starting from 2000. The end-year is 2020 for all countries and regions.

4.1 Capital stocks and other variables

4.1.1 Physical Capital

The initial physical capital stock, K_{it}^P, is given by net property, plant, and equipment (data item PPENT). The capital depreciation rate, δ_{it}^P, is calculated as the amount of depreciation (data item DP) divided by the beginning of the period capital stock.[9] We then construct a measure of the firm's capital stock at current prices. Specifically, we construct an investment-price adjusted capital

[7] Hyper-inflation in local currency and volatile change in nominal exchange rate generate the measurement error. Under this circumstance, firm operation might switch to using U.S. dollar or other currencies, hence the true prices of firm investment are not accurately observed. To ensure the measure of firm-level capital is consistent, we restrict the ceiling of inflation rate as 25% per year, in computing the investment rate and capital stock. Countries Egypt and Zimbabwe are not included in our sample for estimation, because they had extreme hyperinflation in our sample period.

[8] Gauging the amount of intangible capital requires detailed income statement information that conforms to the international financial statement reporting standard. The sub-sample of listed companies in different countries doesn't start in the same years. This is partly constrained by the adoption of common accounting standard around the year 2005.

[9] Negative depreciation of capital is not well-defined. If the depreciation rate is greater than 1, we impute the rate as 1.

stock that accounts for changes in the real cost of physical capital investment by repricing last period's capital stock using today's price of investment (P_t^P) as $K_{t+1}^P = K_t^P(1-\delta_t)\frac{P_{t+1}^P}{P_t^P} + I_{t+1}$. Following (Belo et al., 2022) we infer physical capital investment from the law of motion of capital using this equation (adjusted for inflation). This procedure ensures that the investment and capital stock are consistent with the law of motion for physical capital in the model.

4.1.2 Intangible Capital

Following Eisfeldt and Papanikolaou (2013) we construct a measure of intangible capital based on Selling, General, and Administrative (SG&A) expense data (Compustat data item XSGA).[10] We calculate the installed amount of capital using the perpetual inventory method as follows:

$$K_{j,t+1}^I = \mathrm{I}_{j,t+1}^I + (1-\delta^I) \cdot K_{j,t}^I \cdot \frac{P_{t+1}^I}{P_t^I}. \tag{17}$$

where P_t^I is approximated as the CPI of home country in local currency [11].

We set investment expenditure equal to 30% of SG&A expense following (Eisfeldt and Papanikolaou, 2013) and (Peters and Taylor, 2017).[12] The depreciation rate, δ^I, is calibrated as 20%. We set the initial amount of capital as

$$K_{j,0}^I = \frac{I_{j,0}^I}{g_{\mathrm{Ind}(j)}^I + \delta^I - \pi_{\mathrm{Ind}(j)}^I \cdot (1-\delta^I)}. \tag{18}$$

[10]In the US and Canada, firms report the detailed expenditure of R&D and advertising, estimation could differentiate heterogeneous capital inputs such as knowledge and brand, (see (Belo et al., 2022)). Firms in other countries don't universally report these details. The quantity of investment in intangible capital cannot be inferred from the historical records related to goodwill and other intangible assets in balance sheet. These are valuation-based measures. When comparing the valuation of firms across countries, the SG&A expense is the most comparable measure for the investment expenditure in intangible capital.

[11]Here, the depreciation rate of intangible capital is calibrated as the constant value. So the sub-script of depreciation rate is negliected in equation 17.

[12]The fraction of firms disclosing detailed expense of R&D and advertising, is not comparable across countries. For listed companies residing outside of North America, a small subsample discloses the R&D expense. In alternative calibration, we compute the amount of intangible capital following the procedure in (Peters and Taylor, 2017). The full R&D expense is acknowledged as the investment expenditure. For the firms with knowledge capital that can be directly measured, the total amount of intangible capital is slightly larger than the benchmark measure. The model estimation has smaller cost coefficient for intangible capital. The conclusion for the importance of intangible capital, and cross-country variation are similar. Estimating for intangible capital investment expenditure of detailed categories would be a separated research investigation.

in which $I^I_{j,0}$ is the firm's investment in intangible capital in the first year in the sample, and $\pi^I_{\text{Ind}(j)}$ is the average price growth rate, in the industry, in each country. We let $g^I_{\text{Ind}(j)}$ be industry-specific and set it equal to the average growth rate of the SG&A expense in that industry. We consider the first 2-digits of NAICS industry code to classify the industry in each country. Once we have the initial amount of capital, we derive the new amount of capital in equation (17), using the depreciation rate, SG&A expenses, and investment price index. The investment rate on intangible capital is then given by the ratio of the current period investment and the amount of intangible capital at the beginning of the period I^I_t/K^I_t.

4.1.3 Additional Variables

We measure the debt value B_{it}, as the book value of net total debt, following (Belo et al., 2022). We calculate net debt as long-term debt (Compustat data item DLTT) plus short-term debt (data item DLC), minus cash (data item CHE). When these values are missing, we set the measure to zero. The market value of equity, P_{it}, is the closing price per share (data item PRCCF) multiplied by the number of common shares outstanding (data item CSHO). The market value is based on the year-end price during the firm's fiscal year. All nominal values in local currency are converted into nominal USD using the annual-average exchange rate.

We measure the tax rate, τ_t, as the corporate income tax rate from the Tax Foundation, available for each country. If corporate income tax rate information is unavailable, we use data from Compustat Global-Economic Indicators. Stock variables with subscript t ($t+1$ for debt) are measured and recorded at the end of year t, while flow variables with subscript t are measured over the course of year t and recorded at the end of year $t+1$.

4.2 Summary Statistics

Our sample of 77 countries is representative of the total production across the world. In the online appendix (Table C.1), we show that our sample includes 12,869 firms, with sales representing 36.77% of world GDP per year during the sample period. In Asia, the 10 large equity markets and 16 countries in the Rest of Asia, include 7,501 firms, with sales representing 38.62% of GDP in these countries. For these large countries, per capita GDP in 2020 ranges from $1,849 in India to $56,423 in Singapore.

In Europe, the 4 main equity markets and the 27 countries in the Rest of Europe include an average of 2,801 firms, with sales representing 34.04% of GDP in these countries. In Canada, the United States, and 8 countries in Latin America, the sample includes an average of 2,699 firms, with sales representing 39.09% of GDP in these countries. In Australia, listed companies in the sample have sales equal to 18.20% of GDP. For the 9 countries in Africa, the sales of the listed companies in the sample represent around 12.08% of the GDP in these countries.

Table 1 reports key summary statistics of the observed valuation ratios and their model-implied components according to equation (13), for the major equity markets and regions. The median valuation ratio across all major markets is 1.44, but there is substantial heterogeneity across countries. While China has the highest average valuation ratio, at 2.94, Japan has the lowest, at 0.84. Regarding the average size of scaled intangible capital, it accounts for 38% of total book capital on average across major economies. This proportion is lowest in China, at 20%, and highest in France, at 67%. For regions, the figures are similar, with the average valuation ratio across all regions at 1.38 and the average intangible capital share at 36%.

According to equations (11) and (12), the investment rates determine the shadow prices of the labor and capital inputs. Together with relative magnitude of each capital stock, these variables determine the relative importance of each input for firm value. Columns (3) and (4) in Table 1 show that investment in intangible capital is, on average, higher than investment in physical capital across all countries. The global median investment rate in intangible capital is 24%, with a maximum of 32% in China and a minimum of 19% in India. The global median investment rate in physical capital is 16%, with a maximum of 24% in the USA and a minimum of 3% in India. In terms of relative magnitudes of the capital stocks, column (5) shows that intangible capital is about 38% of total (physical plus intangible) capital across the globe. Again, this average exhibits substantial variation across countries, with a maximum of 67% in France and a minimum of 20 in Canada.

Column (6) of the table reports the cross-correlations of investment rates. As expected, the investment rates are all positively correlated, ranging from 18% to 42% across major equity markets. These correlations are significantly less than one, suggesting that the investment rates for different types of capital inputs exhibit distinct variations in the data. Distinguishing the shadow prices could help explain the observed variation in market value.

5 Estimation Results

This section presents the main empirical findings. Subsection 5.1 reports the parameter estimates and the baseline model's overall fit. Subsection 5.2 discusses the model-implied breakdown of firm value, decomposing market value into physical and intangible capital. This analysis underscores the significance of intangible capital in capturing a firm's market. Subsection 5.3 examines the heterogeneity in the market share of intangible capital, distinguishing between quantity and price variations. The analysis highlights the importance of country-specific adjustment costs in explaining cross-country differences in firm value.

5.1 Parameter Estimates and Model Fit

In Table 2, columns (2-3) and (8-9) present the estimates of adjustment cost parameters for the model applied to larger equity markets and regions. All estimates are positive and statistically significant. The intangible capital adjustment cost parameter (θ_I) is consistently higher than the adjustment cost parameter for physical capital (θ_P), but there is considerable heterogeneity across countries in the estimate magnitude of each parameter. The summary statistic for the "world" region shows that the cross-country average adjustment cost coefficient for physical capital is 3.68, while the average adjustment cost coefficient of intangible capital is 11.60.[13] In addition, the dispersion in the estimated adjustment cost coefficient of intangible capital θ_I is more pronounced than that for physical capital. The standard deviation of estimates across countries for physical capital is 1.86, ranging from 0.42 for Japan to 7.08 for USA.[14] In contrast, the cross-country standard deviation for intangible capital estimates is 6.22.

[13]The cross-country average outcome is calculated including the regions, where there are multiple countries within. As previously mentioned, we assume identical adjustment cost function for countries with the small-size equity market in the same region, considering they have the similar cultural background and legislation origin. This ensures the sufficient sample size to accurately identify the model. Hereafter, the name of terminology of statistics don't differentiate between the countries and the regions of the remaining area in each continent.

[14]As explained in previous section of estimation methodology, within the Latin America, we assume the identical adjustment cost function for the medium-size country Brazil, and other small-size countries. The calculation of standard deviation describes the variation across the 17 large-size countries and the 4 regions where the constituent countries are assumed to be of identical parameters within each region. We explore the more granular estimates in the extended estimation of country-characteristic model.

Notably, θ_I estimates are relatively low for European countries such as France (7.91), Germany (10.02), and the U.K. (9.14), but high in North American countries such as United States (16.84) and Canada (12.07). The pattern is less clear in Asia, where estimates of the intangible capital adjustment cost parameter are low for Japan (2.63), South Korea (4.24), Hong Kong (7.11), and Singapore (7.61), but high for China (32.67), India (19.43), and Taiwan (15.70). In contrast, European countries such as France and Germany show only small differences in the estimated adjustment cost coefficient of intangible capital. The dispersion of the estimated adjustment cost coefficient of intangible capital is much larger in Asia, reflecting the varying levels of economic development and, consequently, the different market environments in which firms operate.

To assess the economic significance of the adjustment cost estimates and evaluate whether the model matches the data with economically reasonable parameter values, we use the functional form specification in equation (10) and the parameter estimates to calculate the realized adjustment costs of each input (denoted as CP and CI). These values are computed as a fraction of a firm's total annual sales as follows:

$$\frac{CP_{it}}{Y_{it}} = \frac{\frac{\theta_{P,c(i)}}{2}\left(\frac{I_{it}^P}{K_{it}^P}\right)^2 K_{it}^P}{Y_{it}} \tag{19}$$

$$\frac{CI_{it}}{Y_{it}} = \frac{\frac{\theta_{I,c(i)}}{2}\left(\frac{I_{it}^I}{K_{it}^I}\right)^2 K_{it}^I}{Y_{it}}. \tag{20}$$

Table 4, columns (2) and (3), report the average realized adjustment costs of each input, computed as the time-series average of cross-sectional medians of the ratios in equations (19) and (20). China stands out as having the highest adjustment cost of intangible capital, at 18.40% of annual sales, followed by 13.01% in the US. For physical capital, the US and European countries top the list.

Table 4 reports the numbers for all firms in our sample (the World). In each year, we calculate the median cost among all firms. In the most recent five years of our sample, the average intangible capital adjustment cost is 5.42% of sales. This cost is higher than the adjustment costs for physical capital, which is about 1.17% of sales. The aggregate cost, expresses as a percentage of the aggregate sales, shows a similar distribution across types of capital and the countries. The fact that the median statistic is higher than the aggregate ratio, reflects that adjustment cost for capital investment matter more for small- to medium-sized firms in each country.

The model with both physical and intangible capital fits the data well when we evaluate model-fitness using the cross-sectional and the time-series fitness measures. In Table 3, the summary panel shows that the cross-sectional R^2 is high, at 88% across all portfolios worldwide, even though the model estimation does not explicitly target this moment. The average time-series R^2 is 55%.

In terms of average valuation ratio errors, the model scaled mean absolute error (m.a.e./$\overline{\text{VR}}$) is 22% on average. Since the subset of portfolios in each country independently identify the adjustment cost coefficients specific to that country, we also report the fitness statistics for individual large countries and regions in Table 2. There is less variation within the country compared to the worldwide. However, the model perform well in most countries, including Indonesia, India, South Korea and United Kingdom. The good model-fit implies that the generalized neoclassical model with intangible and physical capital describes the valuation of firms well across a wide variety of countries.[15]

Overall, the estimation results show that adjustment costs of inputs vary across countries and regions, particularly for intangible capital. The results in Table 2 highlight the importance of quantifying heterogeneous market environments using country-specific adjustment cost parameters.

5.2 The Value of Intangible and Physical Capital

The parameter estimates allow us to compute the model-implied shadow prices of each input and evaluate the contribution of each input to firm value (input shares) based on each input's market value. Specifically, using the estimates reported in Table 2, we compute the model-implied scaled

[15]There is no simple linear relationship between the firm valuation, the investment rate of physical capital, and that of intangible capital. Especially, the bi-variate distribution of the firm valuation and the intensity of intangible capital, is not the simple monotonic relationship.

Table C.17 examines the portfolios where firms are grouped using the lagged period investment rate of physical capital, the investment rate of intangible capital, and the intensity of intangible capital in total amount of capitals. We derive the firms valuation ratio using the parameter estimates in Table 2, then the portfolio-level valuation ratio is calculated for these portfolios of alternative firm characteristic variables. Each firm characteristic variable has 10 decile portfolios. In total, there are 21×30 portfolios cross countries and regions. In these alternative portfolios that are not directly used for model estimation, the measurement error is sufficiently diversified, one can also confirm the model-implied firm valuation is close to the true data observations, as illustrated in Figure D.1. Table C.17 formally reports the fitness of model for these portfolios. In each set of portfolios in those 21 countries and regions, the fitness of the model is high, with comparable statistics value to Table 2. The model with the country-specific cost and two capital inputs explain the firm valuation successfully.

value of each capital input, the values of $q_{it}^{P}\frac{K_{it+1}^{P}}{A_{it+1}}$ and $q_{it}^{I}\frac{K_{it+1}^{I}}{A_{it+1}}$, for each firm in each year. We then substitute these values into equations (8) and (9) to compute the shares of each capital input.[16] To characterize the data in a comprehensive yet parsimonious manner, we summarize the properties of the firm-level input shares in the economy. We compute the median of the intangible share in each year and each country, then calculate the mean across years for each country.

In Table 4, Columns (2) and (8) show the estimated importance of intangible capital for each country and region within each continent. Given the firm-level decomposition of capital, we can calculate the worldwide median market share of intangible capital, which is about 54.9. This indicates that the contribution of intangible capital to a firm's market value across the globe is higher than the contribution of physical capital.

Overall, this analysis shows that intangible capital is an important determinant of firms' market values across the world. In Table C.5 in the online appendix, we report the parameter estimates and model fitness for the counterfactual model, where the firm uses only physical capital for the capital inputs in production. This counterfactual model assumes zero contribution from intangible capital to firm value. To provide a meaningful comparison of the model fit in terms of R^2, we employ the same set of firms used in the baseline model estimation. Comparing the model fitness of the physical capital-only model, which exhibits mostly negative R^2 values, offers another perspective on the importance of intangible capital in firm value.

When an input is costly to adjust, the installed values of the inputs become valuable to the firm because accumulated capital inputs help avoid adjustment costs in the future. If adjustment costs are zero, the shadow prices of the inputs in equations (11) and (12) are simply one (for physical capital) and $(1-\tau_t)$ (for intangible capital). As a result, the value of each capital input is equal to its book-value (adjusted for the tax rate). Columns (5) and (11) list the book share of intangible capital, $\overline{\mu_I}$, in the counterfactual estimation of the contribution of intangible capital to firm value assuming zero adjustment costs. Compared to the 54.92% average cross-country market share, the cross-country average book share is 31.45% for the major equity markets. China stands out with a 24.24% book share of intangible capital versus a 70.26% market share.

The observed high market value of intangible capital can be attributed to two distinct channels.

[16]Note that, by construction, the input shares sum to 100%. For brevity, we report the share of intangible capital in firm valuation.

The first is the quantity channel, where a high book share corresponds to a high market share. This pattern is evident in the United Kingdom, United States and developed European countries. The second channel is the price channel, where a high market share is observed when implied shadow price is high due to the costly investment in intangible capital. This is particularly true for East Asia. Notably, China exhibits the highest intangible investment cost ,θ_I, in the entire sample. These findings highlight the interplay between the quantity and price channels in explaining the market value of intangible capital across different economies.

In summary, the findings presented in this section underscore the importance of the intangible capital input in modern corporations that heavily rely on a high-skill labor force and new technology.

5.3 Heterogeneity of Intangible Capital Value Around the World

The contribution of intangible capital to firm value (μ_I) exhibits substantial dispersion. In Table 4, across the 17 countries and 4 regions where the heterogeneous adjustment cost parameters are directly estimated, the standard deviation is 9.15%. While China sits at the top of the intangible market share, with about 70.26% of the market valuation coming from it, South Korea is at the bottom with 35.60%. Large economies such as the USA and the UK also have above-average intangible capital market shares, at 67.38% and 64.37%, respectively.

Figure 1 provides a visual description of the share of intangible capital across all the countries in our sample. The darkness of the color indicates the share of intangible capital, with darker shades representing higher shares. Countries in the Northern and Western Europe exhibit particularly high intangible market shares, while countries in East Asia show relatively lower shares. Within Asia, the median intangible market share in China is 70.26%, notably higher than Japan's 48.15%. There is significant heterogeneity among individual countries in the contribution of intangible capital to firm value, with a standard deviation of 13.76% across the 77 countries. Detailed statistics are provided in Table C.4.

The quantity channel and the price channel jointly determine the level of firm value and, correspondingly, the composition of capital in firm value. In countries where the cost coefficient of intangible capital is larger than the worldwide average, intangible capital becomes more important for firm valuation, and vice versa. When adjustment costs vary across countries, the importance of intangible capital in firm value changes accordingly.

If the adjustment cost function is homogeneous across all countries, the shadow price of the capital inputs in each country would lead to biased estimation outcomes. Table C.6 reports the point estimates for the model with a homogeneous cost function. The cost parameter for physical capital is 3.69, while that for intangible capital is 10.68. Although these cost coefficients have significantly positive point estimates, this model provides a poor description of the geographical variation in firm value.

In Table 4, columns (6) and (12) present the counterfactual estimation of the contribution of intangible capital to firm value, assuming identical adjustment cost parameters across all countries. Under this assumption, the contribution of intangible capital to firm value ,$\hat{\mu}_I$, for China is 46.86% on average during 2016–2020, compared to the true estimate of 70.26%. A similar underestimation occurs in India. Conversely, assuming global homogeneous capital adjustment costs results in an overestimation for countries like South Korea, where the counterfactual estimate of $\hat{\mu}_I$ is 46, while the true estimate is 35.60%. France exhibits a similar overestimation scenario.

These findings align with the parameters reported in Table 2, which show that adjustment cost parameters for intangible capital in China and India are much higher than the global homogeneous cost, whereas those for South Korea and France are below the global average. In countries such as Thailand and Germany, where the adjustment costs for physical and intangible capital are close to the global average, the counterfactual estimate of $\hat{\mu}_I$ closely matches the true estimate of intangible capital's contribution.

Overall, the estimation results show that the composition of capital in valuation varies across countries. This geographical variation is jointly determined by the quantity of capital and the heterogeneity of capital adjustment costs.

6 Economic Drivers of Intangible Capital Investment

The findings from the previous section highlight the importance of geographical variation in adjustment costs in explaining cross-country differences in firms' market values and their inputs. In this section, we explore the key factors driving these differences in adjustment costs and input market values. To do so, we re-estimate the model using an adjustment cost function that incorporates country-specific characteristics likely to affect firms' ability to invest, and analyze the importance of these characteristics for firm valuation.

We adjust the estimation procedure in the baseline model as follows. Each country's characteristics are represented by the vector X_c, and these characteristics affect the adjustment cost coefficients $\theta_P(X_c)$ and $\theta_I(X_c)$. The vector of country-level characteristics $\overrightarrow{X}_c$ includes various aspects of the market environment and is collected at the national level. The functional forms for the adjustment costs are specified in subsection 3.1.Therefore, for a firm i residing in country $c(i)$, the firm valuation ratio is defined as follows:

$$\begin{aligned} V\hat{R}_{it} = \quad & \left[1 + \theta_P(X_{c(i)}) \cdot (1 - \tau_{c(i),t}) \left(\frac{I^P_{it}}{K^P_{it}}\right)\right] \frac{K^P_{it+1}}{A_{it+1}} \\ & + (1 - \tau_{c(i),t}) \left[1 + \theta_I(X_{c(i)}) \cdot \left(\frac{I^I_{it}}{K^I_{it}}\right)\right] \frac{K^I_{it+1}}{A_{it+1}} \end{aligned} . \tag{21}$$

Once we specify the functional form of the adjustment cost parameters, the model is estimated using the portfolio-level method outlined in subsection 3.2. While one could theoretically analyze the drivers of cross-country heterogeneity in adjustment costs by regressing the estimates reported in subsection 5.1 –21 pairs of adjustment cost parameters– on various country characteristics, this approach may lead to weak identification when evaluating the importance of country characteristics. Our strategy, however, enables us to leverage the heterogeneity of smaller economies within regions as well as the time-series variation in firm value and investment rates to properly identify the importance of country characteristics.

Next, we provide a brief overview of the data used to quantify these country characteristics.

6.1 Country Characteristics Data

Building on previous studies (discussed below), we evaluate six dimensions of country-level characteristics that may impact the adjustment costs of inputs: (1) Protection of Intellectual Property Rights; (2) Employment Contract Protection; (3) Ease of Contract Enforcement; (4) Cost of Financing; (5) Protection of Investor Rights; and (6) Economic Development. Here, we discuss the potential impact of each characteristic on adjustment costs and explain how the data is constructed.

Protection of Intellectual Property Rights. The legal system for intellectual property rights, for example, the strength of protection, the cost of litigation procedure, affects the industry competition for products and services that involves patents and trademarks. The operating expense in the activities that secure the exclusive access and license of intellectual property rights is not directly reported or observed in the booked expense.[17] To measure intellectual property protection across countries, we utilize the variable "trade secrets and industrial patents" from Institutional Profiles Database (Variable B6020). This variable evaluates the legal frameworks, institutional support, and effectiveness of policies designed to safeguard intellectual property rights[18].

Employment Contract Protection. Flexible adjustment of capital usage in firm operation invokes expenses related to change of labor input, the cost related to recruiting and terminating existing employment contract affect the difficulty of capital investment.[19] For employee contract protection, we utilize two variables from Institutional Profiles Database: the "share of permanent contracts across all types of employment contracts" and "employment contract protection with respect to redundancies (i.e., collective dismissal)." The first variable indicates the prevalence of indefinite tenure contracts in the labor market. The second variable assesses the strength of regulations governing the justification and process for terminating multiple employees simultaneously.[20]

[17] Rempel (2021) documented the distortion in arbitration and judicial decision in litigation events related to patent and intellectual property, affects the firm markup and innovation intensity. Incumbent firms spend efforts in deterring the entry of competing firms. Antill et al. (2023) quantify the effect to social welfare from the style of legal system in the decision of patent litigation. The patent litigation system in an economy, determines how an incumbent firms can deter the entry of new firm with similar patents. A patent litigation system favoring the existing patent holder encourages more investment in innovation. In Crouzet et al. (2022b), the ease of imitation determines the cross-section distribution of firm size, firm value, and the factor share. In pursuit of simple analysis, this theoretical model in their paper doesn't explicitly delineate the cost function of investing intangible capital. The extent of how a patent or trademark generates the exclusive profit form a firm, in partly captured by the parameter δ of intangible capital retention in operating profit function. All quantitative prediction over institution environment of intellectual property rights is from the profitability channel. This model of non-rivalry intangible capital has no direct prediction toward how the industrial counterfeiting correlates to the adjustment cost function of intangible capital.

[18] It is reported as a discrete score in range of $\{0, 1, 2, 3, 4\}$, with higher scores indicating stronger legal protections. Institutional Profiles Database reports additional variables related to intellectual property protection, such as industrial counterfeiting, intangible goods, and an index. These variables show a high correlation with the variable we selected, leading us to omit them from our analysis. Similarly, the World Intellectual Property Organization provides an index that is also highly correlated with our chosen variable.

[19] Acharya, Baghai, and Subramanian (2014) specifically focus on the effect over firm innovation productivity, the number of patent granted and citation outcome. Patent application and economic importance measured by citation increases after a state adopted the Wrongful Discharge Laws. The effect over the knowledge capital investment is unclear. Calcagnini, Ferrando, and Giombini (2014) studied cross-country differences in market valuations of listed companies. Firm valuation tends to be lower in economies with stronger protection of employment contract (higher levels of Employment Legislation Law).

[20] These are Variable D6020 and Variable D6022, reported as a discrete score in range of $\{0, 1, 2, 3, 4\}$. The higher scores reflecting stronger protections for workers facing redundancy. Institutional Profiles Database reports additional variables that capture employment protection, such as individual dismissal, worker mobility, and contract

Ease of Contract Enforcement. The efficacy of intellectual property rights protection and employment contract protection depends on the cost of contract enforcement. To differentiate the attitude and culture background from the physical cost of implementation. Specifically, we measure the direct cost: the number of litigation procedures, the time required for completion, and the monetary expenses relative to the value of the litigation target. The measures of cost of contract enforcement are from Doing Business database from the World Bank [21].

Cost of Financing. Our benchmark estimation assumes the separable quadratic adjustment cost function. In a more sophisticated dynamic firm model with financial friction, the high investment invokes the debt issuance or equity issuance to finance the expansion of capital. Investment is costly if associated financing cost is high.[22] In certain countries, the financing cost for firms is high. Banks earn high profits due to market power. We assess the cost of financing through three variables: bank profit, bank concentration, and bank competition. Bank profit is derived from the World Financial Development database, calculated as total income divided by operating costs. Market share data for the three largest banks in each country, which reflects bank concentration, is also from this database. The "Bank Competition Index" is from Institutional Profiles Database.[23]

Protection of Investor Rights. Whether the directors of the board have the efficient communication, whether the shareholders can actively get involved in monitoring the operation, would affect the implementation cost of projects with uncertainty, eg. fewer procedures and internal meetings to get approval.[24] Multiple aspects are considered: (a) information disclosure, how much

protection. However, these variables are highly correlated with the variables we are analyzing, leading us to omit them from our study.

[21] This survey uses a questionnaire developed from Djankov et al. (2003) to evaluate the ease of contract enforcement in each country. The questionnaire outlines a standard business lawsuit and asks experts to estimate the steps and costs involved.

[22] (Chari, Kehoe, and McGrattan, 2007) provide detailed explanation over the equivalence of investment adjustment cost function and shadow price of capitals under other generalized models. Borrowing constraint combined with the idiosyncratic risk can lead to under-investment. For example, in Angeletos (2007); Wang, Wang, and Yang (2012), entrepreneurs of private firms has no equity issuance opportunity, low collateral rate restricts the borrowing capacity among firms of high investment. Listed companies with high cost of equity issuance and high volatility in operating profit, have the similar outcome.

[23] This is Variable C7000, reported as a discrete score in range of {0, 1, 2, 3, 4}, where higher scores indicate a more competitive banking environment.

[24] La Porta et al. (2002) investigate the ownership of the top largest firms in different countries, document fact that block shareholder impedes the corporate governance and erodes corporate value. They argue that better investor protection can improve the revenue from operation. The higher firm valuation is the result of the higher cash-flow growth benefiting from the investor protection. McLean, Zhang, and Zhao (2012) extend the investment-Q regression for investigating the role of geographical variation in investor protection to firm valuation and growth. They documented the investment is more sensitive to firm value, in countries with better investor protection measured using the self-dealing index. However, the empirical approach in McLean, Zhang, and Zhao (2012) only suits for the

information can be collected from the large shareholder, and his activity that involves the conflict of interests; (b) director liability, whether the minor shareholder can sue the director, and to what extent the director would be requested as the punishment for the misconduct; (c) how easy it is for the minor shareholder to launch the lawsuit for suing the large shareholder and board directors. Our measure of investor protection is from Doing Business survey[25].

Economic Development. Finally, we use GDP per capita and population data from the UN statistics database as proxies for economic development.[26]

Table C.7 in the online appendix provides a summary of the likely impact of these country-characteristics on the adjustment costs of intangible capital versus physical capital. As noted above, intangible capital adjustment costs should be sensitive to institutional quality, human capital, and financial market development, reflecting its reliance on innovation, risk, and skilled labor. Physical capital adjustment costs should be influenced by basic infrastructure, regulatory efficiency, and access to financing, as these directly affect the acquisition and installation of tangible assets. While both benefit from economic development and strong institutions, intangible capital requires advanced ecosystems, while physical capital relies on foundational structures.

We collected country characteristics for 73 out of the 77 countries analyzed.[27] Table C.9 in the appendix provides an overview of the country characteristics analyzed.

In Columns (7) to (10) of Table C.9, we present the correlation of each characteristic with the adjustment cost parameters discussed in subsection 5.1. As expected, strong protection of intellectual property rights is associated with lower adjustment costs, particularly for intangible capital. Conversely, a higher number of procedures and longer litigation times correlate with higher adjustment costs, while greater investor protection is linked to lower costs.

However, as noted earlier in this section, the limited number of observations for adjustment costs restricts our ability to jointly test the impact of these variables using this method. Furthermore,

situation of homogeneous capital, but not for the situation where intangible capital is heterogeneous from the physical capital.

[25]This questionnaire is based on the related published economic research article Djankov et al. (2008). In the survey, a business case related to misconduct of large shareholder is described, the evolution of minor shareholder suit for this scenario of business misconduct in a country is assessed. The data is presented in the form of a score ranging from 0 to 10, with higher scores indicating stronger protections.

[26]The national account statistics for the territory of Taiwan is from the Penn World Table, imputed to be comparable with other countries in UN statistics.

[27]The Institutional Profiles Database does not include data for Cayman Islands, Palestine, or Zambia. Romania is not included in the Doing Business survey of United Nations.

correlations may be misleading as they could reflect relationships with other variables. In the next subsection, we outline how we specify the dependence of adjustment cost parameters on these variables and employ the strategy described at the beginning of this section to jointly assess the significance of country characteristics.

6.2 Adjustment Cost Parameter Specification

We define the adjustment cost parameters as

$$\begin{aligned} \theta_I(\mathbf{X}) = &\quad \theta_{I,g} + \boldsymbol{\gamma}^{\boldsymbol{I}} \cdot \mathbf{X_c} \\ \theta_P(\mathbf{X}) = &\quad \theta_{P,g} + \boldsymbol{\gamma}^{\boldsymbol{P}} \cdot \mathbf{X_c} \end{aligned} \tag{22}$$

where the set $\mathbf{X}_c = (\mathbf{X}_1, \mathbf{X}_2)$ includes the variables from the six categories of country characteristics outlined in the previous section $\{\mathbf{X}_z\}_{z=a}^{f}$, and $\mathbf{X}_2 = IntanN$ is a fixed effect that reflects the intensity of intangible capital usage in a given country.

We interpret the slope parameters γ as the incremental cost coefficient that attributed to the status of a country in institutional environment and economic development. Additionally, we express each country-specific characteristic as the deviation from the global average: $\frac{1}{N_c}\sum_c \mathbf{X}_{1,c} = \mathbf{0}$. This formulation allows us to interpret the intercept parameters $\theta_{I,g}$ and $\theta_{P,g}$ as the global adjustment costs for intangible and physical capital, respectively. In other words, these parameters indicate the value of adjustment costs when all country characteristics are set to their global averages and the country belongs to the low intensity group. We categorize countries based on their average book share of intangible capital (K_I/A), dividing them into four groups, which can be viewed as group fixed effects. The average costs are captured by the parameters $\{\gamma^I_{2,n}\}_{n=1}^4$ specific to the group of intangible capital usage.[28] This specification helps obtain the estimation outcome that is statistically robust to non-linear effects from those economic characteristic variables $\mathbf{X}_1$. We require $\sum_{n=1}^4 \gamma^I_{2,n} = 0$ to ensure the no over-identification for parameters $(\theta_{I,g}, \{\gamma^I_{2,n}\}_{n=1}^4)$, and symmetric requirement for the physical capital.[29] For country characteristic variables reported multiple times

[28] The accumulation of intangible capital is endogenously determined in the history. Table C.10 describes countries by their time-series average status in intensity of intangible capital usage. Countries in top quartile of intangible capital usage often have high protection of intellectual property rights, employment contract, low cost of financing.

[29] In estimation, the lowest intensity group is set as the basis group, latent parameters $(\theta_{I,0} = \theta_{I,g} - \gamma^I_{2,n=1}, \{\gamma^I_{2,q} - \gamma^I_{2,n=1}\}_{n=2}^4)$ are directly estimated and then with the linear transformation. For physical capital, we require $\sum_{n=1}^4 \gamma^P_{2,n} = 0$, and the identification of parameters $(\theta_{P,g}, \{\gamma^P_{2,n}\}_{n=1}^4)$ is similar.

throughout our sample, we use their time series averages from 2016 to 2020.

The functional forms outlined in equation (22) enter linearly in the value ratio of equation (21), allowing us to estimate the set of parameters θ and γ using the portfolio-level estimation method outlined in subsection 3.2. Importantly, this method ensures that countries with a large number of firms do not skew the parameter estimates, as each country or each region of the remaining area within continents is represented by an equal number of observations—specifically, the number of portfolios.

6.3 Estimation Results

Here we present the results from the estimation of the model using the adjustment cost parameter specification from equation 22. The results for the baseline specification, which incorporates all the characteristics, are reported in columns (1) and (2) of Table 5. In Table C.9 where the one-by-one correlation of each country characteristic with the adjustment costs estimated in subsection 5.1 is presented, we note that the sign of the correlation may also reflect the relationship of that characteristic with other variables. By employing joint estimation to assess the sensitivity of the adjustment cost parameters to all characteristics simultaneously, we can better isolate the individual effects of each characteristic.

First, note that the intercepts ($\theta_{I,g}$ and $\theta_{P,g}$), which capture the average global values of each adjustment cost, are significantly higher for intangible capital than for physical capital (11.79 compared to 4.05). This finding aligns with the baseline country-level results. Additionally, countries with stronger protection for trade secrets and industrial patents experience lower costs for investing in intangible capital. Stronger employee protections—measured by an increase in provisions for collective dismissal—reduce adjustment costs for intangible capital, while the effect of increased usage of tenure contracts on adjustment costs exhibits a large standard error. Costly contract enforcement leads to higher adjustment costs for intangible capital, and higher profits in the banking sector are associated with increased adjustment costs for intangible capital. The relationship between investor protection and adjustment costs for intangible capital remains unclear. Finally, greater information disclosure tends to increase the pressure on managers responsible for investment decisions. Finally, wealthier countries, as indicated by higher GDP per capita, exhibit significantly higher adjustment costs. This may reflect the impact of a more expensive labor force. Product innovations in larger countries exhibit scale effects, making competition deterrence more challenging. Consequently, larger countries face higher costs for investing in intangible capital.

Countries in the top quartile of intangible capital usage ($IntanN = 4$) share similarities such as strong protection of intellectual property rights, robust employment contracts, and low financing costs. However, it is difficult to draw definitive economic conclusions because these characteristic variables are also correlated. Our measure of intangible capital heavily relies on skilled labor. One possible explanation is that these countries likely have a labor force predominantly composed of highly skilled workers, which correlates with higher adjustment costs for intangible capital.

Overall, we find that the characteristics model fits the data well, with an R^2 of 0.86 for the cross-section and 0.53 for the time series. These values are comparable to the baseline country-specific models. Figure 3 compares the parameter estimates and fit of sub-sample relative to the benchmark model from subsection 5.1. Notably, the characteristics model performs well in most countries and regions except for African countries. We conclude that country fundamentals effectively capture the dynamics of market values for firms across different countries.

Next, we assess which characteristics are most critical for capturing the dynamics of a firm's market value. To do this, we systematically exclude one type of characteristic at a time and compare the resulting estimates. The findings are summarized in Table C.12. Given the strong correlations among these characteristics—particularly regarding protection and enforcement—it is not surprising that excluding intellectual property protection yields similar fit results, as the other variables compensate for its absence. The most significant change in the point estimates of the remaining variables occurs when we exclude characteristics related to financial markets, specifically for intangible capital.[30]

We apply the country characteristics model to evaluate the importance of each component in determining the value of inputs contributing to a firm's market value. The firm valuation ratio (average Q) combines physical and intangible capital as defined in equation 13. The market value

[30]A simple way to calculate the impact on adjustment costs from the country characteristic variable: a standard deviation change in this characteristic increases intangible adjustment costs by 51% of the global value (0.35 * 17.21). To gauge the impact on firm value, we still need the information of capital investment.

of each input can be decomposed into three components,

$$\begin{array}{rcl} \frac{q^I \cdot K^I}{K^P+K^I} &=& (1-\tau_{c,t})\frac{K^I}{K^P+K^I} + (1-\tau_{c,t})\theta_{I,g}\left(\frac{I^I}{K^I}\right)\frac{K^I}{K^P+K^I} + (1-\tau_{c,t}) \cdot \boldsymbol{\gamma^I} \cdot \mathbf{X_c} \cdot \left(\frac{I^I}{K^I}\right)\frac{K^I}{K^P+K^I} \\ \frac{q^P \cdot K^P}{K^P+K^I} &=& \frac{K^P}{K^P+K^I} + (1-\tau_{c,t})\theta_{P,g}\left(\frac{I^P}{K^P}\right)\frac{K^P}{K^P+K^I} + (1-\tau_{c,t}) \cdot \boldsymbol{\gamma^P} \cdot \mathbf{X_c} \cdot \left(\frac{I^P}{K^P}\right)\frac{K^P}{K^P+K^I} \end{array} . \tag{23}$$

with book value $((1-\tau_{c,t})\frac{K^I}{K^P+K^I}$) or $\frac{K^P}{K^P+K^I})$, global value $(1-\tau_{c,t})\theta_{i,g}\left(\frac{I^i}{K^i}\right)\frac{K^i}{K^P+K^I}$ and a characteristic specific value $(1-\tau_{c,t}) \cdot \boldsymbol{\gamma^i} \cdot \mathbf{X_c} \cdot \left(\frac{I^i}{K^i}\right)\frac{K^i}{K^P+K^I}$ where $i = I$ or P. The last component capture the drivers of the heterogeneity in the value of each input that depends on the country characteristics modeled. Given the observed equilibrium outcome, ex-post we cannot tell whether the realized investment rate is discouraged by the anticipated high adjustment cost in the future, or the high discount rate from the risk premium. However, taking the observed investment rates and firm valuation, one can use equation 23 to gauge the direct effect over firm valuation from under-developed institutional infrastructure and financial market.[31] Formally, the price of capital in a country c is determined as

$$\begin{array}{rcl} q^I &=& (1-\tau_c) \cdot [1 + q^I_g + \mathbf{q}^I_X \cdot \mathbf{X_c}] \\ q^P &=& 1 + (1-\tau_c) \cdot [q^P_g + \mathbf{q}^P_X \cdot \mathbf{X_c}] \end{array} \tag{24}$$

Given the observed firm investment rates, the common valuation assuming global average cost is determined as

$$q^I_g = \theta_{I,g} \cdot i^I \quad , \quad q^P_g = \theta_{P,g} \cdot i^P \tag{25}$$

The marginal compensation value q_z for country characteristic variable $X_{z,c}$ is determined by the incremental cost coefficient γ_z,

$$q^I_z = \gamma^I_z \cdot i^I \quad , \quad q^P_z = \gamma^P_z \cdot i^P \tag{26}$$

The valuation of intangible capital contributed by country-specific characteristic of institutional environment and economic development is,

[31] This decomposition estimation is conservative. It would be meaningful to further quantify the indirect effect through discouraging or distorting the investment rate. But this investigation requires fully parameterizing the firm operating profit process (how it is affected by the product market competition and aggregate shocks), and the stochastic discount factor co-moving with the aggregate shocks.

$$\frac{q_z^I K^I}{K^P + K^I} \cdot X_{z,c} = \gamma_z^I \cdot i^I \cdot \frac{K^I}{K^P + K^I} \cdot X_{z,c} \tag{27}$$

for characteristic variable $X_{z,c}$, and symmetrically $\{\frac{q_z^P K^P}{K^P+K^I} \cdot X_{z,c}\}_z$ for the physical capital. Definition equation 27 uses the incremental cost coefficients $\boldsymbol{\gamma^I}$of intangible capital and $\boldsymbol{\gamma^P}$of physical capital. In combination with the composition of capitals and observed investment rates, it translates cross-country differences in institutional infrastructure and financial market development into the resulting impact on capital valuation. This is achieved by applying a correction weight that reflects these differences.

Figure 4 quantifies the contribution of each characteristic to the value of intangible capital (top panel) and physical capital (bottom panel) across countries and regions. If a country's value for a specific characteristic is above (or below) the global average, the sign of the impact matches (or is opposite to) the sign of the coefficient γ. For a country characteristic variable that delineates a specific aspect of institutional environment or the development of market infrastructure, a large magnitude for the incremental cost coefficient, combined with substantial cross-country variation, indicates that the characteristic is economically important for explaining the geographical variation in capital value.

Table 6 reports the formal estimation of the compensation value attributed to the country characteristic variable for the large countries and regions. After obtaining the firm-level estimates, we calculate the aggregate value of capital for each country and region. To provide context, the average value ratio across all countries and regions is 1.83, while the average market value of intangible capital, $\frac{q^I K^I}{K^P+K^I}$, is 0.69. There is substantial variation in firm valuation at the country level, with a standard deviation of 0.43 across 17 countries and 4 regions. As previously mentioned, intangible capital is crucial for total firm value. We observe considerable cross-country heterogeneity in the value of intangible capital, with a standard deviation of 0.42. A significant portion of this variation is influenced by economic development, the protection of intellectual property rights, and the cost of financing. Each component of value, $\frac{q_z^I \cdot K^I}{K^P+K^I} \cdot X_{c,z}$, has the following standard deviations: 0.08 for economic development, 0.14 for the protection of intellectual property rights, and 0.34 for the cost of financing.[32]

[32]This model of heterogeneous adjustment cost contingent on country-specific economic characteristics provides

This finding aligns with economic intuition, as economic development—measured by GDP per capita and population—affects labor costs. Developed countries tend to have a more expensive labor force, resulting in higher adjustment costs and valuations for intangible capital. Countries with an efficient legal system and stronger protection of trade secrets and patents can help mitigate the adjustment costs for intangible capital. Additionally, since intangible capital is riskier and more challenging to collateralize, the financial sector's ability to finance these investments is crucial. A more robust financial sector can lead to lower adjustment costs for intangible capital, thereby increasing its value.

Turning to the value of physical capital, we observe that the protection of intellectual property rights has a negligible effect on the heterogeneity of physical capital value, while economic development and financing play a prominent role. However, the cross-country dispersion associated with these characteristics is smaller compared to that of intangible capital. The standard deviations are 0.13 for both economic development and financing. The greater variation in the value of intangible capital associated with financing costs suggests that the difficulties in financing these assets have a significant effect on their valuation.

7 Robustness

7.1 Domestic Firms

Multinational firms operate in multiple markets. The investment in physical capital and specifically the intangible capital, such as the reputation among customers, the human capital attached to the employees, product innovation of high uncertainty might be more affected by the country where the branch locates. The dynamic model of heterogeneous capital investment decision can be extended for the valuation of multinational firms. Other than the home-country physical capital and the intangible capital, the capitals in foreign countries constitute the firm value. Domestic investment

reasonable estimates of adjustment cost coefficient for most countries, especially the large and medium-size countries. Table C.13 and Figure D.2 also compare the contribution of each characteristic to the value of capitals for Italy, Sweden, Switzerland, Brazil, South Africa and other medium-size countries. Across large and medium-size countries, and other small countries in each sub-region, the geographical variation in $\frac{q_z^I K^I}{K^P + K^I} \cdot X_{z,c}$ from economic development, intellectual property rights, and cost of financing are similarly large. Sweden, Switzerland, other countries in Northern Europe and Western Europe benefit from the stronger protection of intellectual property rights, the cost of investing intangible capital is relatively smaller compared to Italy, Greece and other countries in Southern Europe.

and oversea investment, simultaneous determine the total firm value. Though firms often disclose the geographical distribution of operating sale, employees, disclosure of capital investment and operating expense is not common. This paper didn't explicitly estimate heterogeneous capitals operated in different countries. As the simplified examination, Table C.19 excludes the multinationals from the sample, estimates the model using the domestic firms. We define the domestic firms as firms whose headquarter is identical with the incorporation. Firms residing in Hong Kong are often incorporated in China or Europe. Given the smaller sample of completely local firms, we didn't construct the portfolios for those firms residing and incorporating in Hong Kong.

For firms residing in China and incorporating in China, the new parameter estimate of the intangible capital adjustment cost coefficient is 40.93, larger than the outcome of baseline estimation of 32.67. The point estimate for the physical capital adjustment cost coefficient has smaller value 1.14, but with large standard error. The model is more successful in the sub-sample of domestic firms in China, than the sample with both the multinational firms and the domestic firms. Cross-section R^2 is 0.42 in Table C.19, larger than the counter-part statistics in the baseline estimation. Figure 4 shows the high valuation of intangible capital in China is partly determined by the high cost of financing compared to other countries. There is anecdotal evidence for the limited access to bank loan in China, especially for the small-medium firms and non-State owned Enterprises. Intuitively, oversea listing uses the equity financing to replace the costly financing in the domestic banking sector. This provides a candidate explanation for why the multinational firms residing in China have relatively lower cost in investing intangible capital, compared to domestic firms

7.2 Investment and Q

Section 5 documented substantial variation in the country-specific cost coefficient of intangible capital. In this subsection, we use the alternative method of firm-level equation to estimate the model. This estimation approach is more familiar for the literature, for example Peters and Taylor (2017) discussed when the total firm asset and investment include the knowledge capital and organization capital, firm valuation ratio (total Q, or often named as average Q) can better explains the total investment in the firm-level. We use this estimation to confirm the geographical heterogeneity in capital adjustment cost function.

Estimation minimizes the squared distance between the firm-level observed and model-implied valuation ratio moments at each point in time.[33] This resembles the equivalent OLS regression per sub-sample of country or region,

$$\begin{aligned} & VR_{it} - \frac{K^P_{it+1}}{K^P_{it+1}+K^I_{it+1}} - (1-\tau_{c,t})\frac{K^I_{it+1}}{K^P_{it+1}+K^I_{it+1}} \\ = \quad & \theta_{P,c}\cdot(1-\tau_{c,t})\left(\frac{I^P_{it}}{K^P_{it}}\right)\frac{K^P_{it+1}}{K^P_{it+1}+K^I_{it+1}} + \theta_{I,c}\cdot(1-\tau_{c,t})\left(\frac{I^I_{it}}{K^I_{it}}\right)\frac{K^I_{it+1}}{K^P_{it+1}+K^I_{it+1}} \end{aligned} \tag{28}$$

When the investment rate in intangible capital and that of physical capital have imperfect correlation, or the $\theta_{I,c} \neq \theta_{P,c}$, total investment rate $\frac{I^P_{it}+I^I_{it}}{K^P_{it+1}+K^I_{it+1}}$ is not in exact linear relationship to the total Q of $\frac{V_{it}}{K^P_{it+1}+K^I_{it+1}}$. Intuitively, when cost coefficient of intangible capital is much larger than the physical capital, $\theta_{I,c} > \theta_{P,c}$, the simple total investment rate resembles the equation right-hand-side component $\frac{\theta_{P,c}\cdot I^P_{it}+\theta_{I,c}\cdot I^I_{it}}{K^P_{it+1}+K^I_{it+1}} = \theta_{I,c}\cdot\frac{\frac{\theta_{P,c}}{\theta_{I,c}}\cdot I^P_{it}+I^I_{it}}{K^P_{it+1}+K^I_{it+1}}$ with additional measurement error, provides rough explanation for the total Q.

Table C.20 estimates the true model of heterogeneous capitals, using the firm-level approach, reports the parameters in identical format to Table 2. The firm-level estimation has similar point estimate for country-specific cost coefficient of intangible capital θ_I, but smaller point estimate for the cost coefficients of physical capital θ_P. An intuitive explanation is the attenuation bias. The variation of observed investment of physical capital contains noise irrelevant of the model. The estimator assigns the small θ_P to reduce the equation error. On the contrary, point estimate of θ_I in the firm-level estimation resembles that of the baseline estimation, as shown by Figure D.3, especially in countries such as Indonesia, India, Germany, the U.K. and the U.S.. The variation of investment rate and amount of intangible capital is crucial for explaining the variation of firm valuation ratio. As such, the model estimated using the firm-level method has fitness comparable to baseline estimation of portfolio-level approach, with slight deviation.

Next, we perform the estimation of country-characteristic model using the firm-level moment. The advantage of firm-level approach is that it does not require us to take a stand regarding a particular sorting variable to create the portfolios. McLean, Zhang, and Zhao (2012); Calcagnini, Ferrando, and Giombini (2014) use the investment-Q regression with additional correction as $\frac{I^P_{it}}{K^P_{it}} =$

[33] The estimator is $\widehat{\Theta} = \arg\min_{\Theta} \frac{1}{\sum_{i=1}^{N_F} T_i}\sum_{i=1}^{N_F}\sum_{t=1}^{T_i}\left(VR_{it} - \widehat{VR}_{it}(\Theta)\right)^2$, where the number of firms is N_F and the number of years in the sample for each firm is T_i

$a + b_x \cdot X_c \cdot \frac{V_{it}}{K^P_{it+1}} + b_q \cdot \frac{V_{it}}{K^P_{it+1}} + b_o \cdot X_c + \epsilon$ to investigate the cross-country difference of investment rates and firm value, where the economic development or the protection of employee right is the selected X_c of country-characteristic variable. The estimation of Table C.14 includes the intangible capital that is crucial for firm value.[34] Further, the estimation considers high-dimensional characteristic variables $\mathbf{X_c}$ to underscore the joint effects from development of institutional infrastructure, the financial market and income status in a country. Table C.14 reports the parameter estimates for $(\theta_{P,g}, \theta_{I,g})$ and $(\boldsymbol{\gamma^P}, \boldsymbol{\gamma^I})$. The incremental cost coefficient of the protection of intellectual property right γ^I_{1a} for intangible capital, and the cost of financing γ^I_{1d} are qualitatively similar to the baseline estimation using portfolio-level moments. As previously discussed, the disadvantage in firm-level approach is that the estimation is more sensitive to measurement error and the firm-level data is very noisy. Hence, the estimates are likely to be subject to an attenuation bias. The incremental cost coefficient for the protection of employee right are of large standard error. Estimated model is less accurate than the baseline estimation as we observe the worse fitness.

In summary, firm-level method has biased estimate for the cost coefficient of physical capital. The parameters from this counter-factual estimation shows that accuracy in cost coefficient of intangible capital is important for a model to provide reasonable explanation for the firm valuation. The country-level characteristics are fundamental in accounting for the heterogeneity in adjustment costs and firm market value.

7.3 Sector-Heterogeneity within Country

We also estimate the model allowing for sector-specific heterogeneity in each country. In the online appendix, we show that the resulting increase in both the time-series and cross-sectional R^2 values is, in general, very small. This result indicates that cross-country heterogeneity in adjustment costs is important for the model fit, but, perhaps surprisingly, sector heterogeneity plays only a minor role.

[34] After converting to the denominator of physical capital, equation 13 combining equation 23 resembles

$$\begin{aligned} \frac{V_{it}}{K^P_{it+1}} &= 1 + (1-\tau_{c,t})\theta_{P,g}\left(\frac{I^P_{it}}{K^P_{it}}\right) + (1-\tau_{c,t}) \cdot \boldsymbol{\gamma^P} \cdot \mathbf{X_c} \cdot \left(\frac{I^P_{it}}{K^P_{it}}\right) \\ &\quad + (1-\tau_{c,t})\frac{K^I_{it+1}}{K^P_{it+1}} + (1-\tau_{c,t})\theta_{I,g}\left(\frac{I^I_{it}}{K^I_{it}}\right)\frac{K^I_{it+1}}{K^P_{it+1}} + (1-\tau_{c,t}) \cdot \boldsymbol{\gamma^I} \cdot \mathbf{X_c} \cdot \left(\frac{I^I_{it}}{K^I_{it}}\right)\frac{K^I_{it+1}}{K^P_{it+1}} \end{aligned} \quad (29)$$

8 Conclusion

We incorporate intangible capital into the neoclassical model of investment and estimate its contribution of each input for explaining firm market values across 77 countries between 2000 and 2020. For the major markets, where we estimate country specific parameters, the model performs well in explaining both the time-series and the cross-sectional variation of the valuation ratios across portfolios in the worldwide, with time-series R^2 of 55% and a cross-sectional R^2 of 88%.

We find that the importance of the intangible capital for firm value varies across countries and is substantial, ranging from 35.60% to 70.26% . We show that financial markets assign large and positive values to the installed stocks of the capital inputs because they are costly to adjust, thus firm valuation contains the compensation for the cost of adjusting the inputs. The adjustment cost of intangible capital is higher than that of physical capital. When quantifying the market environment for accumulating intangible capital for each country, we observe dispersed point estimates of adjustment cost parameters.

To understand the drivers of intangible and physical capital adjustment costs, we utilize a model of heterogeneous adjustment cost of capital investment that is contingent on country-specific characteristics likely to affect firms' ability to invest, and analyze the importance of these characteristics for firm valuation. We find that economic development, intellectual property protection and financial market factors—especially the cost of financing—significantly influence the cross-country variation in the value of intangible capital. While similar factors also impact physical capital, their effect is comparatively less pronounced.

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A Tables

Table 1: Descriptive Statistics

This table reports the median of firm-level selected characteristics across all firms in the each country (or territory). The same statistics are calculated for the remaining area of each continent. The same statistics for the whole continent is reported below countries within the continent. The same statistics for the full sample of all the countries (World) are reported in the final rows. Statistics of individual countries in the region are reported in the Appendix Table C.3. Data is winsorized with [2%,98%] by country (or territory). Columns (1) and (7) reports the country and territory, the region, for each continent of Asia, Europe, Americas, Australia and Africa. Firm valuation is Q. Installed physical capital is K^P with investment flow equal to I^P. Installed intangible capital is K^I with investment flow equal to I^I. The median is calculated in each year, the time-series average statistics are reported in the sub-sample of each geographic area (country, territory and region within the continent, or the continent). In Column (6), the correlation $\rho(\frac{I^P}{K^P}, \frac{I^I}{K^I})$ is calculated using all the observations in the sub-sample.

Country/Region (1)	$\frac{Q}{K^I+K^P}$ (2)	$\frac{I^P}{K^P}$ (3)	$\frac{I^I}{K^I}$ (4)	$\frac{K^I}{K^I+K^P}$ (5)	$\rho(\frac{I^P}{K^P}, \frac{I^I}{K^I})$ (6)
China	2.87	0.15	0.32	0.24	0.35
Hong Kong	1.38	0.17	0.28	0.41	0.18
Indonesia	1.32	0.08	0.21	0.26	0.28
India	1.46	0.03	0.19	0.33	0.36
Japan	0.84	0.13	0.22	0.46	0.42
Malaysia	1.24	0.08	0.24	0.26	0.20
Singapore	1.21	0.16	0.28	0.38	0.23
South Korea	1.02	0.11	0.25	0.26	0.31
Thailand	1.54	0.14	0.24	0.28	0.21
Taiwan	1.70	0.13	0.24	0.28	0.28
Rest of Asia	1.51	0.08	0.22	0.27	0.24
Asia	1.37	0.12	0.24	0.32	0.28
France	1.35	0.23	0.24	0.67	0.25
Germany	1.43	0.21	0.24	0.58	0.26
Poland	1.15	0.11	0.25	0.38	0.37
UK	1.50	0.21	0.25	0.60	0.28
Rest of Europe	1.41	0.17	0.24	0.46	0.28
Europe	1.40	0.18	0.24	0.52	0.28
Canada	1.56	0.19	0.28	0.20	0.38
USA	2.05	0.24	0.26	0.62	0.34
Latin America	1.07	0.08	0.20	0.33	0.31
America	1.82	0.21	0.25	0.54	0.35
Australia	1.57	0.22	0.31	0.37	0.27
Africa	1.47	0.08	0.20	0.41	0.26
World	1.46	0.15	0.24	0.38	0.31

Table 2: Parameter Estimates and Model Fit

This table reports the details of parameter estimates. θ_P and θ_I are, respectively, the physical capital and intangible capital adjustment cost coefficients that are specific to country (or territory, region). s.e. stands for Newey-West standard errors with two lags. Columns (1) and (7) report the country and territory, rest of the region, for each region of Asia, Europe, Americas, Australia and Africa. Columns (2) to (3) report the point estimate and the standard error for parameters specific to the country (or territory,region) in Asia. Columns (8) to (9) report the same statistics for countries in Europe and other regions. We calculate model fit for each country (or territory, other countries in the region). In Columns (3) to (5) and Columns (10) to (12), $XS-R^2$ is the cross-sectional R^2 for the 20 portfolios in the country (or territory, region), $TS-R^2$ is the time-series R^2, and $m.a.e./\overline{VR}$ is the mean absolute valuation error scaled by the absolute value of the ratio.

Country/Region		Point Estimate		Model Fit			Country/Region		Point Estimate		Model Fit		
		θ_P	θ_I	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$			θ_P	θ_I	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$
(1)		(2)	(3)	(4)	(5)	(6)	(7)		(8)	(9)	(10)	(11)	(12)
China		2.57	32.67	0.25	0.04	0.30	France		4.91	7.91	0.62	0.12	0.23
	s.e.	(1.18)	(2.70)					s.e.	(0.79)	(0.64)			
Hong Kong		2.31	7.11	0.72	0.28	0.26	Germany		4.64	10.02	0.73	0.18	0.26
	s.e.	(0.38)	(0.78)					s.e.	(1.32)	(1.30)			
Indonesia		4.58	14.26	0.82	0.41	0.22	Poland		3.44	4.54	0.77	0.23	0.28
	s.e.	(0.57)	(1.29)					s.e.	(1.26)	(0.79)			
India		4.41	19.43	0.73	0.19	0.28	UK		5.42	9.14	0.83	0.47	0.19
	s.e.	(0.68)	(1.52)					s.e.	(0.57)	(0.68)			
Japan		0.42	2.63	0.20	0.07	0.18	Rest of Europe		3.55	11.80	0.83	0.49	0.22
	s.e.	(0.40)	(0.37)					s.e.	(0.66)	(0.89)			
Malaysia		2.35	12.30	0.70	0.20	0.19							
	s.e.	(0.51)	(0.93)				Canada		3.37	12.07	0.90	0.42	0.21
Singapore		1.21	7.61	0.62	0.23	0.25		s.e.	(0.31)	(0.73)			
	s.e.	(0.48)	(0.59)				USA		7.08	16.84	0.87	0.59	0.17
South Korea		1.13	4.24	0.56	0.28	0.13		s.e.	(0.72)	(0.92)			
	s.e.	(0.34)	(0.48)				Latin America		2.17	8.51	0.84	0.50	0.17
Thailand		3.33	11.60	0.74	0.24	0.23		s.e.	(0.40)	(0.74)			
	s.e.	(0.62)	(1.17)										
Taiwan		3.67	15.70	0.77	0.13	0.18	Australia		3.17	10.75	0.67	0.32	0.24
	s.e.	(0.55)	(1.08)					s.e.	(0.40)	(0.80)			
Rest of Asia		5.46	13.41	0.71	0.37	0.16							
	s.e.	(0.83)	(1.08)										
							Africa		8.16	11.12	0.46	0.37	0.20
								s.e.	(1.04)	(0.69)			
Summary of Parameter Estimates and Model Fit													
							World	Mean	3.68	11.60	0.88	0.55	0.22
								S.D.	(1.86)	(6.22)			

Table 3: Summary of Models

This table reports the summary of parameter estimates and measures of fit for the benchmark model and counter-factual models. Columns in **Benchmark Model** report the estimation outcome for the benchmark model of country-specific adjustment cost function. Columns in **Model with Physical Capital Only** report the estimation outcome for the model of country-specific adjustment cost function and single capital input of physical capital. We assume the intangible capital plays no role in the production function nor the adjustment cost function. Columns in **Model with Homogeneous Cost** report the estimation outcome for the model of homogeneous adjustment cost function and two capital inputs. We assume the identical adjustment cost function everywhere. Column (1) reports the geographic area, all countries used for estimation (World), the regions of Asia, Europe, Americas, Australia and Africa. In Panel (a) of parameter estimates, Columns (2) to (3), Columns (5) to (6) and Columns (8) to (9) report the summary statistics of average parameters within the geographic area. θ_P and θ_I are, respectively, the physical capital and intangible capital adjustment cost coefficients. Standard deviation for coefficients cross countries are reported for the models of country-specific adjustment cost function. In Panel (b) of model fit, Columns (2) to (4) report the model fit, $XS-R^2$ is the cross-sectional R^2 for the 21×20 portfolios in the world (or the subset of portfolios in the region), $TS-R^2$ is the time-series R^2, and $m.a.e./\overline{VR}$ is the mean absolute valuation error scaled by the absolute value of the ratio. Columns (5) to (7) and Columns (8) to (10) report the same statistics for the counter-factual estimation.

Panel (a) Summary of Parameter Estimate

Area		Benchmark Model: Point Estimate			Model with Physical Capital Only: Point Estimate			Model with Homogeneous Cost: Point Estimate	
		θ_P	θ_I		θ_P	θ_I		θ_P	θ_I
(1)		(2)	(3)		(5)	(6)		(8)	(9)
World	Mean	3.68	11.60	Mean	12.21	-	Mean	3.69	10.68
	S.D.	(1.86)	(6.22)	S.D.	(5.05)	-	S.D.	(0)	(0)

Panel (b) Model Fit

Area	Benchmark Model: Model Fit			Model with Physical Capital Only: Counter-factual Model Fit			Model with Homogeneous Cost: Counter-factual Model Fit		
	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
World	0.88	0.55	0.22	0.13	-0.27	0.40	0.31	0.20	0.30
Asia	0.88	0.56	0.23	0.37	-0.09	0.38	0.19	0.11	0.34
Europe	0.83	0.41	0.23	-0.39	-0.64	0.41	0.56	0.28	0.26
Americas	0.94	0.70	0.18	-0.00	-0.30	0.41	0.44	0.34	0.27
Oceania	0.67	0.32	0.24	-1.69	-1.07	0.46	0.77	0.32	0.25
Africa	0.46	0.37	0.20	-5.17	-1.01	0.40	-0.70	0.21	0.23

Table 4: Capital Accounting: Share of Intangible

This table reports the contribution of intangible capital in the firm valuation. Columns (1) and (6) report the geographic area (country, territory and region within the continent, or the continent). Columns (2) and (7) report the contribution of intangible capital in the firm valuation for each country, denoted as market share μ_I, reported in unite of percentage (%). The same statistics for the region is reported below countries within the region. The same statistics for the full sample of all the countries (World) are reported in the final rows. Other countries are reported in Table C.4. Columns (3) to (4), and Columns (8) to (9) report the ratio of adjustment cost of capital investment in firm sale, denoted as c_I for the intangible capital and c_P for the physical capital , reported in unite of percentage (%). Columns (5) and (11) report the percentage of intangible capital in the book capitals, denoted as book share $\overline{\mu}_I$. Columns (6) and (12) report the counter-factual estimation assuming the model of homogeneous adjustment cost function in Table 3, denoted as counterfactual estimated share $\widehat{\mu}_I$. Both the statistics of share and estimated adjustment cost are calculated as the median across firms in the geographic area. The time-series average during the year 2016-2020 are reported.

Country/Region	Share	Adjustment Cost		Counterfactual		Country/Region	Share	Adjustment Cost		Counterfactual	
	μ_I	c_I	c_P	$\overline{\mu}_I$	$\widehat{\mu}_I$		μ_I	c_I	c_P	$\overline{\mu}_I$	$\widehat{\mu}_I$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
China	70.26	18.40	0.91	24.24	46.86	France	64.93	7.84	3.98	56.98	71.48
Hong Kong	59.31	4.44	1.32	44.34	62.61	Germany	61.47	7.34	3.51	48.70	64.76
Indonesia	40.62	4.95	1.09	18.95	37.06	Poland	45.94	2.49	0.98	34.78	58.50
India	54.42	3.77	0.85	27.12	45.06	UK	64.37	6.88	4.17	56.16	69.72
Japan	48.15	1.50	0.17	38.52	58.82	Rest of Europe	61.25	7.22	2.13	41.92	59.52
Malaysia	47.71	4.83	0.76	24.02	43.82	Europe	60.81	6.69	2.48	46.52	63.29
Singapore	54.81	3.73	0.63	36.63	55.55						
South Korea	35.60	1.93	0.29	22.78	46.00						
Thailand	43.95	6.07	1.62	23.56	42.02	Canada	35.72	5.27	3.55	16.99	33.72
Taiwan	52.33	6.07	1.53	26.88	45.53	USA	67.38	13.01	6.41	51.81	67.03
Rest of Asia	43.03	4.24	2.16	21.36	40.33	Rest of America	48.85	3.16	0.72	30.33	51.07
Asia	53.00	4.68	0.67	27.55	47.77	Americas	60.80	9.16	4.26	42.72	60.59
						Australia	53.32	8.80	5.16	33.47	52.53
						Africa	58.21	3.88	2.52	35.57	58.23
						World	54.92	5.42	1.17	31.45	51.72
						S.D.	(9.15)	(3.52)	(1.69)	(11.16)	(9.98)

Table 5: Parameter Estimates of Country-Characteristic Model

This table reports the parameter estimates for the model specification of country-specific state-contingent adjustment cost function. Global Cost Coefficients $\theta_{\mathbf{g}}$ and Incremental Cost Coefficient $\boldsymbol{\gamma}$ for each dimension of country characteristic variables are reported. In Panel (C), $XS-R^2$ is the cross-sectional R^2 for the 21 × 20 portfolios in the globe, $TS-R^2$ is the time-series R^2, and $m.a.e./\overline{VR}$ is the mean absolute valuation error scaled by the absolute value of the ratio. P-value of t-stat are indicated using * for p<0.10, ** for p<0.05, *** for p<0.010.

	Point Estimate	
Panel (A) Global Cost Coefficient		
	$\theta_{P,g}$	θ_{Ig}
	4.05 ***	11.79 ***
s.e.	(0.32)	(0.64)
Panel (B) Incremental Cost Coefficients		
	γ_x^P	γ_x^I
(a) Intellectual Property (X_{1a})		
Secrets and Patents	-0.39	-3.29 **
s.e.	(0.42)	(0.77)
(b) Employment Contract Protection (X_{1b})		
Tenure Contract	-0.40	-0.59
s.e.	(0.28)	(0.44)
Collective Dismissal	-0.33 *	0.05
s.e.	(0.20)	(0.35)
(c) Contract Enforcement (X_{1c})		
Procedures	-0.01	0.47 ***
s.e.	(0.04)	(0.08)
Litigation Fee (%)	0.02	-0.01
s.e.	(0.02)	(0.03)
Litigation Years (log)	0.64 *	-2.27 **
s.e.	(0.36)	(0.64)
(d) Financial Market (X_{1d})		
Bank Profit	1.76 *	17.21 ***
s.e.	(0.87)	(1.53)
Concentration (%)	-0.08 **	0.01
s.e.	(0.03)	(0.05)
Competition	0.95 **	1.41 *
s.e.	(0.32)	(0.68)
(e) Investor Protection (X_{1e})		
Information Disclosure	-0.11	-0.74 **
s.e.	(0.17)	(0.30)
Director Liability	-0.33 **	-0.33 *
s.e.	(0.08)	(0.15)
Shareholder Suits	0.35 *	1.27 **
s.e.	(0.18)	(0.25)
(f) Economic Development (X_{1f})		
GDP per capita	0.74 *	1.75 **
s.e.	(0.32)	(0.62)
Population	-0.49 **	0.87 *
s.e.	(0.20)	(0.44)
Intensity of Intangible Capital (X_2)		
$\mathbf{1}(IntanN = 1)$	1.03 **	1.82 *
s.e.	(0.43)	(0.89)
$\mathbf{1}(IntanN = 2)$	-1.02 *	-3.57 **
s.e.	(0.46)	(0.80)
$\mathbf{1}(IntanN = 3)$	-1.90 **	-5.48 ***
s.e.	(0.35)	(0.53)
$\mathbf{1}(IntanN = 4)$	1.89 **	7.22 ***
s.e.	(0.45)	(0.70)
Panel (C) Statistics		
XS-R^2		0.86
TS-R^2		0.53
$m.a.e./\overline{VR}$		0.23

Table 6: Country-Specific Value of Firm

This table reports the composition of firm value. Column (4) reports the market value of intangible capital $\frac{q^I \cdot K^I}{K^P+K^I} = (1-\tau_{c,t})\frac{K^I}{K^P+K^I} + (1-\tau_{c,t})\theta_{I,g}\left(\frac{I^I}{K^I}\right)\frac{K^I}{K^P+K^I} + (1-\tau_{c,t})\cdot\boldsymbol{\gamma^I}\cdot\mathbf{X_c}\cdot\left(\frac{I^I}{K^I}\right)\frac{K^I}{K^P+K^I}$. Column (5) reports the book value $(1-\tau_{c,t})\frac{K^I}{K^P+K^I}$. Column (6) reports the global average valuation $(1-\tau_{c,t})\theta_{I,g}\left(\frac{I^I}{K^I}\right)\frac{K^I}{K^P+K^I}$. Column (7) reports the characteristic-specific valuation of intangible capital $(1-\tau_{c,t})\cdot\boldsymbol{\gamma_1^I}\cdot\mathbf{X_{1,c}}\cdot\left(\frac{I^I}{K^I}\right)\frac{K^I}{K^P+K^I}$ for all country-specific characteristic variables in Table C.9. Column (8) reports the valuation explained by the ranking of intensity of intangible capital usage, $(1-\tau_{c,t})\cdot\boldsymbol{\gamma_2^I}\cdot\mathbf{X_{2,c}}\cdot\left(\frac{I^I}{K^I}\right)\frac{K^I}{K^P+K^I}$. Columns (9) to (13) report the market value of physical capital $\frac{q^P \cdot K^P}{K^P+K^I}$ and its composition. Column (10) reports the book value $\frac{K^P}{K^P+K^I}$. Column (11) reports the global average valuation $(1-\tau_{c,t})\theta_{P,g}\left(\frac{I^P}{K^P}\right)\frac{K^P}{K^P+K^I}$. Column (12) reports the characteristic-specific valuation of physical capital $(1-\tau_{c,t})\cdot\boldsymbol{\gamma_1^P}\cdot\mathbf{X_{1,c}}\cdot\left(\frac{I^P}{K^P}\right)\frac{K^P}{K^P+K^I}$. Column (13) reports the valuation explained by the ranking of intensity of intangible capital usage $(1-\tau_{c,t})\cdot\boldsymbol{\gamma_2^P}\cdot\mathbf{X_{2,c}}\cdot\left(\frac{I^P}{K^P}\right)\frac{K^P}{K^P+K^I}$. Table continues in next page.

Country/Region	Firm Value		Intangible	Composition of Intangible Capital Market Value				Physical	Composition of Physical Capital Market Value			
	Data	Model	Market	Book	Globe	Characteristic	Intensity	Market	Book	Globe	Characteristic	Intensity
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
China	1.95	2.67	1.57	0.16	0.52	1.05	-0.16	1.10	0.79	0.42	-0.01	-0.11
Hong Kong	1.06	1.56	0.42	0.18	0.50	-0.03	-0.23	1.14	0.80	0.50	0.08	-0.23
Indonesia	2.07	1.82	0.66	0.17	0.41	0.01	0.06	1.16	0.78	0.37	-0.08	0.09
India	2.29	1.70	0.70	0.17	0.33	0.30	-0.10	0.99	0.74	0.22	0.08	-0.06
Japan	1.28	1.14	0.41	0.30	0.75	-0.29	-0.35	0.73	0.58	0.34	-0.03	-0.16
Malaysia	1.83	1.49	0.43	0.13	0.30	0.09	-0.09	1.06	0.83	0.35	-0.03	-0.09
Singapore	1.76	1.41	0.52	0.16	0.43	0.12	-0.20	0.90	0.81	0.52	-0.19	-0.24
South Korea	1.08	1.28	0.46	0.25	0.66	-0.24	-0.20	0.81	0.67	0.35	-0.12	-0.09
Thailand	2.16	1.93	0.69	0.16	0.50	0.18	-0.15	1.25	0.80	0.70	-0.08	-0.18
Taiwan	2.06	2.22	0.82	0.19	0.50	0.29	-0.15	1.40	0.77	0.62	0.16	-0.16
Rest of Asia	2.40	2.21	0.76	0.15	0.38	0.18	0.05	1.45	0.81	0.45	0.07	0.11
France	2.34	1.86	0.93	0.36	0.90	-0.88	0.55	0.93	0.46	0.45	-0.19	0.21
Germany	1.89	2.15	0.90	0.27	0.70	-0.51	0.43	1.25	0.61	0.55	-0.16	0.26
Poland	1.20	1.74	0.51	0.22	0.62	-0.04	-0.29	1.23	0.73	0.46	0.25	-0.22
UK	2.28	2.13	0.84	0.30	0.69	-0.57	0.42	1.29	0.64	0.44	0.00	0.21
Rest of Europe	1.91	1.78	0.70	0.24	0.59	-0.32	0.20	1.08	0.69	0.40	-0.07	0.06
Canada	1.59	1.63	0.47	0.12	0.35	-0.06	0.05	1.16	0.83	0.41	-0.19	0.10
USA	3.32	2.70	1.38	0.27	0.77	-0.13	0.47	1.32	0.61	0.45	0.05	0.21
Latin America	1.01	1.42	0.62	0.19	0.39	-0.02	0.05	0.80	0.72	0.15	-0.08	0.02
Australia	1.88	1.68	0.67	0.21	0.51	0.18	-0.24	1.01	0.70	0.42	0.10	-0.19
Africa	1.60	1.48	0.67	0.22	0.48	-0.23	0.20	0.81	0.70	0.22	-0.17	0.06
Summary												
Large Countries (Territories), Regions of Remaining Area												
Mean	1.83	1.81	0.69	0.21	0.54	-0.04	-0.01	1.11	0.73	0.44	-0.03	-0.03
S.D.	0.43	0.38	0.28	0.07	0.16	0.42	0.26	0.19	0.10	0.11	0.12	0.16

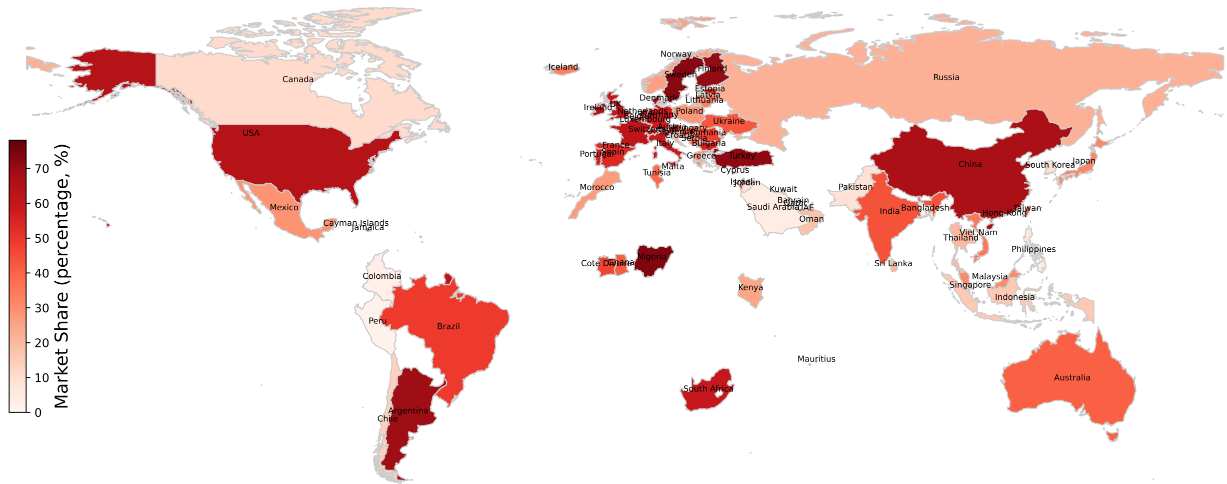
Table 6: Country-Specific Value of Firm (Table Continued)

This table reports the composition of characteristic-specific valuation of capitals. Columns (7a) to (7f), report the sum of intangible capital value affected by the characteristic variables in each scope of institutional environment and economic development $(1-\tau_{c,t})\cdot\boldsymbol{\gamma}_{\boldsymbol{z}}^{\boldsymbol{I}}\cdot\mathbf{X}_{\mathbf{z},\mathbf{c}}\cdot\left(\frac{I^I}{K^I}\right)\frac{K^I}{K^P+K^I}$ respectively: (a) Protection of Intellectual Property Rights (in abbreviation IPR) , (b) Employment Contract Protection (in abbreviation Labor), (c) Ease of Contract Enforcement (in abbreviation Contract), (d) Cost of Financing (in abbreviation Finance), (e) Protection of Investor Rights (in abbreviation Shareholder), and (f) Economic Development (in abbreviation Devp.). Columns (12a) to (12f) report the sum of physical capital value affected by the characteristic variables in each scope $(1-\tau_{c,t})\cdot\boldsymbol{\gamma}_{\boldsymbol{z}}^{\boldsymbol{P}}\cdot\mathbf{X}_{\mathbf{z},\mathbf{c}}\cdot\left(\frac{I^P}{K^P}\right)\frac{K^P}{K^P+K^I}$ respectively.

Country/Region	Composition of Characteristic-Specific Intangible Capital Value						Composition of Characteristic-Specific Physical Capital Value					
(1)	IPR (7a)	Labor (7b)	Contract (7c)	Finance (7d)	Shareholder (7e)	Devp. (7f)	IPR (12a)	Labor (12b)	Contract (12c)	Finance (12d)	Shareholder (12e)	Devp. (12f)
China	0.27	0.02	0.07	0.74	-0.18	0.13	0.08	0.08	-0.04	0.12	0.02	-0.26
Hong Kong	-0.02	-0.03	-0.13	0.10	-0.00	0.05	-0.01	-0.00	-0.05	0.02	-0.04	0.16
Indonesia	0.10	-0.00	0.09	0.11	-0.28	-0.01	0.03	0.03	0.05	0.19	-0.17	-0.22
India	0.17	0.02	-0.01	0.11	0.01	0.00	0.04	0.01	0.08	0.16	-0.00	-0.20
Japan	-0.24	-0.00	-0.00	-0.36	0.10	0.21	-0.04	-0.02	-0.04	0.07	0.03	-0.02
Malaysia	-0.01	0.01	-0.05	0.19	-0.04	-0.00	-0.00	0.04	-0.01	0.07	-0.09	-0.04
Singapore	-0.14	-0.00	-0.15	0.37	-0.01	0.05	-0.06	0.00	-0.09	-0.17	-0.08	0.20
South Korea	-0.21	0.00	0.03	-0.23	0.05	0.12	-0.04	-0.05	-0.07	0.02	0.02	0.00
Thailand	-0.02	-0.03	0.06	0.22	-0.04	-0.02	-0.01	-0.01	-0.08	0.30	-0.06	-0.22
Taiwan	-0.02	0.02	0.22	0.06	-0.04	0.04	-0.01	0.02	-0.06	0.15	0.01	0.06
Rest of Asia	0.01	0.00	0.04	0.18	-0.06	0.01	-0.01	0.04	0.01	0.15	-0.13	0.02
France	-0.28	0.00	-0.15	-0.61	-0.06	0.21	-0.05	-0.07	-0.04	-0.08	0.05	0.01
Germany	-0.02	0.06	-0.06	-0.65	-0.03	0.19	-0.01	0.11	-0.06	-0.18	-0.03	0.01
Poland	-0.02	-0.00	-0.08	-0.17	0.22	0.02	-0.01	0.00	0.00	0.08	0.22	-0.05
UK	-0.22	-0.04	-0.13	-0.31	-0.06	0.18	-0.05	-0.04	0.00	0.10	-0.04	0.03
Rest of Europe	-0.15	-0.02	-0.09	-0.23	0.07	0.09	-0.03	-0.02	-0.02	-0.11	0.05	0.07
Canada	-0.01	0.00	-0.00	-0.15	0.03	0.08	-0.00	-0.06	0.00	-0.13	-0.04	0.05
USA	-0.24	-0.05	-0.01	-0.28	0.12	0.32	-0.05	0.03	-0.05	0.19	-0.04	-0.04
Latin America	0.09	-0.01	0.06	-0.11	-0.07	0.02	0.01	-0.01	-0.00	-0.01	-0.03	-0.04
Australia	-0.16	0.03	-0.10	0.21	0.09	0.11	-0.05	-0.02	-0.04	-0.04	0.15	0.09
Africa	0.02	0.02	-0.08	-0.18	0.02	-0.04	0.01	0.01	0.00	-0.12	-0.00	-0.07
Summary												
Large Countries (Territories), Regions of Remaining Area												
Mean	-0.05	0.00	-0.02	-0.04	-0.02	0.08	-0.01	0.00	-0.02	0.04	-0.02	-0.02
S.D.	0.14	0.02	0.10	0.34	0.10	0.08	0.03	0.05	0.04	0.13	0.08	0.13

B Figures

Market Share of Intangible Capital around the World



Measure: Median of firm variable within Country.
Time-series average statistic during 2016-2020.
Homecountry is Headquarter.
Country (region) has heterogenous adjustment cost parameters.

Figure 1: Contribution of Intangible Capital in Firm Value across Globe

This figure plots the contribution of intangible capital in the firm valuation in individual countries, using the heatmap. The statistics are plotted for countries in Table 4 and Appendix Table C.4. The statistic for the contribution of intangible capital in the firm valuation are graphed. The statistic is the time-series average of median market share μ_I from the year 2016 to the year 2020, using the available firm-year observations inside the country. The market share μ_I is estimated using the Benchmark model and Benchmark estimation specification in Table 2 . For countries with insufficient observations of public listed firms, they are omitted in the heatmap.

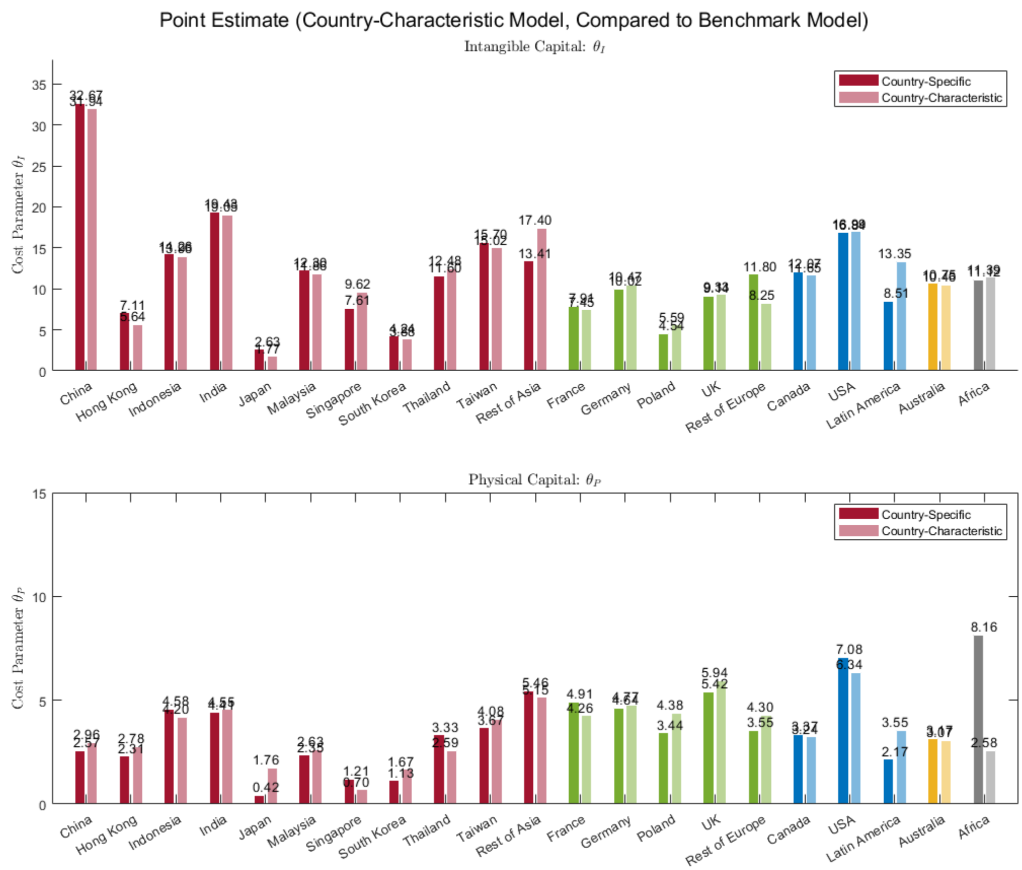


Figure 2: Estimates of Cost Coefficients in Country Characteristics Model

This figure compares the parameter estimates in the baseline model of country-specific adjustment cost and the parameter estimates in the alternative model of country characteristics. The subfigure in first row reports the parameters for intangible capital. The bar of yellow color describes the estimation outcome for the baseline model. For each of the 17 countries, 4 regions, the quadratic cost coefficient in the adjustment cost function is estimated. The bar of purple color describes the model-implied quadrature cost coefficient using the characteristic model. For each of the 73 countries, the quadratic cost coefficient in the adjustment cost function is a function over the status of intellectual property protection, labor market protection, cost of contract enforcement, cost of financing, status of investor protection, and economic development. For the 56 countries in the 4 regions (Rest of Asia, Rest of Europe, Latin America, Africa), the average outcome of model-implied quadrature cost coefficient are plotted. The subfigure in the second row reports the parameters for the physical capital. The bar of dark red color, the light red color describes the estimation outcomes of the two specifications respectively, for countries and the remaining area in Asia. The dark and light green colors are for countries and the remaining area in Europe. The blue colors are for Americas. The yellow colors are for Australia (Oceania). The gray colors are for Africa.

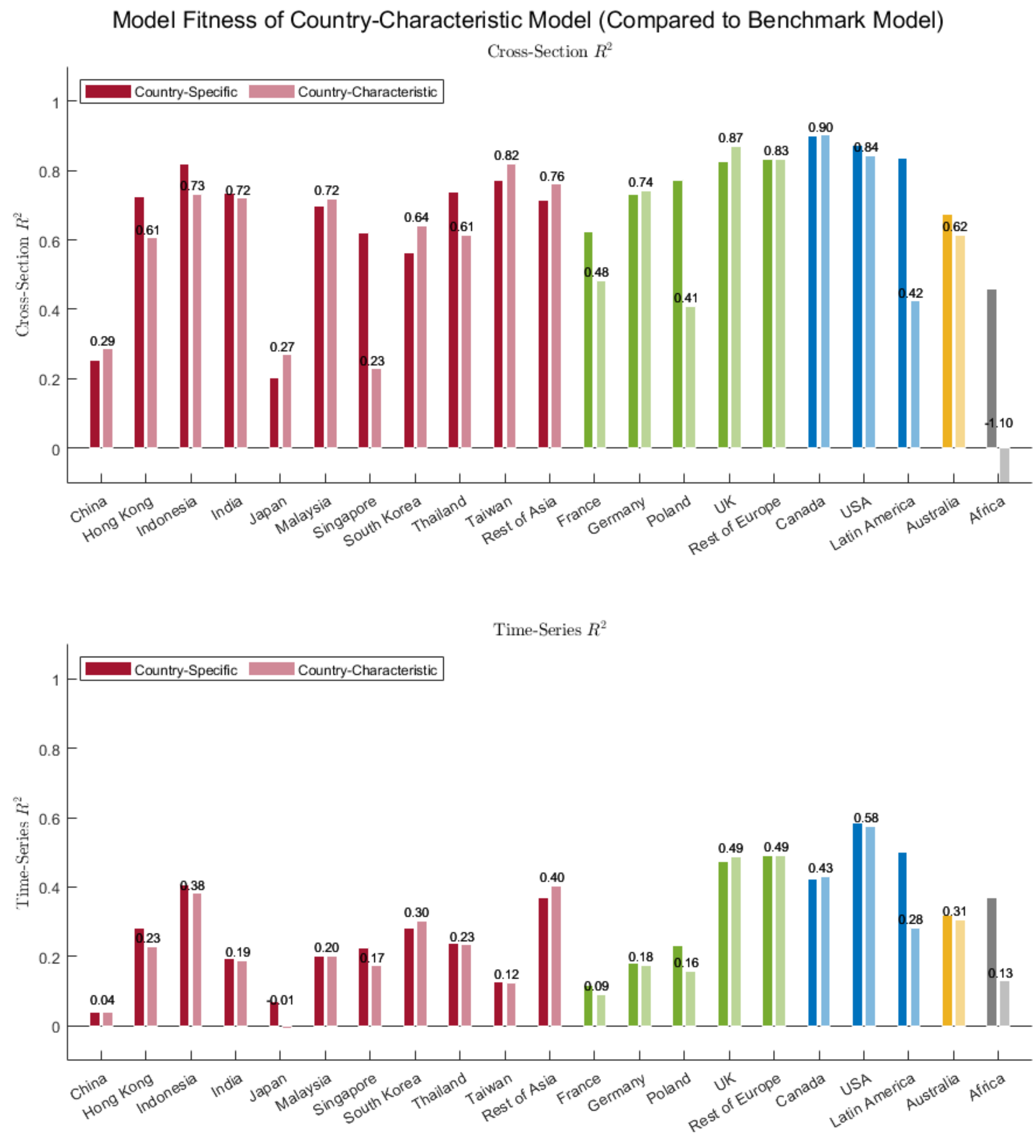


Figure 3: Fitness of Country Characteristics Model

This figure compares the fitness of model of country-specific adjustment cost function, and the alternative model of country characteristics. Estimation outcome of model of country-specific adjustment cost function is from the Baseline estimation. The country-characteristics model is estimated using the portfolio-level moment of the subsample of 17 countries and 56 countries in the 4 regions of remaining area. Country characteristic variables are the respect to the trade secrets and industry patents, extent of using tenure contract, protection of collective dismissal, cost of contract enforcement, cost of financing, status of investor protection, and economic development. The subfigure in first row reports the cross-section R^2. The bar of yellow color describes the estimation outcome of the country-specific model. The bar of purple color describes the estimation outcome of the country-characteristics model. The data label of numbers denote the cross-section R^2 of the country-characteristics model. The subfigure in second row reports the time-series R^2. The bar of blue color describes the estimation outcome of the country-specific model. The bar of green color describes the estimation outcome of the country-characteristics model. The data label of numbers denotes the time-series R^2 of the country-characteristics model. Within each geographic area (of 17 countries, Rest of Asia, Rest of Europe, Latin America, Africa), firms are grouped into 20 portfolios. Model-implied valuation is calculated for each model, then the statistics of fitness are calculated using the portfolio-level moments. The construction of portfolios, calculation of statistics are identical with Table 2 in the draft. The bar of dark red color, the light red color describes the estimation outcomes of the two specifications respectively, for countries and the remaining area in Asia. The dark and light green colors are for countries and the remaining area in Europe. The blue colors are for Americas. The yellow colors are for Australia (Oceania). The gray colors are for Africa.

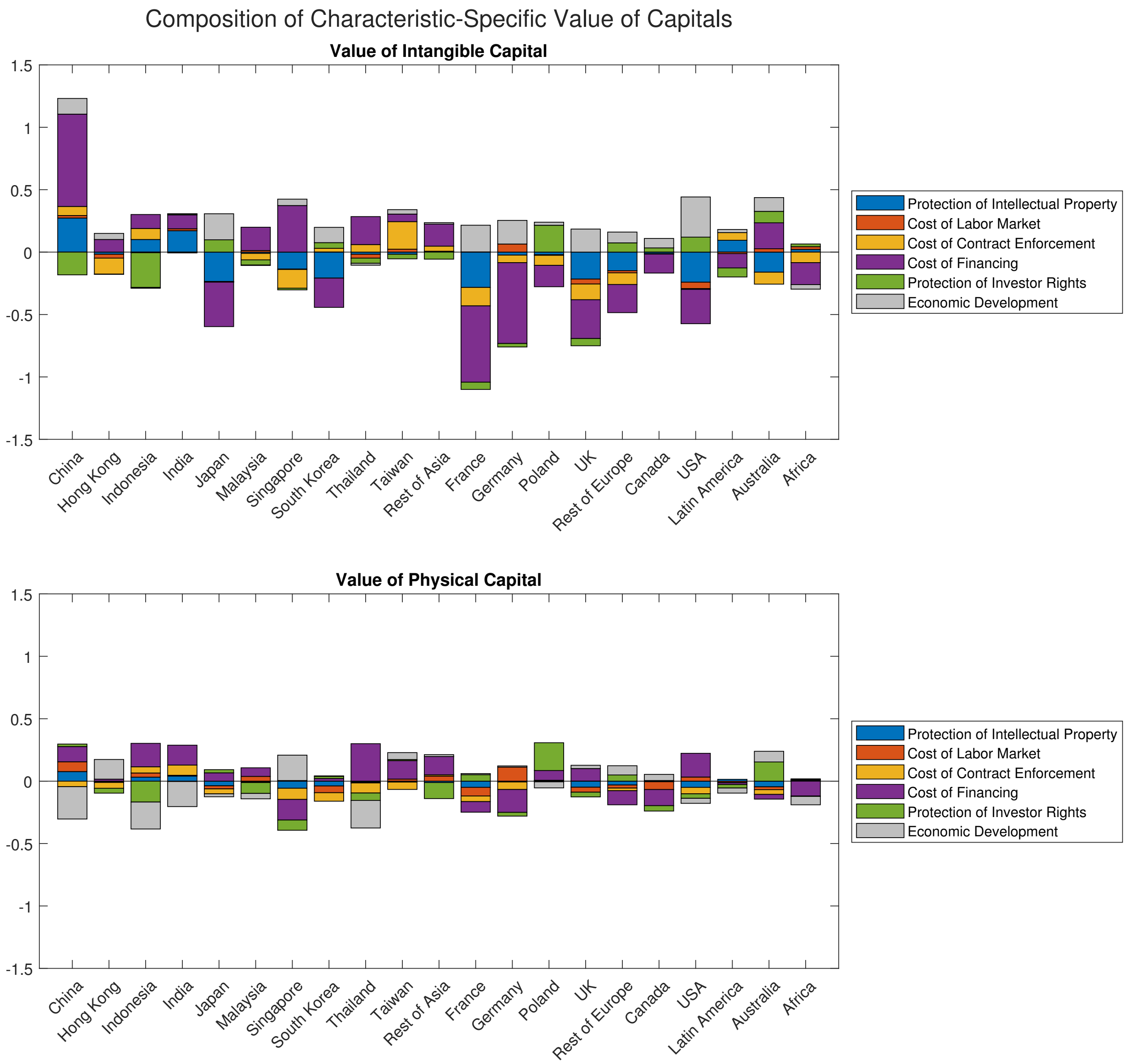


Figure 4: Composition of Characteristic-Specific Value

This figure reports the model-implied characteristic-specific valuation for the model of country-specific state-contingent adjustment cost function. The valuation of intangible capital from country-characteristic variables is reported in the first row. For each aspect z of country-characteristic variables, the cost compensation in value of intangible capital is calculated as $\{\boldsymbol{\gamma}_{\boldsymbol{z}}^{\boldsymbol{I}} \cdot \mathbf{X}_{\mathbf{c},z} \cdot \frac{i^I \cdot K^I}{K^P+K^I}\}_z$. The component $\frac{i^I \cdot K^I}{K^P+K^I} = \frac{1}{T}\sum_t \frac{\sum_i i^I_{it} K^I_{it+1}}{\sum_i K^I_{it+1}+K^P_{it+1}}$ is calculated as the aggregate statistic for each geographic area (of 17 countries, 4 regions of Rest of Asia, Rest of Europe, Latin America, Africa) and each year during 2016-2020. The similar statistic is reported for physical capital in the second row.

C Additional Tables

C.1 Descriptive Statistics and Estimation Outcome for Countries

Table C.1: Descriptive Statistics for Countries

The table below reports the descriptive statistics of listed corporations, and the snapshot of national statistics in the year 2020. **Start** is the start year where the analysis is performed for each country, the end year is 2020 for all countries. **Firms (Average)** counts the average number of listed firms with qualified financial reports during the full sample period and **Firms (2020)** for the number in the year 2020. $\frac{Y}{GDP}$ reports the ratio of total output produced by firms, over the GDP of home-country, in the unit of percentage. $\frac{VA}{GDP}$ reports the ratio of total value-added (COGS-SALES) by firms, over the GDP of home-country, in the unit of percentage. Time-series average of ratios during the full sample period is reported, respectively. **Per capita** reports the GDP per capita of firms' home-country, in the unit of dollars in year 2020 (in constant price of year 2015). The same statistics are reported for each region of remaining area. The same statistics for the whole continent is reported below countries and region within the continent. The same statistics for the full sample of all the countries (**World**) are reported in the final rows. All national statistics comes from the UN-stat. All statistics of listed corporations are calculated by authors. The world-wide GDP uses the all the countries that UN statistic reports the national statistics. Table continued in the next page.

Country/Region (1)	Start (2)	Firms (Average) (3)	$\frac{Y}{GDP}$ (%) (4)	$\frac{VA}{GDP}$ (%) (5)	Firms (2020) (6)	Per Capita (USD) (7)
China	2001	1131	23.55	5.42	2090	10166
Hong Kong	2002	468	146.20	46.95	736	41715
Indonesia	2000	220	14.82	4.21	356	3757
India	2001	1004	20.32	7.92	1535	1849
Japan	2000	1556	95.77	27.64	1590	34637
Malaysia	2002	437	39.23	10.13	583	10617
Singapore	2002	257	37.59	9.22	307	56423
South Korea	2000	419	70.75	18.35	813	31674
Thailand	2000	310	47.50	11.52	455	6199
Taiwan	2001	976	52.43	11.73	1466	46761
Rest of Asia	2000	769	11.51	3.72	1179	4895
Asia	2000	7501	38.62	10.46	11110	7073

Table C.1: Descriptive Statistics for Countries (Table Continued)

Country/Region (1)	Start (2)	Average Firms (3)	$\frac{Y}{GDP}$ (%) (4)	$\frac{VA}{GDP}$ (%) (5)	Firms 2020 (6)	Per Capita (USD) (7)
France	2007	189	48.67	20.91	272	35700
Germany	2006	202	30.78	11.54	264	40992
Poland	2007	150	11.58	2.90	216	14681
UK	2000	523	34.27	12.67	454	42455
Rest of Europe	2000	1021	32.81	13.29	1339	21874
Europe	2000	2084	34.04	13.54	2545	27036
Canada	2000	342	28.81	8.50	301	42391
USA	2000	2002	44.24	16.08	1681	58148
Latin America	2000	355	19.49	7.03	461	8555
Americas	2000	2699	39.09	14.08	2443	29093
Australia	2004	286	18.20	6.70	345	53244
Africa	2006	182	12.08	4.59	220	2704
World	2000	12869	36.77	12.25	16831	12330

Table C.2: Descriptive Statistics for Other Countries within Regions

The table below reports the descriptive statistics of listed corporations for individual countries in the region of remaining area of each continent. Column (1) reports the name of the geographic area (region). Column (2) reports the country (or territory). Columns (3) reports the start year when the firms in the country is included for analysis . Columns (4) to (8) report the statistics identical with Table C.1 for each country. Table continues in the next page.

Region (1)	Country (2)	Start (3)	Average Firms (4)	$\frac{Y}{GDP}$ (%) (5)	$\frac{VA}{GDP}$ (%) (6)	Firms 2020 (7)	Per Capita (USD) (8)
	Cote Divoire	2010	12	3.92	1.04	12	2313
	Ghana	2013	11	4.65	1.72	9	2044
	Kenya	2007	18	6.80	3.61	13	1560
	Morocco	2006	32	9.79	4.24	21	3061
Africa	Mauritius	2014	10	14.09	4.47	10	9015
	Nigeria	2006	47	2.64	1.22	50	2434
	Tunisia	2007	26	5.62	1.44	25	3574
	South Africa	2006	111	34.00	12.39	74	5116
	Zambia	2014	8	12.39	4.03	6	1250
	Argentina	2000	29	4.85	1.79	30	12348
	Brazil	2000	119	18.26	6.28	137	8229
	Cayman Islands	2008	21	343.55	64.13	57	86788
Latin America	Chile	2000	70	37.65	12.37	75	12954
	Colombia	2001	17	16.28	6.21	22	5889
	Jamaica	2007	15	15.13	5.40	21	4532
	Mexico	2000	58	23.99	9.49	70	8921
	Peru	2000	42	18.54	7.23	49	5792
	United Arab Emirates	2006	32	4.63	1.58	27	37498
	Bangladesh	2008	60	3.38	1.15	104	1666
	Bahrain	2008	12	13.66	3.82	12	19343
	Cyprus	2004	30	28.27	8.57	25	26942
	Israel	2000	117	20.87	7.86	168	39912
	Jordan	2002	42	13.41	3.16	33	4029
	Kuwait	2005	41	20.18	8.71	40	24433
	Sri Lanka	2001	79	9.77	3.12	121	4148
Rest of Asia	Oman	2003	32	10.08	2.12	32	13737
	Pakistan	2000	132	12.04	2.51	198	1447
	Philippines	2000	55	17.50	6.30	86	3270
	Palestine	2013	12	6.66	3.25	13	2747
	Qatar	2009	15	12.08	4.56	15	56019
	Saudi Arabia	2002	66	16.24	6.90	106	18691
	Turkey	2000	139	8.98	2.26	191	12039
	Viet Nam	2007	162	14.34	3.00	176	2656

Table C.2: Descriptive Statistics for Other Countries within Regions (Table Continued)

Region (1)	Country (2)	Start (3)	Average Firms (4)	$\frac{Y}{GDP}$ (%) (5)	$\frac{VA}{GDP}$ (%) (6)	Firms 2020 (7)	Per Capita (USD) (8)
	Austria	2002	32	24.92	8.79	34	42898
	Belgium	2001	44	22.15	8.15	50	40264
	Bulgaria	2008	23	5.04	1.24	24	7904
	Switzerland	2000	97	75.28	35.30	121	85506
	Denmark	2000	55	32.07	16.66	57	56583
	Spain	2007	70	19.58	9.12	65	25254
	Estonia	2006	11	11.22	2.73	10	19803
	Finland	2000	50	55.43	19.82	71	44692
	Greece	2000	120	19.24	3.36	95	17778
	Croatia	2006	37	15.69	5.58	31	12803
	Hungary	2000	9	14.96	3.99	7	14502
	Ireland	2000	38	62.25	24.46	36	79464
	Iceland	2013	10	33.93	11.11	12	57119
Rest of Europe	Italy	2007	123	9.49	3.53	139	28857
	Lithuania	2004	19	6.53	1.58	17	17666
	Luxembourg	2002	18	209.18	45.94	25	105581
	Latvia	2006	12	0.51	0.15	6	15695
	Malta	2015	10	9.00	5.79	11	29764
	Netherlands	2000	52	42.37	14.02	50	47156
	Norway	2005	69	16.42	6.91	91	74481
	Portugal	2007	25	30.74	9.58	24	19958
	Romania	2008	39	5.65	1.96	45	10856
	Russia	2003	65	42.75	20.82	56	9704
	Serbia	2013	14	7.24	2.21	10	6486
	Slovenia	2007	10	16.54	3.37	6	23149
	Sweden	2000	138	53.11	18.61	244	52920
	Ukraine	2011	12	0.53	0.17	2	2238

Table C.3: Descriptive Firm Statistics for Other Countries within Regions

The table below reports the descriptive statistics of listed corporations for individual countries in the region of remaining area of each continent. Column (1) reports the name of the geographic area (region). Column (2) reports the country (or territory). Column (3) reports the ratio between firm valuation and total amount of capitals $TK = K^P + K^I$. Columns (4) to (11) report the statistics identical with Table 1 for each country. Table continues in the next page.

Region	Country	Median				Standard Deviation				Correlation
		$\frac{Q}{TK}$	$\frac{I^P}{K^P}$	$\frac{I^I}{K^I}$	$\frac{K^I}{TK}$	$\frac{Q}{TK}$	$\frac{I^P}{K^P}$	$\frac{I^I}{K^I}$	$\frac{K^I}{TK}$	$\rho(\frac{I^P}{K^P}, \frac{I^I}{K^I})$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Africa	Cote Divoire	1.54	0.19	0.23	0.51	1.74	0.20	0.09	0.14	0.08
	Ghana	0.87	-0.02	0.10	0.53	1.32	0.22	0.05	0.22	0.42
	Kenya	1.02	0.06	0.20	0.33	1.92	0.20	0.08	0.22	0.23
	Morocco	2.53	0.10	0.26	0.37	1.93	0.21	0.10	0.20	0.26
	Mauritius	1.06	0.11	0.23	0.26	1.06	0.20	0.12	0.20	0.13
	Nigeria	0.97	-0.01	0.16	0.42	1.52	0.22	0.10	0.21	0.32
	Tunisia	2.12	0.06	0.20	0.35	1.62	0.19	0.10	0.14	0.23
	South Africa	1.35	0.11	0.21	0.50	1.54	0.24	0.15	0.28	0.23
	Zambia	0.74	-0.07	0.14	0.42	0.70	0.27	0.34	0.26	0.13
Latin America	Argentina	0.76	-0.05	0.09	0.55	1.77	0.34	0.06	0.25	0.07
	Brazil	1.09	0.09	0.19	0.42	1.69	0.47	0.12	0.24	0.37
	Cayman Islands	1.34	0.18	0.31	0.26	2.44	1.27	0.19	0.25	0.16
	Chile	1.33	0.09	0.22	0.25	1.27	0.22	0.08	0.19	0.32
	Colombia	0.89	0.05	0.21	0.19	1.40	0.66	0.14	0.16	0.45
	Jamaica	1.39	0.08	0.17	0.63	2.33	0.73	0.10	0.23	0.12
	Mexico	1.10	0.08	0.21	0.35	1.38	0.27	0.08	0.21	0.20
	Peru	0.65	0.10	0.23	0.20	1.13	0.33	0.10	0.15	0.32
Rest of Asia	United Arab Emirates	1.61	0.15	0.26	0.19	2.41	0.34	0.13	0.21	0.29
	Bangladesh	2.19	0.05	0.23	0.14	2.01	0.35	0.09	0.20	0.10
	Bahrain	1.62	0.14	0.24	0.24	1.84	0.56	0.09	0.23	-0.00
	Cyprus	0.67	0.06	0.22	0.21	0.60	0.41	0.11	0.22	0.17
	Israel	1.59	0.22	0.26	0.53	2.42	0.54	0.11	0.25	0.23
	Jordan	1.66	0.03	0.22	0.19	1.71	0.27	0.09	0.16	0.11
	Kuwait	2.15	0.16	0.25	0.23	5.10	0.86	0.16	0.21	0.23
	Sri Lanka	0.95	0.04	0.21	0.25	0.92	0.25	0.09	0.16	0.19
	Oman	1.71	0.12	0.26	0.18	1.36	0.50	0.12	0.17	0.15
	Pakistan	1.26	0.02	0.18	0.17	1.66	0.28	0.09	0.19	0.19
	Philippines	1.55	0.14	0.25	0.23	2.86	0.60	0.17	0.20	0.16
	Palestine	1.55	0.08	0.23	0.30	4.76	0.33	0.09	0.18	-0.01
	Qatar	2.25	0.18	0.30	0.09	4.20	0.78	0.16	0.18	0.11
	Saudi Arabia	2.60	0.08	0.26	0.14	3.20	0.25	0.12	0.16	0.10
	Turkey	1.45	-0.02	0.13	0.41	1.88	0.35	0.07	0.22	0.16
	Viet Nam	1.71	0.09	0.24	0.34	1.99	0.45	0.10	0.22	0.19

Table C.3: Descriptive Firm Statistics for Other Countries within Regions (Table Continued)

Region	Country	Median				Standard Deviation				Correlation
		$\frac{Q}{TK}$	$\frac{I^P}{K^P}$	$\frac{I^I}{K^I}$	$\frac{K^I}{TK}$	$\frac{Q}{TK}$	$\frac{I^P}{K^P}$	$\frac{I^I}{K^I}$	$\frac{K^I}{TK}$	$\rho(\frac{I^P}{K^P}, \frac{I^I}{K^I})$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Austria	1.25	0.17	0.23	0.46	1.91	0.29	0.12	0.22	0.41
	Belgium	1.52	0.19	0.24	0.49	2.73	0.85	0.13	0.24	0.53
	Bulgaria	1.11	0.07	0.21	0.34	2.36	0.20	0.21	0.19	0.28
	Switzerland	1.68	0.21	0.26	0.58	2.58	0.31	0.11	0.24	0.20
	Denmark	1.17	0.17	0.23	0.57	3.34	0.34	0.13	0.24	0.22
	Spain	1.78	0.16	0.23	0.45	2.75	0.36	0.11	0.24	0.20
	Estonia	1.61	0.14	0.22	0.48	2.39	0.36	0.17	0.22	0.28
	Finland	1.60	0.20	0.22	0.61	2.22	0.36	0.15	0.25	0.14
	Greece	1.12	0.07	0.23	0.29	1.24	0.31	0.12	0.21	0.37
	Croatia	0.93	0.08	0.20	0.28	1.01	0.20	0.12	0.17	0.35
	Hungary	1.06	0.13	0.21	0.42	0.99	0.20	0.14	0.23	0.32
	Ireland	2.32	0.22	0.26	0.53	2.49	0.45	0.15	0.24	0.19
	Iceland	2.23	0.27	0.21	0.45	1.61	0.48	0.05	0.26	0.12
Rest of Europe	Italy	1.60	0.19	0.24	0.52	2.59	0.40	0.16	0.25	0.15
	Lithuania	1.00	0.13	0.23	0.34	1.19	0.51	0.21	0.21	0.42
	Luxembourg	1.22	0.16	0.25	0.27	3.82	0.46	0.22	0.23	0.26
	Latvia	0.79	0.11	0.19	0.24	1.28	0.40	0.13	0.21	0.27
	Malta	2.65	0.12	0.29	0.24	5.75	0.45	0.10	0.31	0.21
	Netherlands	1.67	0.24	0.25	0.58	3.20	0.35	0.14	0.24	0.20
	Norway	1.39	0.19	0.27	0.29	2.81	0.62	0.25	0.30	0.36
	Portugal	1.28	0.13	0.21	0.47	1.46	0.30	0.24	0.24	0.18
	Romania	0.62	0.03	0.19	0.31	0.51	0.15	0.10	0.18	0.21
	Russia	1.10	0.05	0.18	0.28	1.46	0.25	0.19	0.21	0.22
	Serbia	0.79	0.07	0.18	0.34	0.92	0.20	0.23	0.18	0.05
	Slovenia	0.99	0.10	0.20	0.34	0.78	0.15	0.11	0.20	0.31
	Sweden	2.08	0.27	0.26	0.64	3.34	0.48	0.13	0.24	0.22
	Ukraine	0.83	-0.05	0.13	0.26	1.23	0.32	0.11	0.20	0.47

Table C.4: Capital Accounting: Share of Intangible in Other Countries within Regions

The table below reports the descriptive statistics of listed corporations for individual countries in the region of remaining area of each continent. Column (1) reports the name of the geographic area (region). Column (2) reports the country (or territory). Column (3) reports the contribution of intangible capital in the firm valuation for each country, denoted as market share μ_I, reported in unite of percentage (%). Columns (4) to (7) report the statistics identical with Table 4 for each country. Table continues in the next page. In the panel of summary, country-level standard deviation is reported, calculated for the estimated share and adjustment cost across all individual countries and territories in Table 4 and Table C.4.

Region	Country	Share	Adjustment Cost		Counterfactual Share	
		Market μ_I(%)	c_I (% sales)	c_P (% sales)	Book $\overline{\mu}_I$(%)	Homo. Est. $\widehat{\mu_I}$(%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Africa	Cote Divoire	56.10	6.85	4.49	42.93	65.35
	Ghana	53.56	1.72	2.62	38.94	51.67
	Kenya	45.21	5.25	1.67	24.97	46.10
	Morocco	45.70	5.87	2.62	29.58	51.51
	Mauritius	37.78	5.83	4.55	25.04	44.02
	Nigeria	78.11	3.27	6.34	39.44	63.19
	Tunisia	51.87	3.59	1.36	31.43	51.33
	South Africa	63.96	3.86	2.25	47.00	68.04
	Zambia	85.72	4.04	9.41	31.23	66.14
Latin America	Argentina	71.26	0.69	2.36	64.68	73.09
	Brazil	58.69	2.85	0.89	41.34	61.55
	Cayman Islands	49.62	4.62	1.65	30.52	49.39
	Chile	38.04	3.76	0.62	21.32	39.63
	Colombia	28.71	2.22	0.45	15.15	32.69
	Jamaica	71.94	5.30	0.80	55.42	71.25
	Mexico	46.26	4.07	0.73	27.94	49.18
	Peru	26.87	2.96	0.50	14.45	28.29
Rest of Asia	United Arab Emirates	46.89	9.51	3.92	20.49	38.24
	Bangladesh	29.99	5.02	1.21	9.56	23.64
	Bahrain	36.31	7.53	7.35	20.47	31.67
	Cyprus	41.85	7.85	2.98	22.37	36.70
	Israel	58.89	7.37	7.15	44.54	59.44
	Jordan	36.78	6.19	0.86	16.78	31.17
	Kuwait	46.77	7.25	5.42	21.89	40.64
	Sri Lanka	48.89	8.42	1.23	20.25	40.36
	Oman	47.24	10.54	3.99	20.15	40.23
	Pakistan	36.24	2.34	1.73	12.15	27.34
	Philippines	36.61	8.61	4.30	16.50	31.84
	Palestine	48.73	8.95	2.39	26.53	43.92
	Qatar	27.51	8.57	13.37	9.14	21.40
	Saudi Arabia	35.13	7.39	1.52	12.99	28.84
	Turkey	75.92	2.27	2.47	37.93	63.25
	Viet Nam	56.02	5.27	1.18	28.46	49.17

Table C.4: Capital Accounting: Share of Intangible in Other Countries within Regions (Table Continued)

Region	Country	Share	Adjustment Cost		Counterfactual Share	
		Market $\mu_I(\%)$	c_I (% sales)	c_P (% sales)	Book $\overline{\mu}_I(\%)$	Homo. Est. $\widehat{\mu_I}(\%)$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Austria	59.62	7.58	2.24	39.17	57.66
	Belgium	59.25	6.68	2.32	37.96	57.17
	Bulgaria	60.59	7.13	0.74	36.98	58.76
	Switzerland	69.87	10.24	2.25	52.86	68.06
	Denmark	70.78	10.18	2.67	53.97	68.94
	Spain	60.52	7.80	2.44	39.87	58.44
	Estonia	61.08	4.41	1.02	45.20	59.16
	Finland	72.98	6.44	2.32	58.55	71.20
	Greece	46.35	5.68	0.98	26.11	44.45
	Croatia	45.08	4.52	1.12	28.00	43.20
	Hungary	55.24	5.17	2.29	35.50	53.39
	Ireland	69.06	9.29	3.63	55.09	67.07
	Iceland	48.28	7.44	8.72	34.93	46.11
Rest of Europe	Italy	62.70	8.31	2.85	44.80	60.74
	Lithuania	48.88	4.04	1.55	34.99	46.80
	Luxembourg	45.07	5.25	2.51	27.37	43.16
	Latvia	51.01	6.80	2.18	28.25	42.09
	Malta	30.29	11.87	4.77	16.69	28.69
	Netherlands	66.31	8.15	2.96	49.98	64.33
	Norway	45.58	6.36	5.40	26.56	43.58
	Portugal	61.21	6.28	2.53	42.43	59.20
	Romania	58.22	9.99	0.86	32.59	56.43
	Russia	44.84	2.78	1.53	26.88	43.48
	Serbia	51.29	4.81	0.78	30.91	49.53
	Slovenia	39.21	1.55	1.65	25.72	38.14
	Sweden	74.42	10.20	4.25	62.06	72.69
	Ukraine	54.07	2.30	2.97	28.19	53.16
Summary						
Large countries (or Territories, from Table 4), Other countries in Rest of Regions						
	S.D.	(13.76)	(2.88)	(2.38)	(13.22)	(13.17)

C.2 Estimation of Counterfactual Models

C.2.1 Single-Capital Model

C.2.2 Homogeneous-Cost Model

Table C.5: Counter-Factual Accounting: Single Capital

Table C.5 reports the counter-factual outcome where we assume the intangible capital plays no role in the production function nor the adjustment cost function. The point estimate of adjustment cost coefficient in the physical capital, the statistics of model fit, the model-implied adjustment cost are reported. The standard error of parameter is reported in the parenthesis in the row below. Definitions of statistics are identical to Table 2 and 4.

Country/Region	Point Estimate	Model Fit			Cost	Country/Region	Point Estimate	Model Fit			Cost
	θ_P	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$	c_P		θ_P	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$	c_P
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
China	17.81	-1.64	-1.23	0.47	6.30	France	15.21	-1.59	-1.91	0.45	12.33
	(1.15)						(1.41)				
Hong Kong	7.33	-0.53	-0.55	0.39	4.19	Germany	15.58	-0.32	-0.74	0.38	11.80
	(0.43)						(1.17)				
Indonesia	12.34	-0.69	-0.49	0.35	2.94	Poland	8.59	-2.60	-0.50	0.42	2.44
	(0.69)						(0.95)				
India	12.37	-2.36	-1.38	0.52	2.40	UK	15.68	-1.16	-1.00	0.41	12.07
	(1.11)						(0.82)				
Japan	6.56	-3.41	-2.10	0.33	2.64	Rest of Europe	13.81	-0.45	-0.60	0.40	8.28
	(0.47)						(0.81)				
Malaysia	11.25	-0.07	-1.13	0.31	3.65						
	(0.52)										
Singapore	6.53	-0.59	-0.76	0.38	3.41	Canada	7.61	-1.38	-1.12	0.44	8.02
	(0.51)						(0.48)				
South Korea	5.61	-3.94	-1.61	0.27	1.44	USA	24.03	-1.20	-1.07	0.42	21.77
	(0.36)						(1.48)				
Thailand	10.27	-1.18	-0.71	0.34	5.00	Latin America	7.25	-0.57	-0.86	0.35	2.41
	(0.55)						(0.45)				
Taiwan	12.37	-1.90	-1.74	0.35	5.15						
	(0.66)					Australia	8.60	-1.69	-1.07	0.46	14.01
Rest of Asia	14.61	-0.40	-0.66	0.28	5.77		(0.47)				
	(0.83)										
						Africa	22.95	-5.17	-1.01	0.40	7.10
							(1.37)				

Table C.6: Counter-Factual Model of Homogeneous Cost Function

Table C.5 reports the counter-factual outcome for the model of homogeneous adjustment cost function and two capital inputs. We assume the identical adjustment cost function everywhere, $\theta_c \equiv \theta_g$. Panel (A) reports the point estimates of parameters. In Panel (B), the statistics of model fit, the model-implied adjustment cost are reported for the sub-sample of each country or each region. Definitions of statistics are identical to Table 2 and 4.

Panel (A) Point Estimate		
	$\theta_{P,g}$	$\theta_{I,g}$
	(1)	(2)
	3.69	10.68
s.e.	(0.18)	(0.28)

Panel (B) Model Fit and Estimated Costs in Sub-sample of Countries and Regions											
	Counterfactual Model Fit			Cost			Counterfactual Model Fit			Cost	
Country/Region	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$	c_P	c_I	Country/Region	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$	c_P	c_I
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
China	-3.99	-1.27	0.48	6.02	1.30	France	0.30	-0.03	0.25	10.59	2.99
Hong Kong	-0.25	-0.10	0.33	6.66	2.11	Germany	0.70	0.18	0.27	7.83	2.79
Indonesia	0.08	0.15	0.27	3.71	0.88	Poland	-5.49	-0.65	0.46	5.87	1.05
India	-0.89	-0.27	0.33	2.07	0.71	UK	0.80	0.46	0.20	8.04	2.84
Japan	-38.27	-11.28	0.75	6.11	1.49	Rest of Europe	0.79	0.47	0.22	6.53	2.21
Malaysia	0.80	0.18	0.19	4.19	1.20						
Singapore	-4.87	-1.04	0.40	5.23	1.93	Canada	0.90	0.41	0.22	4.66	3.89
South Korea	-10.71	-3.40	0.39	4.86	0.95	USA	-0.86	-0.33	0.33	8.26	3.34
Thailand	0.73	0.22	0.23	5.59	1.80	Latin America	0.68	0.32	0.20	3.97	1.23
Taiwan	0.13	-0.09	0.23	4.13	1.54						
Rest of Asia	-0.12	0.05	0.21	3.38	1.46	Australia	0.77	0.32	0.25	8.74	6.01
						Africa	-0.70	0.21	0.23	3.73	1.14

C.3 Country Characteristics

Table C.7: Summary of the effect of country-characteristics on adjustment costs

This table reports summary of the effects of country-characteristics on the adjustment costs of physical capital and intangible capital. Column (1) reports the country-characteristics. Column (2) and (3) reports the likely impact on the cost of intangible capital and physical capital respectively.

Factor (1)	Intangible Capital (2)	Physical Capital (3)
(a) Protection of Intellectual Property Rights	Critical for safeguarding innovation and returns.	Minimal impact.
(b) Employment Contract Protection	Raises costs by limiting workforce flexibility.	Moderate impact; affects labor for construction.
(c) Ease of Contract Enforcement	Crucial for trust-intensive, collaborative agreements.	Important for procurement and construction.
(d) Cost of Financing	Strongly affects costs due to risk and lack of collateral.	Important but less critical due to tangible collateral.
(e) Protection of Investor Rights	Essential for encouraging funding of risky intangibles.	Helpful but less critical.
(f) Economic Development	Strongly reduces costs via advanced ecosystems.	Lowers costs via basic infrastructure and systems.
(g) Regulatory Environment	Inhibits or facilitates innovation and adaptability.	Delays or streamlines installation processes.
(h) Infrastructure Availability	Critical for digital adoption.	Crucial for transportation and utilities.

Table C.8: Explanation of the impact of country-characteristics on adjustment costs

This table reports a summary of the explanation of the impact of country-characteristics on adjustment costs of intangible capital versus physical capital?". The summary of viewpoint is in Table C.7

(a) Protection of Intellectual Property Rights (IPR)

Intangible Capital: Strong IPR protection lowers adjustment costs significantly by safeguarding returns on innovation, R&D, and other intangible investments. Without IPR, firms are less willing to invest in or adopt intangible assets.
Physical Capital: Minimal impact, as physical assets rely more on direct ownership rights rather than intellectual protections.
Summary: Critical for intangible capital, minimal for physical capital.

(b) Employment Contract Protection

Intangible Capital: High labor protection increases adjustment costs by limiting flexibility in hiring or restructuring to fit new organizational or technological needs.
Physical Capital: Also affected, but to a lesser extent, as adjustments often involve one-time labor use (e.g., installation or construction) rather than continuous adaptation.
Summary: More impactful for intangible capital, where ongoing workforce adaptation is key.

(c) Ease of Contract Enforcement

Intangible Capital: Critical for reducing adjustment costs, as intangible assets often involve collaborative agreements like licensing, R&D partnerships, or service contracts.
Physical Capital: Important but less critical; physical assets primarily require straightforward procurement or construction contracts.
Summary: Important for both, but more critical for intangible capital due to reliance on complex, trust-intensive agreements.

(d) Cost of Financing

Intangible Capital: Strongly affects adjustment costs, as intangible investments often lack collateral value, increasing reliance on affordable, accessible financing.
Physical Capital: Also affected, but physical assets are easier to collateralize, making them less dependent on favorable financing conditions.
Summary: More impactful for intangible capital due to its higher risk and limited collateral.

(e) Protection of Investor Rights

Intangible Capital: Strong protection reduces adjustment costs by encouraging funding for risky, high-uncertainty intangible investments.
Physical Capital: Also benefits, but the impact is less pronounced since physical investments are easier to monitor and collateralize.
Summary: Critical for intangible capital, moderately important for physical capital.

(f) Economic Development

Intangible Capital: Higher development significantly lowers costs by providing skilled labor, robust institutions. and advanced infrastructure essential for innovation and adoption.
Physical Capital: Also benefits, but physical assets mainly depend on basic infrastructure like roads and electricity, which are often present even in moderately developed economies.
Summary: Crucial for both, but more impactful for intangible capital due to its reliance on advanced ecosystems.

(g) Regulatory Environment and Permitting

Intangible Capital: Overregulation increases costs by stifling innovation and making it harder to adapt new business models or technologies.
Physical Capital: Excessive regulation increases costs by delaying construction or requiring expensive compliance measures.
Summary: Important for both, with comparable impacts.

(h) Infrastructure Availability

Intangible Capital: Access to digital and technological infrastructure (e.g., broadband, cloud computing) reduces adjustment costs by enabling adoption of intangible investments.
Physical Capital: Relies on physical infrastructure (e.g., transportation, electricity) for installation and operation, making availability crucial.
Summary: Essential for both, but the type of infrastructure needed differs (digital for intangible, physical for tangible).

Table C.9: Descriptive Statistics of Economic Status in Countries

This table reports the descriptive statistics for country-level characteristic variables. Panel (a) reports assessment of respect for intellectual property rights relating to trade secrets and industrial patents from Institutional Profiles Database. Countries of strong respect has value 4. Countries of no respect has value 0. Panel (b) reports the assessment of provision of tenure contract and collective dismissal. Panel (c), the cost of contract enforcement, reports the number of procedures in litigation, the fee as the percentage of claim value, the years for completing the filing, resolution of dispute, and the enforcement of court decision. These are statistics in the year 2016, provided by World Bank Doing Business database. Panel (d), the cost of financing reports the statistics calculated using World Financial Development database, Bank profit is the ratio between the operating income and the total operating cost. Concentration is the market share of largest three banks in a country. The statistics are reported as the time-series average outcome during 2016-2020. The assessment of competition is from Institutional Profiles Database. Panel (e) reports assessment of the protection of minority investor. Information Disclosure describes how much information can be collected from the large shareholder. Director Liability describes to what extent the director can be punished for the misconduct. Shareholder Suits describes how easy it is to launch the lawsuit. These are statistics in the year 2016, provided by World Bank Doing Business database. Panel (f) reports the status of economic development. The GDP per capita and the population use the log value. Statistics are outcomes of the year 2016, provided from the UN database. Statistics of mean, median, cross-section standard deviation, minimal value, maximal value, are reported for countries with assessment from Institutional Profiles Database. In Columns (7) to (10), correlation statistics are reported between the Country/Region characteristic variables and the cost coefficients in the Benchmark model of country-specific adjustment cost function. Correlation to adjustment cost coefficient of physical capital, cost coefficient of intangible capital, are calculated across 17 countries and 4 regions. Cost coefficients are from the baseline estimation. For region with multiple countries, region-level characteristic uses the simple-average outcomes across countries within.

Variables of Market Feature	Descriptive Stats					Correlation			
	mean	median	s.e.	min	max	θ_P	(s.e.)	θ_I	(s.e.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(a) **Intellectual Property Rights**									
Secrets and Patents	2.88	3.00	0.99	0.00	4.00	-0.22	(0.26)	-0.66 **	(0.19)
(b) **Labor Market**									
Tenure	2.88	3.00	0.93	1.00	4.00	0.01	(0.15)	-0.31 **	(0.12)
Collective Dismissal	2.26	2.00	1.00	0.00	4.00	-0.26	(0.18)	-0.36 **	(0.10)
(c) **Contract Enforcement**									
Procedures	35.55	35.55	6.36	21.00	51.00	0.31 *	(0.14)	0.48 **	(0.09)
Litigation Fee (%)	25.44	23.20	11.55	9.00	74.00	0.27 **	(0.09)	0.05	(0.25)
Litigation Years	1.70	1.43	0.80	0.45	4.33	0.25 *	(0.13)	0.31 *	(0.18)
(d) **Financial Market**									
Bank Profit	1.91	1.91	0.35	1.16	3.05	-0.26 *	(0.16)	0.61 **	(0.22)
Concentration (%)	60.33	60.33	15.38	29.79	94.02	-0.31	(0.24)	-0.35 *	(0.18)
Competition	2.99	3.00	0.75	1.00	4.00	0.22 *	(0.11)	-0.38	(0.34)
(e) **Investor Protection**									
Information Disclosure	6.70	7.00	2.17	0.00	10.00	-0.36 *	(0.17)	0.19	(0.15)
Director Liability	5.33	5.00	2.13	1.00	9.00	-0.06	(0.15)	-0.24	(0.26)
Shareholder Suits	6.44	7.00	1.88	1.00	9.00	-0.20	(0.14)	-0.45 **	(0.13)
(f) **Economic Development**									
GDP per capita	9.56	9.68	1.18	7.18	11.60	-0.26	(0.22)	-0.41 **	(0.16)
Population	16.72	16.86	1.77	12.71	21.07	0.21	(0.23)	0.66 **	(0.16)

Table C.10: Descriptive Statistics of Economic Status in Countries

This table reports the classification of countries along the ranking of intensity of using intangible capital for production. The statistic of intensity of using intangible capital is calculated as the time-series average outcome during 2016-2020. Countries are grouped into 4 quartiles, from lowest to the highest. Column (2) reports the large countries of each quartile. Column (3) reports other countries in the rest of regions. Cayman Islands, Palestine, Zambia. Romania are in parenthesis, not included for estimating the country-characteristic model, due to the incomplete profile of characteristic variables.

Intensity (1)	Large Countries (2)	Other Countries (3)
1	Canada , Malaysia	(Cayman Islands) , Greece , Croatia , Jordan , Kenya , Luxembourg , Morocco , Nigeria , Oman , Philippines , Portugal , Qatar , (Romania) , Russia , Saudi Arabia , Serbia , (Zambia)
2	China , Indonesia , Thailand , Taiwan	UAE , Austria , Bangladesh , Bahrain , Chile , Colombia , Estonia , Hungary , Kuwait , Sri Lanka , Mauritius , Norway , Pakistan , Peru , Slovenia , Tunisia
3	Hong Kong , India , South Korea , Poland , Singapore	Argentina , Belgium , Bulgaria , Brazil , Cote Divoire , Cyprus , Lithuania , Mexico , Netherlands , (Palestine) , Turkey , Ukraine , Viet Nam , South Africa
4	Australia , Germany , France , UK , Japan , USA	Switzerland , Denmark , Spain , Finland , Ghana , Ireland , Iceland , Israel , Italy , Jamaica , Latvia , Malta , Sweden

Table C.11: Descriptive Statistics of Economic Status in Subset of Countries

Panel A in this table reports the summary statistics for country-level characteristic variables in Table C.9. Statistics reported in Column (2) to (3) are calculated using the subset of countries with the lowest quartile of intensity of intangible capital usage. The names of countries are reported in Table C.10. Panel (B), Panel (C) and Panel (D) report the statistics for the subset of countries in the 2nd quartile, 3rd quartile and 4th quartile respectively.

Variables of Market Feature	Countries $IntanN = 1$		Countries $IntanN = 2$		Countries $IntanN = 3$		Countries $IntanN = 4$	
	mean	median	mean	median	mean	median	mean	median
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(a) **Intellectual Property Rights**								
Secrets and Patents	2.53	3.00	2.64	3.00	2.99	3.00	3.37	3.00
(b) **Labor Market**								
Tenure	2.74	3.00	2.64	2.44	2.99	3.00	3.16	3.00
Collective Dismissal	2.00	2.00	2.23	2.13	2.34	2.00	2.47	3.00
(c) **Contract Enforcement**								
Procedures	41.47	41.00	35.45	35.77	32.79	34.00	32.47	32.00
Litigation Fee (%)	29.45	22.80	23.77	22.75	22.50	23.20	26.13	23.60
Litigation Years	2.09	1.64	1.66	1.28	1.34	1.38	1.70	1.44
(d) **Financial Market**								
Bank Profit	2.09	1.95	2.00	1.91	1.92	1.91	1.62	1.59
Concentration (%)	59.17	60.33	53.88	53.89	58.85	60.33	69.78	72.80
Competition	2.95	3.00	3.00	3.00	3.00	3.00	3.00	3.00
(e) **Investor Protection**								
Information Disclosure	6.79	8.00	6.62	6.85	6.92	7.00	6.47	7.00
Director Liability	6.16	6.00	4.83	5.00	5.03	5.00	5.32	5.00
Shareholder Suits	5.53	6.00	6.34	6.72	7.20	7.00	6.68	6.00
(f) **Economic Development**								
GDP per capita	9.26	9.52	9.22	9.21	9.64	9.60	10.13	10.56
Population	16.39	16.72	17.12	17.43	16.58	16.25	16.82	16.65

Table C.12: Parameter Estimates of Alternative Characteristic Models

This table reports the parameter estimates for the alternative models of country-specific state-contingent adjustment cost function. Global Cost Coefficients and Incremental Cost Coefficient for each dimension of country characteristic variables are reported. P-value of t-stat are indicated using * for p<0.10, ** for p<0.05, *** for p<0.010.

	Model (1)		Model (2)		Model (3)		Model (4)		Model (5)		Model (6)	
Panel (A) Global Coefficient												
	$\theta_{P,g}$	θ_{Ig}	$\theta_{P,g}$	θ_{Ig}	$\theta_{P,g}$	θ_{Ig}	$\theta_{P,g}$	θ_{Ig}	$\theta_{P,g}$	θ_{Ig}	$\theta_{P,g}$	θ_{Ig}
	3.87 ***	11.09 ***	4.25 ***	11.76 ***	4.19 ***	11.94 ***	3.51 ***	9.55 ***	3.50 ***	11.97 ***	3.45 ***	13.35 ***
s.e.	(0.32)	(0.67)	(0.32)	(0.58)	(0.30)	(0.59)	(0.33)	(0.52)	(0.24)	(0.44)	(0.26)	(0.43)
Panel (B) Incremental Coefficients												
	γ_x^P	γ_x^I	γ_x^P	γ_x^I	γ_x^P	γ_x^I	γ_x^P	γ_x^I	γ_x^P	γ_x^I	γ_x^P	γ_x^I
(a) Intellectual Property												
Secrets and Patents			-0.86 *	-3.69 **	-0.88 **	-3.03 **	1.31 **	-3.11 **	-0.01	-1.05	-0.29	-2.32 **
s.e.			(0.40)	(0.67)	(0.26)	(0.57)	(0.43)	(0.86)	(0.37)	(0.76)	(0.38)	(0.63)
(b) Employment Contract Protection												
Tenure Contract	-0.49 *	-1.54 **			-0.37	-0.47	-0.92 **	-1.83 **	-0.64 **	-1.10 **	-0.57 *	-0.88 *
s.e.	(0.27)	(0.39)			(0.26)	(0.42)	(0.27)	(0.45)	(0.25)	(0.38)	(0.28)	(0.41)
Collective Dismissal	-0.37 *	-1.04 **			-0.12	-0.14	-0.92 **	-1.79 ***	0.00	-0.54 *	-0.53 **	0.11
s.e.	(0.19)	(0.33)			(0.20)	(0.32)	(0.17)	(0.28)	(0.20)	(0.28)	(0.18)	(0.30)
(c) Contract Enforcement												
Procedures	-0.00	0.63 ***	-0.01	0.43 ***			0.11 **	0.08	-0.01	0.60 ***	0.01	0.42 **
s.e.	(0.04)	(0.08)	(0.04)	(0.08)			(0.04)	(0.08)	(0.04)	(0.07)	(0.05)	(0.08)
Litigation Fee (%)	-0.01	-0.05 *	0.04 *	-0.01			-0.03	0.03	-0.02	-0.03	0.01	-0.10 **
s.e.	(0.02)	(0.03)	(0.02)	(0.03)			(0.02)	(0.04)	(0.02)	(0.03)	(0.02)	(0.03)
Litigation Years (log)	0.98 **	0.10	0.31	-2.61 **			1.38 **	0.25	0.71 **	0.15	0.58 *	-2.51 **
s.e.	(0.27)	(0.57)	(0.36)	(0.59)			(0.36)	(0.67)	(0.27)	(0.56)	(0.35)	(0.65)
(d) Financial Market												
Bank Profit	1.74 *	14.20 ***	2.59 **	16.66 ***	2.10 **	17.25 ***			2.54 **	15.36 ***	-0.65	20.77 ***
s.e.	(0.89)	(1.57)	(0.73)	(1.14)	(0.89)	(1.44)			(0.79)	(1.17)	(0.77)	(1.48)
Concentration (%)	-0.10 **	0.08 *	-0.09 **	0.04 *	-0.09 **	-0.03			-0.13 ***	0.01	-0.02	-0.07 **
s.e.	(0.03)	(0.05)	(0.02)	(0.03)	(0.02)	(0.04)			(0.02)	(0.03)	(0.02)	(0.02)
Competition	0.86 **	-0.13	1.12 **	1.67 **	1.41 ***	1.79 **			1.17 **	-0.27	0.47 *	2.66 **
s.e.	(0.33)	(0.73)	(0.30)	(0.60)	(0.25)	(0.55)			(0.31)	(0.55)	(0.30)	(0.56)
(e) Investor Protection												
Information Disclosure	0.03	0.24	-0.32 *	-0.92 **	-0.11	-1.11 **	0.37 **	0.67 **			0.24 *	-0.84 **
s.e.	(0.15)	(0.30)	(0.15)	(0.24)	(0.12)	(0.22)	(0.16)	(0.25)			(0.16)	(0.27)
Director Liability	-0.29 **	-0.10	-0.33 **	-0.44 **	-0.38 **	-0.35 **	-0.29 **	-0.49 **			-0.43 **	-0.26 *
s.e.	(0.08)	(0.14)	(0.07)	(0.13)	(0.07)	(0.14)	(0.08)	(0.17)			(0.08)	(0.14)
Shareholder Suits	0.19	0.64 **	0.40 **	1.41 ***	0.40 **	1.02 **	0.07	0.81 **			0.56 **	1.22 **
s.e.	(0.16)	(0.24)	(0.17)	(0.24)	(0.12)	(0.21)	(0.16)	(0.25)			(0.16)	(0.24)
(f) Economic Development												
GDP per capita	0.76 **	1.10 *	0.95 **	1.65 **	0.69 **	1.79 **	0.16	2.42 **	0.87 **	2.00 **		
s.e.	(0.31)	(0.54)	(0.31)	(0.63)	(0.26)	(0.50)	(0.32)	(0.58)	(0.30)	(0.63)		
Population	-0.45 *	1.20 **	-0.59 **	1.23 **	-0.61 **	1.00 **	0.26 *	0.93 **	-0.39 *	0.57 *		
s.e.	(0.21)	(0.46)	(0.18)	(0.32)	(0.20)	(0.43)	(0.13)	(0.23)	(0.18)	(0.33)		
Intensity of Intangible Capital												
$\mathbf{1}(IntanN = 1)$	1.12 **	1.28	0.77 *	2.24 **	1.36 **	3.37 **	1.13 **	1.72 *	0.77 *	-0.01	0.95 **	3.74 **
s.e.	(0.42)	(0.90)	(0.43)	(0.91)	(0.32)	(0.72)	(0.35)	(0.77)	(0.44)	(0.93)	(0.37)	(0.72)
$\mathbf{1}(IntanN = 2)$	-1.39 **	-3.58 **	-0.75 *	-3.19 **	-1.27 **	-1.99 **	-1.64 **	2.19 **	-1.50 **	-3.57 **	-1.26 **	-5.57 ***
s.e.	(0.44)	(0.79)	(0.38)	(0.65)	(0.31)	(0.62)	(0.42)	(0.77)	(0.40)	(0.72)	(0.37)	(0.61)
$\mathbf{1}(IntanN = 3)$	-1.56 **	-3.94 ***	-2.14 ***	-5.57 ***	-2.27 ***	-6.71 ***	-0.36	-4.62 ***	-1.17 **	-3.54 ***	-1.40 **	-6.65 ***
s.e.	(0.33)	(0.56)	(0.35)	(0.52)	(0.30)	(0.44)	(0.34)	(0.61)	(0.30)	(0.42)	(0.35)	(0.59)
$\mathbf{1}(IntanN = 4)$	1.83 **	6.24 ***	2.11 **	6.53 ***	2.17 **	5.33 ***	0.87 *	0.72	1.90 **	7.12 ***	1.71 **	8.47 ***
s.e.	(0.44)	(0.72)	(0.40)	(0.56)	(0.44)	(0.67)	(0.42)	(0.57)	(0.43)	(0.64)	(0.37)	(0.66)
Panel (C) Statistics												
XS-R^2		0.85		0.86		0.86		0.76		0.84		0.85
TS-R^2		0.52		0.53		0.53		0.46		0.52		0.53
$m.a.e./\overline{VR}$		0.23		0.23		0.23		0.25		0.23		0.23

Table C.13: Country-Specific Value of Firm for Other Countries within Regions

This table reports the composition of firm value for countries and sub-regions within each region. Column (1) reports the country, or the remaining area of the sub-region. Columns (2) to (13) report the statistics identical with Table 6 for each country. Table continues in the next page. In the panel of summary, standard deviation is calculated for the estimated valuation across large countries and territories in Table 6, medium countries and other areas in Table C.13 .

Country/Area	Firm Value		Intangible	Composition of Intangible Capital Market Value				Physical	Composition of Physical Capital Market Value			
	Data	Model	Market	Book	Globe	Characteristic	Intensity	Market	Book	Globe	Characteristic	Intensity
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
[Within Rest. Asia]												
Israrel	1.87	2.22	0.88	0.27	0.67	-0.48	0.41	1.34	0.62	0.47	0.04	0.22
Pakistan	1.68	1.62	0.50	0.11	0.24	0.12	0.04	1.12	0.85	0.22	-0.01	0.06
Turkey	1.41	1.51	0.80	0.29	0.41	0.30	-0.19	0.70	0.64	0.09	0.02	-0.04
Viet Nam	2.42	2.14	0.90	0.21	0.71	0.20	-0.21	1.24	0.74	0.61	0.04	-0.15
Rest of Southern Asia	1.97	2.24	0.65	0.15	0.47	-0.04	0.07	1.59	0.79	0.49	0.18	0.13
Rest of Western Asia	2.69	2.33	0.74	0.09	0.28	0.33	0.04	1.59	0.89	0.47	0.10	0.12
[Within Rest. Europe]												
Greece	0.99	1.08	0.07	0.14	0.33	-0.30	-0.10	1.01	0.81	0.30	-0.03	-0.08
Italy	1.82	2.50	0.99	0.26	0.73	-0.45	0.45	1.52	0.66	0.67	-0.12	0.31
Sweden	2.50	3.05	1.82	0.39	0.96	-0.12	0.59	1.23	0.50	0.51	-0.02	0.24
Switzerland	3.17	1.76	0.85	0.37	0.94	-1.03	0.57	0.91	0.54	0.36	-0.15	0.17
Rest of Eastern Europe	0.73	1.34	0.21	0.10	0.17	-0.01	-0.05	1.13	0.87	0.28	0.04	-0.07
Rest of Southern Europe	1.81	1.68	0.74	0.27	0.69	-0.02	-0.20	0.94	0.63	0.44	0.00	-0.13
Rest of Northern Europe	2.49	2.55	1.40	0.31	0.83	-0.16	0.42	1.14	0.63	0.44	-0.01	0.09
Rest of Western Europe	1.90	1.42	0.37	0.21	0.54	-0.46	0.08	1.05	0.72	0.46	-0.21	0.08
[Within Rest. Amer.]												
Brazil	0.95	1.26	0.50	0.16	0.29	-0.13	0.18	0.76	0.75	0.09	-0.12	0.04
Rest of Latin Amer.	1.06	1.57	0.72	0.22	0.47	0.09	-0.05	0.84	0.69	0.20	-0.04	-0.01
[Within Africa]												
South Africa	1.48	1.49	0.71	0.23	0.52	-0.37	0.32	0.78	0.68	0.23	-0.24	0.11
Rest of Africa	1.98	1.46	0.56	0.18	0.35	0.18	-0.15	0.89	0.75	0.17	0.04	-0.07
Summary												
Large Countries (Territories), Medium Countries , Sub-regions of Remaining Area												
Mean	1.88	1.89	0.76	0.22	0.56	-0.08	0.05	1.14	0.71	0.43	-0.01	0.00
S.D.	0.57	0.48	0.37	0.08	0.22	0.41	0.30	0.23	0.11	0.14	0.11	0.17

Table C.13: Country-Specific Value of Firm for Other Countries within Regions (Table Continued)

This table reports the composition of characteristic-specific valuation of capitals, for countries and sub-regions within each region. Columns (7a) to (7f), (12a) to (12f) report the statistics identical with Table 6 for each country. Table continues in the next page. In the panel of summary, standard deviation is calculated for the estimated valuation across large countries and territories in Table 6, medium countries and other areas in Table C.13 .

Country/Area	Composition of Characteristic-Specific Intangible Capital Value						Composition of Characteristic-Specific Physical Capital Value					
(1)	IPR (7a)	Labor (7b)	Contract (7c)	Finance (7d)	Shareholder (7e)	Devp. (7f)	IPR (12a)	Labor (12b)	Contract (12c)	Finance (12d)	Shareholder (12e)	Devp. (12f)
[Within Rest. Asia]												
Israrel	-0.02	0.00	-0.16	-0.41	-0.02	0.14	-0.01	-0.07	0.11	-0.02	0.03	-0.00
Pakistan	0.12	-0.00	0.04	0.00	-0.01	-0.04	0.04	0.00	0.03	0.09	-0.02	-0.16
Turkey	0.10	-0.00	0.03	0.22	-0.07	0.03	0.01	-0.01	-0.01	0.05	-0.01	-0.02
Viet Nam	0.37	0.06	0.09	0.17	-0.38	-0.11	0.11	0.17	-0.05	0.31	-0.18	-0.33
Rest of Southern Asia	-0.00	-0.01	-0.07	-0.06	0.16	-0.05	-0.00	0.02	0.11	0.15	0.14	-0.24
Rest of Western Asia	-0.03	0.01	0.10	0.35	-0.11	0.02	-0.03	0.07	-0.02	0.23	-0.21	0.06
[Within Rest. Europe]												
Greece	-0.01	0.02	-0.13	-0.12	-0.04	-0.00	-0.00	0.01	0.12	-0.18	-0.01	0.03
Italy	-0.03	-0.04	-0.15	-0.41	0.11	0.06	-0.01	-0.06	0.10	-0.29	-0.05	0.19
Sweden	-0.30	-0.01	-0.11	0.14	0.02	0.14	-0.06	0.05	-0.01	-0.22	0.06	0.16
Switzerland	-0.29	-0.05	-0.12	-1.02	0.26	0.20	-0.04	-0.03	-0.00	-0.26	0.03	0.15
Rest of Eastern Europe	-0.01	-0.00	0.02	-0.07	0.03	0.01	-0.00	0.00	-0.05	0.09	0.09	-0.09
Rest of Southern Europe	-0.02	0.02	0.11	-0.19	-0.03	0.08	-0.01	0.03	-0.02	0.01	-0.03	0.02
Rest of Northern Europe	-0.26	-0.03	-0.22	0.14	0.12	0.09	-0.05	-0.04	-0.03	-0.14	0.06	0.18
Rest of Western Europe	-0.17	-0.02	-0.17	-0.22	0.04	0.08	-0.05	-0.07	-0.03	-0.24	0.04	0.13
[Within Rest. Amer.]												
Brazil	-0.01	0.00	0.08	-0.17	-0.07	0.03	-0.00	-0.01	0.00	-0.04	-0.03	-0.03
Rest of Latin Amer.	0.19	-0.02	0.04	-0.07	-0.08	0.02	0.03	-0.01	-0.01	0.01	-0.02	-0.04
[Within Africa]												
South Africa	-0.02	0.02	-0.14	-0.22	0.01	-0.03	-0.00	0.01	0.01	-0.15	-0.03	-0.07
Rest of Africa	0.14	0.01	0.07	-0.05	0.07	-0.06	0.04	0.00	-0.01	-0.01	0.07	-0.05
Summary												
Large Countries (Territories), Medium Countries , Sub-regions of Remaining Area												
Mean	-0.04	-0.00	-0.03	-0.06	-0.01	0.06	-0.01	0.01	-0.00	0.02	-0.01	-0.02
S.D.	0.16	0.03	0.11	0.36	0.13	0.09	0.04	0.05	0.06	0.16	0.09	0.15

Table C.14: Parameter Estimates of Country-Characteristic Model using Firm-level Method

This table reports the parameter estimates for the estimation specification of firm-level method, for the model of country-specific state-contingent adjustment cost function. Global Cost Coefficients and Incremental Cost Coefficient for each dimension of country characteristic variables are reported. Standard error and statistics of fitness are calculated in the same definition of Table 2, using the same portfolios. In Panel (C), $XS-R^2$ is the cross-sectional R^2 for the 21×20 portfolios in the globe, $TS-R^2$ is the time-series R^2, and $m.a.e./\overline{VR}$ is the mean absolute valuation error scaled by the absolute value of the ratio. P-value of t-stat are indicated using * for p<0.10, ** for p<0.05, *** for p<0.010.

	Point Estimate	
Panel (A) Global Cost Coefficient		
	$\theta_{P,g}$	θ_{Ig}
	1.33 **	14.07 ***
s.e.	(0.35)	(0.64)
Panel (B) Incremental Cost Coefficients		
	γ_x^P	γ_x^I
(a) Intellectual Property (X_{1a})		
Secrets and Patents	-0.11	-2.38 **
s.e.	(0.47)	(0.81)
(b) Employment Contract Protection (X_{1b})		
Tenure Contract	-0.23	-0.45
s.e.	(0.31)	(0.45)
Collective Dismissal	-0.10	-0.84 *
s.e.	(0.21)	(0.37)
(c) Contract Enforcement (X_{1c})		
Procedures	0.02	0.17 *
s.e.	(0.05)	(0.08)
Litigation Fee (%)	0.00	0.00
s.e.	(0.03)	(0.04)
Litigation Years (log)	-0.06	0.93
s.e.	(0.39)	(0.71)
(d) Financial Market (X_{1d})		
Bank Profit	0.16	13.63 ***
s.e.	(0.96)	(1.65)
Concentration (%)	-0.00	-0.10 *
s.e.	(0.03)	(0.05)
Competition	0.13	1.83 **
s.e.	(0.36)	(0.71)
(e) Investor Protection (X_{1e})		
Information Disclosure	-0.06	-0.83 **
s.e.	(0.18)	(0.31)
Director Liability	-0.07	-0.08
s.e.	(0.09)	(0.16)
Shareholder Suits	0.14	0.04
s.e.	(0.19)	(0.27)
(f) Economic Development (X_{1f})		
GDP per capita	0.64 *	2.47 **
s.e.	(0.36)	(0.62)
Population	0.42 *	0.18
s.e.	(0.22)	(0.43)
Intensity of Intangible Capital (X_2)		
$\mathbf{1}(IntanN=1)$	-0.11	2.68 **
s.e.	(0.49)	(0.92)
$\mathbf{1}(IntanN=2)$	0.20	-1.79 *
s.e.	(0.54)	(0.82)
$\mathbf{1}(IntanN=3)$	-0.63 *	-4.42 ***
s.e.	(0.38)	(0.59)
$\mathbf{1}(IntanN=4)$	0.55	3.53 **
s.e.	(0.49)	(0.73)
Panel (C) Statistics		
XS-R^2		0.77
TS-R^2		0.48
$m.a.e./\overline{VR}$		0.24

C.4 Robustness of Baseline Estimation

C.4.1 Robustness Estimation of Country-Specific Adjustment Cost Function

Table C.15: Summary of Alternative Estimations

	Statistics Reported	Difference from Baseline Estimation
Evaluation of Model Fitness		
Table C.16	Fitness, Starting Year	The fitness is calculated using all the years. Table 2 reports the 2006-2020 outcome.
Table C.17	Fitness	The estimation uses 30 portfolios sorted based on proxies of the lagged firm-level variables: intensity of intangible capital, investment rate in physical capital and investment rate of intangible capital. Table2 reports the fitness of portfolios used for estimation.
Measure and Data Construction		
Table C.18	Point Estimates, Fitness	This table adjusts the sector-specific formation rate of intangible capital, formation rate is from (Gulen et al., 2022). Baseline estimation assumes the same formation rate of intangible capital across countries.
Table C.19	-	Baseline estimation assumes the same adjustment cost function for firms residing in the same country. Firms with different incorporation location from its headquarter location are excluded from the sample.
Estimation Method		
Table C.20	Point Estimates, Fitness	The parameters are estimated using firm-level outcome, Baseline estimation uses portfolio-level outcome.

Table C.16: Model Fit in Full Sample

This table reports the measures of fit for the base line model specification. The beginning year for each country is reported in Column (1). In columns (2) to (4), within in each country, we calculate model fit for the entire sample used for estimation. Columns (5)-(8) report the beginning year, calculate the model fit for each region.

	Start	Model Fit				Start	Model Fit		
		XS-R^2	TS-R^2	$m.a.e./\overline{VR}$			XS-R^2	TS-R^2	$m.a.e./\overline{VR}$
	(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)
China	2001	0.24	0.12	0.31	France	2007	0.62	0.12	0.23
Hong Kong	2002	0.82	0.26	0.27	Germany	2006	0.73	0.18	0.26
Indonesia	2000	0.92	0.49	0.26	Poland	2007	0.77	0.23	0.28
India	2001	0.89	0.30	0.29	UK	2000	0.88	0.45	0.21
Japan	2000	0.28	0.07	0.18	Rest of Europe	2000	0.83	0.44	0.23
Malaysia	2002	0.74	0.21	0.18					
Singapore	2002	0.70	0.23	0.24	Canada	2000	0.90	0.44	0.20
South Korea	2000	0.66	0.32	0.20	USA	2000	0.91	0.55	0.18
Thailand	2000	0.81	0.35	0.24	Latin America	2000	0.86	0.49	0.21
Taiwan	2001	0.84	0.21	0.19					
Rest of Asia	2002	0.60	0.29	0.20	Australia	2004	0.72	0.25	0.24
					Africa	2006	0.46	0.37	0.20
Summary of Estimation									
					Asia		0.91	0.56	0.24
					Europe		0.84	0.40	0.24
					Americas		0.96	0.70	0.19
					Australia		0.72	0.25	0.24
					Africa		0.46	0.37	0.20
					World		0.90	0.55	0.23

Table C.17: Model Fit in Firm-Characteristic Portfolios

This table reports the measures of fit for the base line model specification. The parameters of model is identical with Table 5-6. In columns (1) to (3), within in each country, the fitness of model is calculated for the 30 portfolios sorted based on proxies of the lagged firm-level variables, {intensity of intangible capital, investment rate in physical capital, investment rate in intangible capital} (10 portfolios for each input). Columns (4)-(6) calculate the model fit for portfolios in each region.

	Model Fit				Model Fit		
	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$		XS-R^2	TS-R^2	$m.a.e./\overline{VR}$
	(1)	(2)	(3)		(4)	(5)	(6)
China	0.22	0.02	0.30	France	0.62	0.12	0.23
Hong Kong	0.62	0.26	0.26	Germany	0.73	0.18	0.26
Indonesia	0.64	0.32	0.23	Poland	0.77	0.23	0.28
India	0.58	0.07	0.28	UK	0.88	0.45	0.21
Japan	0.25	0.10	0.18	Rest of Europe	0.83	0.44	0.23
Malaysia	0.73	0.18	0.18				
Singapore	0.56	0.22	0.25	Canada	0.90	0.44	0.20
South Korea	0.47	0.25	0.14	USA	0.91	0.55	0.18
Thailand	0.65	0.21	0.23	Latin America	0.86	0.49	0.21
Taiwan	0.75	0.11	0.18				
Rest of Asia	0.64	0.28	0.16	Australia	0.72	0.25	0.24
				Africa	0.46	0.37	0.20
Summary of Estimation							
				Asia	0.92	0.57	0.23
				Europe	0.83	0.42	0.24
				Americas	0.95	0.69	0.18
				Australia	0.63	0.33	0.23
				Africa	0.67	0.44	0.20
				World	0.88	0.54	0.22

Table C.18: Parameter Estimates and Model Fit (Measure of Intangible)

This table reports the parameter estimates and measures of fit for the baseline model specification. The estimation procedure adjusts the sector-specific formation rate of intangible capital for the firms in Consumption, Manufacturing, Hi-tech and Health sector, using parameters in (Gulen et al., 2022). The estimation uses 20 portfolios sorted based on proxies of the lagged inputs in valuation equation (10 portfolios for each input). θ_P and θ_I are, respectively, the physical capital and intangible capital adjustment cost parameters. s.e. stands for Newey-West standard errors with three lags. $XS-R^2$ is the cross-sectional R^2, $TS-R^2$ is the time-series R^2, and $m.a.e./\overline{VR}$ is the mean absolute valuation error scaled by the absolute value of the ratio. We calculate model fit for the 2006-2020 sample for which most of the countries have data.

Country/Region		Point Estimate		Model Fit			Country/Region		Point Estimate		Model Fit		
		θ_P	θ_I	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$			θ_P	θ_I	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$
(1)		(2)	(3)	(4)	(5)	(6)	(7)		(8)	(9)	(10)	(11)	(12)
China		3.34	26.75	0.23	0.02	0.30	France		4.49	6.49	0.58	0.12	0.21
	s.e.	(1.17)	(2.27)					s.e.	(0.65)	(0.50)			
Hong Kong		2.38	6.11	0.71	0.26	0.26	Germany		3.95	7.96	0.73	0.17	0.25
	s.e.	(0.36)	(0.71)					s.e.	(1.07)	(0.97)			
Indonesia		4.64	13.41	0.78	0.36	0.22	Poland		3.68	3.84	0.76	0.24	0.28
	s.e.	(0.57)	(1.31)					s.e.	(1.30)	(0.77)			
India		2.17	8.61	0.13	0.03	0.23	UK		5.07	7.85	0.82	0.47	0.19
	s.e.	(0.38)	(0.53)					s.e.	(0.53)	(0.58)			
Japan		0.16	2.34	0.15	0.07	0.18	Rest of Europe		3.40	9.86	0.84	0.48	0.21
	s.e.	(0.39)	(0.34)					s.e.	(0.61)	(0.75)			
Malaysia		1.98	11.68	0.70	0.20	0.18							
	s.e.	(0.48)	(0.88)				Canada		3.48	9.86	0.85	0.36	0.21
Singapore		1.31	6.91	0.57	0.21	0.25		s.e.	(0.29)	(0.63)			
	s.e.	(0.49)	(0.55)				USA		6.82	12.89	0.81	0.51	0.17
South Korea		1.15	3.28	0.47	0.22	0.14		s.e.	(0.65)	(0.68)			
	s.e.	(0.35)	(0.42)				Latin America		2.12	8.28	0.84	0.50	0.17
Thailand		3.30	10.86	0.73	0.23	0.23		s.e.	(0.41)	(0.74)			
	s.e.	(0.63)	(1.12)										
Taiwan		3.50	11.84	0.78	0.07	0.18	Australia		3.07	9.54	0.64	0.33	0.23
	s.e.	(0.52)	(0.81)					s.e.	(0.39)	(0.72)			
Rest of Asia		6.64	9.67	0.54	0.24	0.18							
	s.e.	(0.84)	(1.10)										
							Africa		8.05	10.90	0.36	0.37	0.20
								s.e.	(1.04)	(0.67)			
Summary of Estimation													
							World	Mean	3.66	9.87	0.87	0.53	0.22
								S.D.	(1.88)	(5.10)			

Table C.19: Parameter Estimates and Model Fit (Domestic Firms)

This table reports the parameter estimates and measures of fit for the sub-sample of domestic firms. For firms with different incorporation location from its headquarter location, they are excluded from the sample. The estimation uses 20 portfolios sorted based on proxies of the lagged inputs in valuation equation (10 portfolios for each input). θ_P and θ_I are, respectively, the physical capital and intangible capital adjustment cost parameters. s.e. stands for Newey-West standard errors with three lags. $XS-R^2$ is the cross-sectional R^2, $TS-R^2$ is the time-series R^2, and $m.a.e./\overline{VR}$ is the mean absolute valuation error scaled by the absolute value of the ratio. We calculate model fit for the 2006-2020 sample for which most of the countries have data. Portfolios in Hong Kong is unavailable because there isn't sufficient size of sample for firms with identical incorporation location and headquarter location.

Country/Region		Point Estimate		Model Fit			Country/Region		Point Estimate		Model Fit		
		θ_P	θ_I	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$			θ_P	θ_I	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$
(1)		(2)	(3)	(4)	(5)	(6)	(7)		(8)	(9)	(10)	(11)	(12)
China		1.14	40.93	0.42	0.20	0.29	France		5.06	7.85	0.63	0.12	0.23
	s.e.	(1.13)	(2.80)					s.e.	(0.81)	(0.65)			
Hong Kong		-	-	-	-	-	Germany		4.79	9.77	0.73	0.17	0.26
	s.e.							s.e.	(1.28)	(1.26)			
Indonesia		4.60	14.28	0.82	0.41	0.22	Poland		3.39	4.56	0.76	0.23	0.28
	s.e.	(0.57)	(1.30)					s.e.	(1.27)	(0.80)			
India		4.41	19.39	0.73	0.18	0.28	UK		5.40	9.21	0.81	0.45	0.21
	s.e.	(0.67)	(1.52)					s.e.	(0.64)	(0.72)			
Japan		0.42	2.62	0.20	0.07	0.18	Rest of Europe		3.62	11.77	0.83	0.48	0.22
	s.e.	(0.40)	(0.37)					s.e.	(0.70)	(0.91)			
Malaysia		2.27	12.44	0.69	0.18	0.19							
	s.e.	(0.50)	(0.91)				Canada		3.41	11.95	0.88	0.40	0.22
Singapore		1.36	7.16	0.40	0.19	0.25		s.e.	(0.31)	(0.73)			
	s.e.	(0.47)	(0.56)				USA		7.12	16.91	0.87	0.58	0.17
South Korea		1.16	4.22	0.55	0.28	0.13		s.e.	(0.73)	(0.93)			
	s.e.	(0.34)	(0.47)				Latin America		2.11	8.54	0.82	0.50	0.18
Thailand		3.27	11.71	0.74	0.24	0.23		s.e.	(0.40)	(0.75)			
	s.e.	(0.61)	(1.17)										
Taiwan		3.75	15.91	0.77	0.11	0.18	Australia		3.15	10.73	0.66	0.31	0.25
	s.e.	(0.57)	(1.10)					s.e.	(0.39)	(0.80)			
Rest of Asia		6.01	11.57	0.67	0.32	0.17							
	s.e.	(0.87)	(1.03)										
							Africa		8.37	11.26	0.47	0.38	0.20
								s.e.	(1.07)	(0.69)			
Summary of Estimation													
							World	Mean	3.74	12.14	0.89	0.57	0.22
								S.D.	(2.01)	(7.77)			

Table C.20: Parameter Estimates and Model Fit (Firm-level Method)

This table reports the parameter estimates and measures of fit for the alternative specification of firm-level method. Parameters are estimated using the firm-level moments. The standard error and statistics of fitness are calculated using 20 portfolios sorted based on proxies of the lagged inputs in valuation equation (10 portfolios for each input). θ_P and θ_I are, respectively, the physical capital and intangible capital adjustment cost parameters. s.e. stands for Newey-West standard errors with three lags. $XS-R^2$ is the cross-sectional R^2, $TS-R^2$ is the time-series R^2, and $m.a.e./\overline{VR}$ is the mean absolute valuation error scaled by the absolute value of the ratio. We calculate model fit for the 2006-2020 sample for which most of the countries have data.

Country/Region		Point Estimate		Model Fit			Country/Region		Point Estimate		Model Fit		
		θ_P	θ_I	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$			θ_P	θ_I	XS-R^2	TS-R^2	$m.a.e./\overline{VR}$
(1)		(2)	(3)	(4)	(5)	(6)	(7)		(8)	(9)	(10)	(11)	(12)
China		3.37	28.14	0.12	-0.02	0.31	France		3.54	8.56	0.49	0.10	0.23
	s.e.	(0.14)	(0.45)					s.e.	(0.47)	(0.33)			
Hong Kong		0.61	9.98	0.59	0.24	0.27	Germany		3.73	10.34	0.68	0.17	0.26
	s.e.	(0.07)	(0.26)					s.e.	(0.37)	(0.41)			
Indonesia		1.74	19.08	0.68	0.38	0.23	Poland		2.37	4.88	0.65	0.21	0.27
	s.e.	(0.20)	(0.70)					s.e.	(0.25)	(0.26)			
India		2.62	22.25	0.74	0.20	0.28	UK		2.50	10.56	0.62	0.37	0.22
	s.e.	(0.12)	(0.42)					s.e.	(0.17)	(0.24)			
Japan		1.49	2.29	0.16	-0.02	0.19	Rest of Europe		1.78	12.63	0.76	0.44	0.23
	s.e.	(0.07)	(0.07)					s.e.	(0.33)	(0.34)			
Malaysia		1.53	12.38	0.59	0.19	0.19							
	s.e.	(0.12)	(0.34)				Canada		2.03	13.02	0.83	0.42	0.22
Singapore		0.81	7.54	0.52	0.21	0.25		s.e.	(0.10)	(0.33)			
	s.e.	(0.10)	(0.28)				USA		4.02	18.19	0.75	0.53	0.18
South Korea		1.04	5.42	0.81	0.37	0.13		s.e.	(0.14)	(0.17)			
	s.e.	(0.09)	(0.19)				Latin America		0.58	10.96	0.79	0.49	0.18
Thailand		1.59	14.44	0.50	0.24	0.23		s.e.	(0.10)	(0.47)			
	s.e.	(0.13)	(0.36)										
Taiwan		2.32	15.85	0.59	0.12	0.19	Australia		1.65	11.35	0.24	0.23	0.25
	s.e.	(0.10)	(0.24)					s.e.	(0.13)	(0.43)			
Rest of Asia		1.10	17.06	0.17	0.16	0.19							
	s.e.	(0.11)	(0.36)										
							Africa		4.20	10.87	-0.43	0.25	0.22
								s.e.	(0.33)	(0.56)			
Summary of Estimation													
							World	Mean	2.13	12.66	0.82	0.52	0.23
								S.D.	(1.08)	(5.87)			

C.4.2 Extended Model of Country-Sector Specific Adjustment Cost Function

Table C.21: Descriptive Statistics for Sectors in Countries

The table below reports the selected statistics of listed corporations in the industry sectors of each country (or territory, region). **Firms** N_f counts the average number of listed firms with qualified financial reports during the full sample period. $\frac{K^I}{TK}$ reports the median of ratio $\frac{K^I}{K^I+K^P}$ of intangible capital over the total amount of capitals in each sector. The time-series average statistics during the full sample is reported. The 89 sets of country-sectors are classified using Fama-French 10 industries in each country (or territory, region). Columns (1) and (7) report the country and territory, rest of the region, for each region of Asia, Europe, Americas, Australia and Africa. Column (2) and Column (3) report the point estimates of Non-Durable consumption sector in countries. Column (4) and Column (5) report the point estimates of Durable consumption sector in countries. Column (6) and Column (7) report the point estimates of Manufacturing sector in countries. Columns (8) to (9), (10) to (11), (12) to (13), (14) to (15) report the point estimates of Energy sector, Hi-Tech sector, Shopping sector, Health sector, respectively in countries. For firms in a country-sector that have less than 60 firms per year 2011-2020, they are classified as the other sector in that country. Column (16) and Column (17) report the point estimates of Other sector in countries.

Country/Region	NonDurable		Durable		Manufacturing		Energy		Hi-Tech		Shopping		Health		Other	
	N_f	$\frac{K^I}{TK}$	N_f	$\frac{K^I}{TK}$	N_f	$\frac{K^I}{TK}$	N_f	$\frac{K^I}{TK}$	N_f	$\frac{K^I}{TK}$	N_f	$\frac{K^I}{TK}$	N_f	$\frac{K^I}{TK}$	N_f	$\frac{K^I}{TK}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
China	168	0.27	107	0.32	543	0.18	-	-	174	0.34	109	0.35	135	0.38	181	0.15
Hong Kong	100	0.45	-	-	110	0.33	-	-	80	0.45	94	0.64	-	-	195	0.33
Indonesia	57	0.24	-	-	61	0.22	-	-	-	-	-	-	-	-	138	0.32
India	275	0.33	104	0.41	545	0.31	-	-	92	0.50	-	-	94	0.36	233	0.27
Japan	151	0.53	110	0.32	468	0.39	-	-	149	0.51	351	0.60	-	-	341	0.33
Malaysia	90	0.19	-	-	176	0.24	-	-	-	-	-	-	-	-	267	0.29
Singapore	-	-	-	-	78	0.34	-	-	-	-	66	0.55	-	-	172	0.34
South Korea	69	0.41	55	0.23	195	0.21	-	-	78	0.27	-	-	-	-	124	0.35
Thailand	62	0.34	-	-	113	0.24	-	-	-	-	-	-	-	-	182	0.29
Taiwan	103	0.26	70	0.31	324	0.23	-	-	514	0.32	70	0.59	59	0.28	77	0.20
Others in Asia	278	0.26	-	-	339	0.22	-	-	59	0.65	100	0.47	61	0.39	319	0.20
France	-	-	-	-	63	0.63	-	-	-	-	-	-	-	-	221	0.68
Germany	-	-	-	-	97	0.57	-	-	-	-	-	-	-	-	186	0.59
Poland	-	-	-	-	67	0.29	-	-	-	-	-	-	-	-	157	0.45
UK	-	-	-	-	93	0.57	-	-	-	-	84	0.62	-	-	339	0.61
Others in Europe	205	0.42	58	0.55	359	0.43	60	0.13	122	0.67	124	0.60	97	0.60	251	0.32
Canada	-	-	-	-	-	-	93	0.04	-	-	-	-	-	-	266	0.33
USA	127	0.63	67	0.60	348	0.51	126	0.05	389	0.77	277	0.65	184	0.72	302	0.42
Others in Americas	107	0.39	-	-	116	0.28	-	-	-	-	-	-	-	-	193	0.33
Australia	-	-	-	-	68	0.59	-	-	-	-	-	-	-	-	308	0.30
Africa	53	0.38	-	-	61	0.37	-	-	-	-	-	-	-	-	141	0.45

Table C.22: Estimation Outcome of Country-Sector Model

This table reports the parameter estimates for the model of country-sector-specific adjustment cost function. The model is estimated using the 89 sets of country-sector portfolios, which contains 6 portfolios in each sector of each country (or territory, region). Column (2) and Column (3) report the point estimates of Non-Durable consumption sector in countries. Column (4) and Column (5) report the point estimates of Durable consumption sector in countries. Column (6) and Column (7) report the point estimates of Manufacturing sector in countries. Columns (8) to (9), (10) to (11), (12) to (13), (14) to (15) report the point estimates of Energy sector, Hi-Tech sector, Shopping sector, Health sector, respectively in countries. For firms in a country-sector that have less than 60 firms per year 2011-2020, they are classified as the other sector in that country. Column (16) and Column (17) report the point estimates of Other sector in countries. Columns (18) to (20) report the fitness statistics using same definition and identical portfolios with Table 2 in each country (or territory, region).

Country/Region		NonDurable		Durable		Manufacturing		Energy		Hi-Tech	
		$\theta_{P,c,s}$	$\theta_{I,c,s}$	$\theta_{P,c,s}$	$\theta_{I,c,s}$	$\theta_{P,c,s}$	$\theta_{I,c,s}$	$\theta_{P,c,s}$	$\theta_{I,c,s}$	$\theta_{P,c,s}$	$\theta_{I,c,s}$
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
China		2.73	31.66	4.18	22.92	-1.90	50.60	-	-	2.41	33.51
	s.e.	(1.75)	(3.62)	(1.71)	(3.23)	(1.25)	(4.63)	-	-	(2.28)	(5.00)
Hong Kong		0.96	6.23	-	-	1.01	10.41	-	-	0.54	9.52
	s.e.	(0.41)	(0.76)	-	-	(0.64)	(1.24)	-	-	(0.53)	(1.17)
Indonesia		5.14	18.61	-	-	3.48	14.59	-	-	-	-
	s.e.	(0.95)	(2.54)	-	-	(0.66)	(1.49)	-	-	-	-
India		3.24	16.45	3.26	16.70	3.95	18.40	-	-	5.76	19.36
	s.e.	(0.41)	(1.51)	(1.05)	(2.29)	(0.77)	(2.14)	-	-	(1.54)	(2.93)
Japan		-0.25	1.07	0.05	1.91	0.09	3.80	-	-	2.03	4.46
	s.e.	(0.66)	(0.42)	(0.55)	(0.79)	(0.62)	(0.80)	-	-	(1.02)	(0.92)
Malaysia		1.42	14.27	-	-	0.77	12.76	-	-	-	-
	s.e.	(0.64)	(1.53)	-	-	(0.58)	(0.95)	-	-	-	-
Singapore		-	-	-	-	1.74	3.81	-	-	-	-
	s.e.	-	-	-	-	(0.70)	(1.13)	-	-	-	-
South Korea		2.12	0.21	0.27	2.18	1.03	4.65	-	-	0.13	7.42
	s.e.	(0.74)	(0.57)	(0.36)	(0.94)	(0.53)	(1.33)	-	-	(0.29)	(0.61)
Thailand		3.56	10.47	-	-	1.63	13.57	-	-	-	-
	s.e.	(1.13)	(2.18)	-	-	(0.79)	(2.33)	-	-	-	-
Taiwan		2.33	14.07	2.37	15.10	2.78	15.73	-	-	3.77	17.14
	s.e.	(0.87)	(1.75)	(0.68)	(1.59)	(0.60)	(1.16)	-	-	(0.66)	(1.25)
Others in Asia		3.67	13.67	-	-	6.41	18.78	-	-	2.85	11.96
	s.e.	(1.28)	(1.63)	-	-	(2.00)	(3.31)	-	-	(1.17)	(0.96)

Table Continued

Table C.22: Estimation Outcome of Country-Sector Model (Table Continued)

Country/Region		Shopping		Health		Other		Model Fitness		
		$\theta_{P,c,s}$ (12)	$\theta_{I,c,s}$ (13)	$\theta_{P,c,s}$ (14)	$\theta_{I,c,s}$ (15)	$\theta_{P,c,s}$ (16)	$\theta_{I,c,s}$ (17)	XS-R^2 (18)	TS-R^2 (19)	$m.a.e./\overline{VR}$ (20)
China		0.46	23.48	2.06	34.06	2.95	38.54	0.31	0.10	0.29
	s.e.	(1.74)	(2.73)	(2.37)	(3.55)	(1.51)	(6.04)			
Hong Kong		2.42	5.34	-	-	2.13	9.56	0.70	0.30	0.26
	s.e.	(0.50)	(0.57)	-	-	(0.79)	(2.11)			
Indonesia		-	-	-	-	5.41	11.41	0.80	0.38	0.23
	s.e.	-	-	-	-	(1.11)	(2.46)			
India		-	-	5.21	25.75	4.54	26.74	0.77	0.20	0.28
	s.e.	-	-	(1.34)	(2.34)	(0.77)	(2.99)			
Japan		-0.65	1.11	-	-	-0.93	5.91	0.23	0.12	0.17
	s.e.	(0.87)	(0.46)	-	-	(0.52)	(0.77)			
Malaysia		-	-	-	-	3.00	12.41	0.68	0.22	0.18
	s.e.	-	-	-	-	(0.87)	(1.56)			
Singapore		0.37	7.20	-	-	2.03	8.30	0.72	0.25	0.24
	s.e.	(0.56)	(0.65)	-	-	(0.60)	(0.87)			
South Korea		-	-	-	-	1.25	5.96	0.54	0.27	0.14
	s.e.	-	-	-	-	(0.64)	(0.58)			
Thailand		-	-	-	-	4.19	11.07	0.75	0.24	0.22
	s.e.	-	-	-	-	(1.10)	(1.81)			
Taiwan		0.37	14.47	5.04	15.30	1.83	25.20	0.73	0.14	0.18
	s.e.	(0.69)	(1.02)	(1.20)	(2.06)	(0.57)	(1.97)			
Others in Asia		3.72	14.48	5.16	17.80	3.41	18.94	0.74	0.41	0.15
	s.e.	(1.02)	(1.50)	(1.88)	(2.65)	(0.66)	(1.74)			

Table Continued

Table C.22: Estimation Outcome of Country-Sector Model (Table Continued)

Country/Region		NonDurable		Durable		Manufacturing		Energy		Hi-Tech	
		$\theta_{P,c,s}$	$\theta_{I,c,s}$	$\theta_{P,c,s}$	$\theta_{I,c,s}$	$\theta_{P,c,s}$	$\theta_{I,c,s}$	$\theta_{P,c,s}$	$\theta_{I,c,s}$	$\theta_{P,c,s}$	$\theta_{I,c,s}$
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
France		-	-	-	-	1.84	7.37	-	-	-	-
	s.e.	-	-	-	-	(1.24)	(1.16)	-	-	-	-
Germany		-	-	-	-	3.53	8.19	-	-	-	-
	s.e.	-	-	-	-	(1.59)	(1.54)	-	-	-	-
Poland		-	-	-	-	3.17	6.06	-	-	-	-
	s.e.	-	-	-	-	(1.21)	(1.20)	-	-	-	-
UK		-	-	-	-	6.28	8.19	-	-	-	-
	s.e.	-	-	-	-	(1.00)	(1.02)	-	-	-	-
Others in Europe		1.72	10.15	2.33	9.66	3.44	8.86	2.12	16.16	3.19	16.45
	s.e.	(0.76)	(0.90)	(1.03)	(1.23)	(0.82)	(1.16)	(0.37)	(2.62)	(2.05)	(1.84)
Canada		-	-	-	-	-	-	2.96	6.95	-	-
	s.e.	-	-	-	-	-	-	(0.31)	(5.16)	-	-
USA		7.33	15.17	12.40	10.90	11.65	15.31	2.95	15.17	13.72	15.60
	s.e.	(4.38)	(2.57)	(1.73)	(1.49)	(1.38)	(1.76)	(0.41)	(4.68)	(2.17)	(1.89)
Others in Americas		1.46	7.10	-	-	2.18	9.13	-	-	-	-
	s.e.	(0.53)	(1.34)	-	-	(0.47)	(0.95)	-	-	-	-
Australia		-	-	-	-	2.91	10.16	-	-	-	-
	s.e.	-	-	-	-	(1.03)	(1.26)	-	-	-	-
Africa		6.14	14.31	-	-	8.82	11.78	-	-	-	-
	s.e.	(1.79)	(1.64)	-	-	(1.44)	(1.36)	-	-	-	-

Table Continued

Table C.22: Estimation Outcome of Country-Sector Model (Table Continued)

Country/Region		Shopping		Health		Other		Model Fitness		
		$\theta_{P,c,s}$ (12)	$\theta_{I,c,s}$ (13)	$\theta_{P,c,s}$ (14)	$\theta_{I,c,s}$ (15)	$\theta_{P,c,s}$ (16)	$\theta_{I,c,s}$ (17)	XS-R^2 (18)	TS-R^2 (19)	$m.a.e./\overline{VR}$ (20)
France		-	-	-	-	5.73	8.03	0.63	0.12	0.23
	s.e.	-	-	-	-	(1.13)	(1.13)			
Germany		-	-	-	-	5.11	10.85	0.76	0.21	0.26
	s.e.	-	-	-	-	(1.80)	(2.07)			
Poland		-	-	-	-	3.06	4.55	0.76	0.24	0.28
	s.e.	-	-	-	-	(1.00)	(0.67)			
UK		2.22	7.09	-	-	6.07	9.90	0.85	0.46	0.20
	s.e.	(0.79)	(0.85)	-	-	(0.92)	(1.25)			
Others in Europe		1.98	8.95	4.15	23.50	4.53	9.68	0.87	0.52	0.21
	s.e.	(0.55)	(0.80)	(2.21)	(2.35)	(0.84)	(1.57)			
Canada		-	-	-	-	4.60	11.18	0.92	0.42	0.22
	s.e.	-	-	-	-	(0.57)	(1.12)			
USA		2.63	11.13	13.10	17.59	6.67	17.42	0.92	0.63	0.16
	s.e.	(0.97)	(0.83)	(2.54)	(1.73)	(1.01)	(1.82)			
Others in Americas		-	-	-	-	2.67	8.21	0.83	0.50	0.18
	s.e.	-	-	-	-	(0.52)	(1.15)			
Australia		-	-	-	-	3.38	10.83	0.70	0.32	0.24
	s.e.	-	-	-	-	(0.54)	(1.31)			
Africa		-	-	-	-	6.62	11.63	0.37	0.37	0.20
	s.e.	-	-	-	-	(1.23)	(1.07)			

D Additional Figures

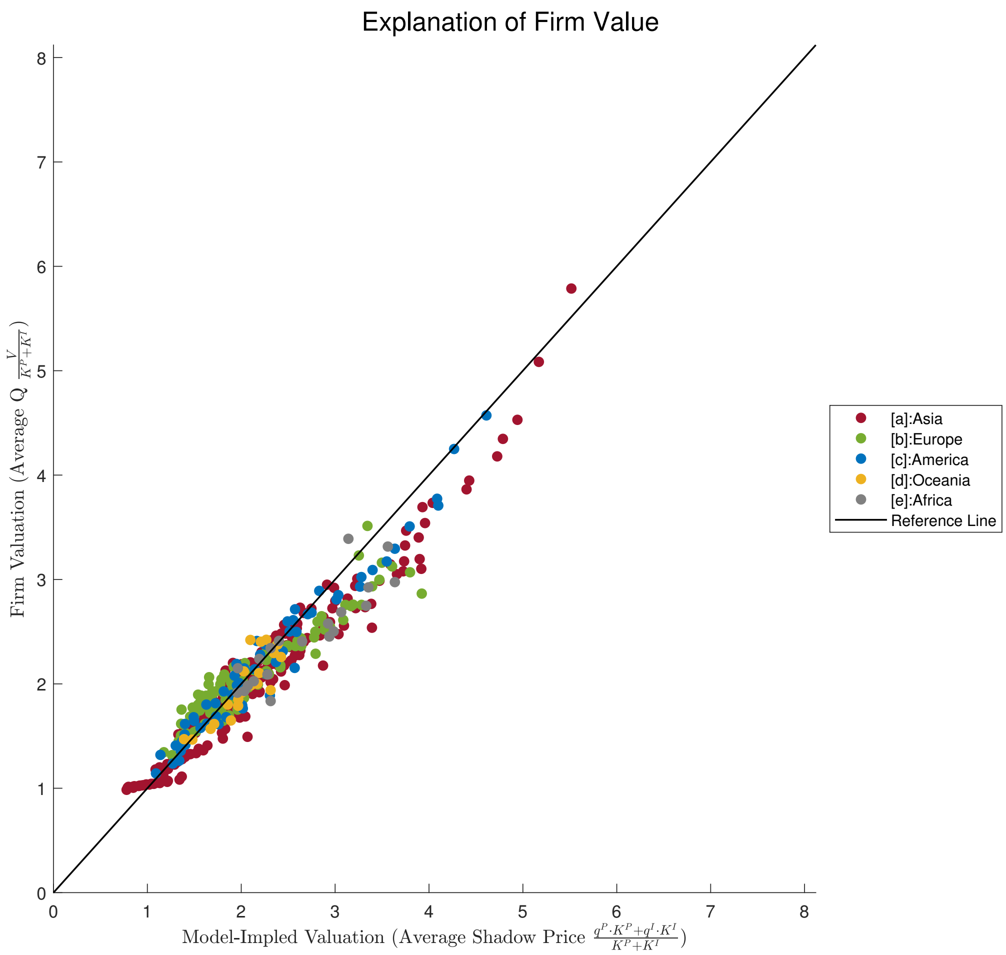


Figure D.1: Model-Implied Firm Value in Portfolios

This figure reports the model-implied valuation and the firm valuation. The model-implied valuation is the average shadow price of capitals in each portfolio is $\overline{VR}_j = \frac{1}{N_j}\sum_i \frac{q_i^P K_i^P + q_i^I K_i^I}{K_i^P + K_i^I}$. The firm valuation is $VR_j = \frac{1}{N_j}\sum_i \frac{P+B}{K_i^P + K_i^I}$. Each geographic area (of 17 countries, Rest of Asia, Rest of Europe, Africa, Latin America) has 30 portfolios sorted based on lagged firm-level variables: book-share of intangible capital, investment rate in physical capital and investment rate of intangible capital. The time-series average during period during 2006-2020 is reported in the figure. The red dots present the portfolios of countries, territories, the remaining area in Asia. The green dots present the portfolios of countries, the remaining area in Europe. The blue dots are for the Americas. The yellow dots and gray dots present the portfolios in Oceania (Australia) and Africa respectively.

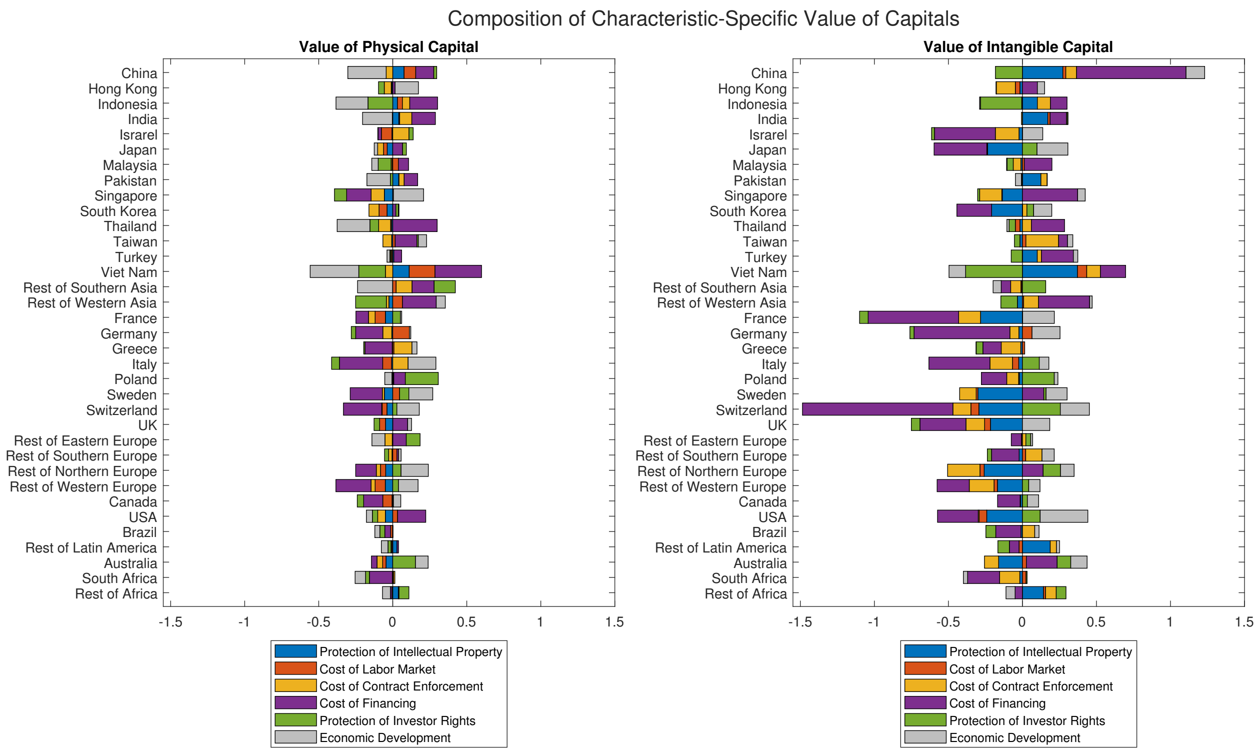


Figure D.2: Composition of Characteristic-Specific Value

This figure reports the model-implied characteristic-specific valuation for the model of country-specific state-contingent adjustment cost function. The statistics for the 17 large-size countries, 10 medium-size countries, other small-size countries in the remaining area of 8 UN-sub-regions are reported. The valuation of intangible capital from country-characteristic variables are reported in the first row. For each aspect z of country-characteristic variables, the cost compensation in value of intangible capital is calculated as $\{\boldsymbol{\gamma}_{\boldsymbol{z}}^{\boldsymbol{I}} \cdot \mathbf{X}_{\mathbf{c},z} \cdot \frac{i^I \cdot K^I}{K^P+K^I}\}_z$. The component $\frac{i^I \cdot K^I}{K^P+K^I} = \frac{1}{T}\sum_t \frac{\sum_i i^I_{it} K^I_{it+1}}{\sum_i K^I_{it+1}+K^P_{it+1}}$ is calculated as the aggregate statistic for each geographic area (of 27 countries, 8 sub-regions) and each year during 2016-2020. The similar statistic is reported for physical capital in the second row.

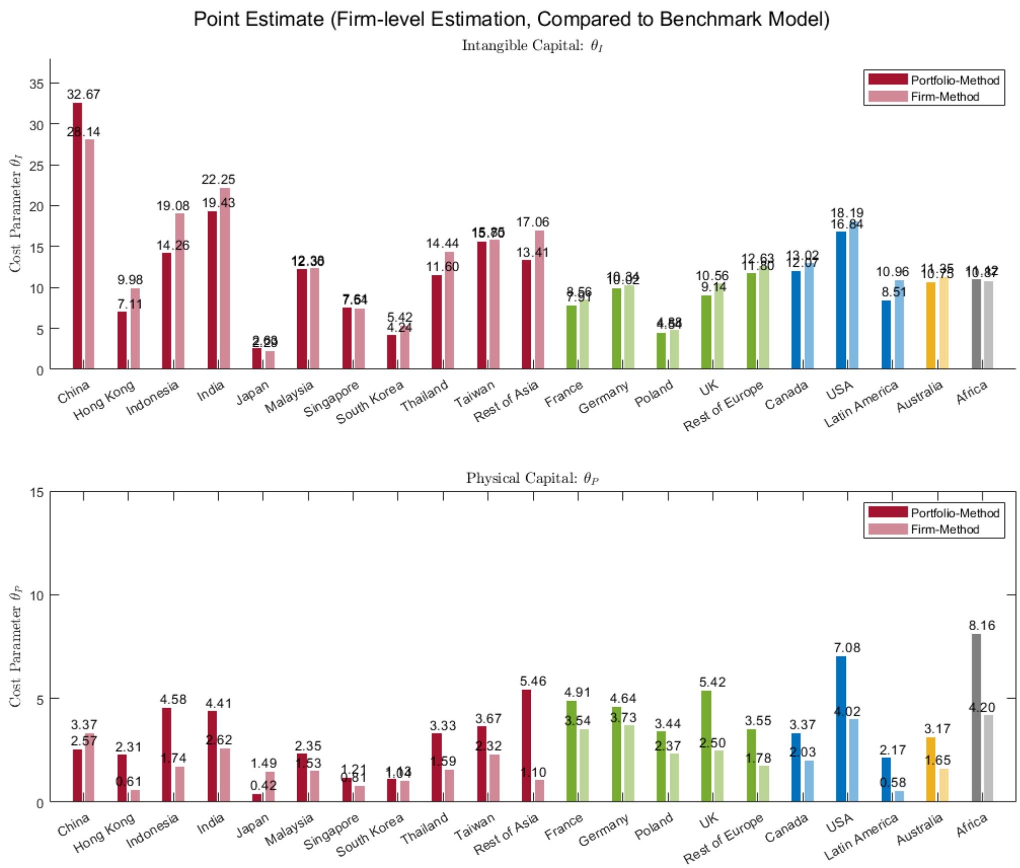


Figure D.3: Estimates of Cost Coefficients in Firm-level Estimation

This figure compares the parameter estimates in the baseline estimation method of portfolio-level moment, and the parameter estimates in the alternative specification of firm-level moment. The top figure reports the parameters for intangible capital. The bar of yellow color describes the estimation outcome using the portfolio-level moment. The bar of purple color describes the estimation outcome using the firm-level moment. The bottom figure reports the parameters for the physical capital. The bar of blue color, the green color describes the estimation outcomes of the two specifications respectively.

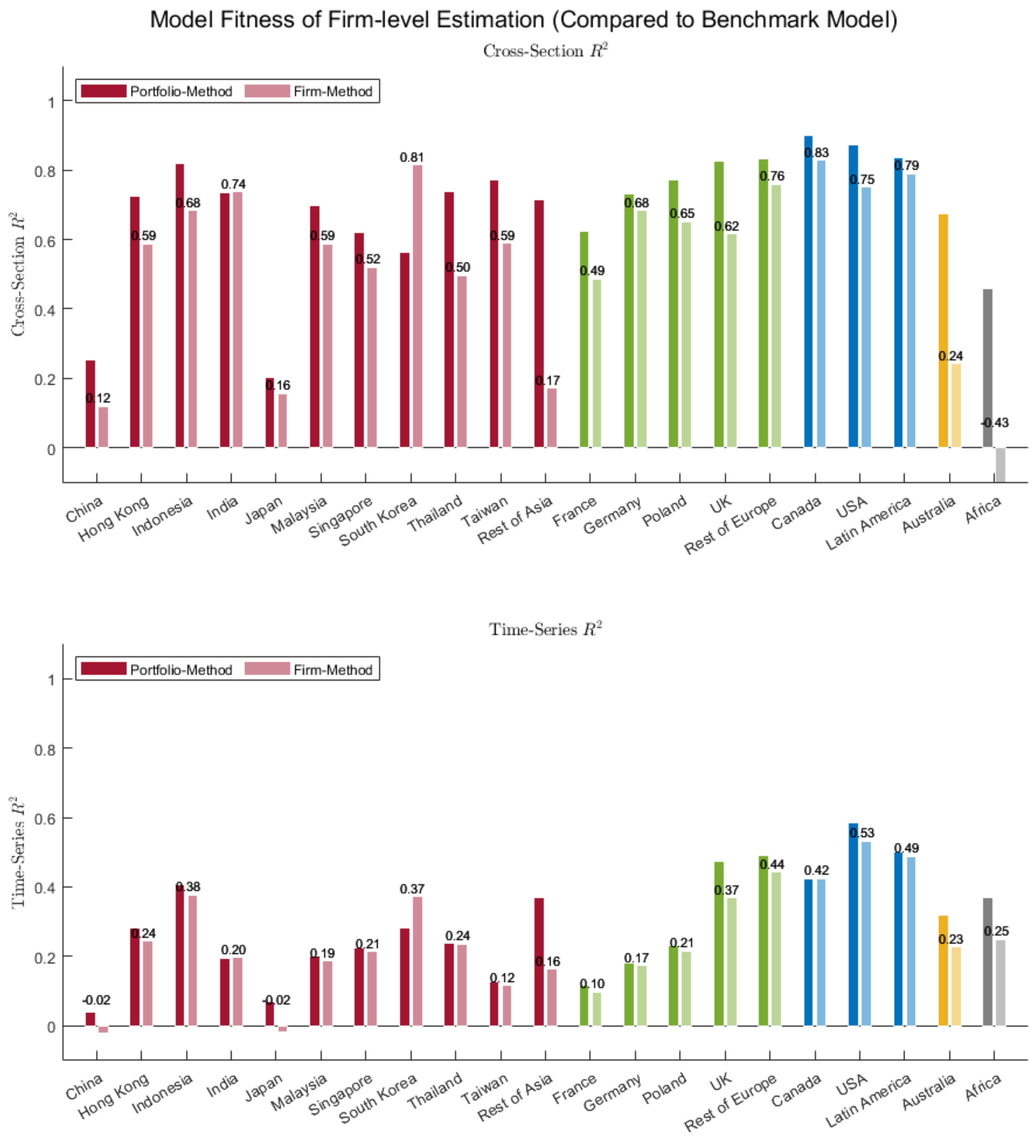


Figure D.4: Fitness of Model in Firm-level Estimation

This figure compares the fitness of model in the baseline specification of portfolio-level estimation, and the model of firm-level estimation. The top figure reports the cross-section R^2. The bar of yellow color describes the estimation outcome using the portfolio-level moment. The bar of purple color describes the estimation outcome using the firm-level moment. The data label of numbers denotes the cross-section R^2 of firm-level estimation. The bottom figure reports the time-series R^2. The bar of blue color describes the estimation outcome using the portfolio-level moment. The bar of green color describes the estimation outcome using the firm-level moment. The data label of numbers denotes the time-series R^2 of firm-level estimation. These statistics of fitness are calculated using the portfolio-level moments. The construction of portfolios, calculation of statistics are identical with Table 2.

E Math Appendix

This appendix section provides the proof for the valuation equation 5. The proof is direct extension of (Hayashi, 1982) with consideration of multiple types of capital inputs and debt.

Theorem [Hayashi,1982]: Denote $P_{it} \equiv V_{it} - D_{it}$ be the ex-dividend equity value. If profit function $\Pi(.)$ and cost function $C(.)$ are Constant Return to Scale, firm's value maximization implies that

$$P_{it} + B_{it+1} = q_{it}^{P} K_{it+1}^{P} + q_{it}^{I} K_{it+1}^{I}, \tag{30}$$

in which

$$\begin{aligned} q_{it}^{P} &= 1 + (1-\tau_t) \cdot \tfrac{\partial C_{it}}{\partial I_{it}^{P}}, \\ q_{it}^{I} &= (1-\tau_t) \cdot (1 + \tfrac{\partial C_{it}}{\partial I_{it}^{I}}). \end{aligned} \tag{31}$$

Proof:

The Bellman equation of firm equity valuation is

$$V(X_{it}, K_{it}^{P}, K_{it}^{I}) \equiv \max_{\{L_{it+\triangle t}, \mathbf{I}_{it+\triangle t}, \mathbf{K}_{it+\triangle t+1}, B_{it+\triangle t+1}\}_{\triangle t=0}^{\infty}} D_{it} + E_t\left[M_{t+1} \cdot V(X_{it+1}, K_{it+1}^{P}, K_{it+1}^{I})\right], \tag{32}$$

$$s.t. \quad \begin{aligned} D_{it} \equiv (1-\tau_t)[\Pi_{it} - C_{it} - I_{it}^{I}] \quad & -I_{it}^{P} + B_{it+1} - r_{it}^{B} B_{it} \\ & + \tau_t \delta_{it}^{P} K_{it}^{P} + \tau_t (r_{it}^{B} - 1) B_{it}. \end{aligned} \tag{33}$$

$$K_{it+1}^{P} = I_{it}^{P} + (1-\delta_{it}^{P}) K_{it}^{P} \tag{34}$$

$$K_{it+1}^{I} = I_{it}^{I} + (1-\delta_{it}^{I}) K_{it}^{I} \tag{35}$$

The X_{it} is vector of state variables of aggregate productivity and firm productivity. Optimal physical capital investment reflects the marginal value of physical capital (K_{it+1}^{P}):

$$\underbrace{1 + (1-\tau_t)\frac{\partial C_{it}}{\partial I_{it}^{P}}}_{q_{it}^{P}\text{: Physical Capital Marginal q}} = E_t\left[M_{t+1} \cdot \frac{\partial V}{\partial K^{P}}(X_{it+1}, K_{it+1}^{P}, K_{it+1}^{I})\right] \tag{36}$$

Optimal intangible capital investment reflects the marginal value of intangible capital (K^I_{it+1}):

$$\underbrace{(1-\tau_t)\left[1+\frac{\partial C_{it}}{\partial I^I_{it}}\right]}_{q^I_{it}\text{: Intangible Capital Marginal q}} = E_t\left[M_{t+1}\cdot\frac{\partial V}{\partial K^I}(X_{it+1},K^P_{it+1},K^I_{it+1})\right] \tag{37}$$

We assume the Modigliani-Miller environment, total firm valuation is irrelevant of capital structure. Equity value maximization implies the total firm valuation maximization, $r^B_{it}B_{it} + V(X_t,\mathbf{K}_{it}) = \overline{V}(X_t,\mathbf{K}_{it})$. If profit function $\Pi(.)$ and cost function $C(.)$ are Constant Return to Scale w.r.t $\mathbf{K}_{it} = (K^P_{it}, K^I_{it})$, firm's value maximization implies that

$$\overline{V}(X_t, a\cdot K^P_{it}, a\cdot K^I_{it}) = a\cdot\overline{V}(X_t,K^P_{it},K^I_{it}), \tag{38}$$

Homogeneity of Degree One implies the equation below,

$$\frac{\partial\overline{V}}{\partial K^P}(X_t,a\cdot K^P_{it},a\cdot K^I_{it})\cdot K^P_{it} + \frac{\partial\overline{V}}{\partial K^I}(X_t,a\cdot K^P_{it},a\cdot K^I_{it})\cdot K^I_{it} = a\cdot\overline{V}(X_t,K^P_{it},K^I_{it}), \tag{39}$$

At $a=1$, the total firm valuation is quantity of capital(s) multiplied by the marginal valuation of capital(s). In the Modigliani-Miller environment, total firm valuation is irrelevant of debt. Marginal value of physical capital for the equity valuation is identical with the first-order partial derivative of total firm valuation,

$$\frac{\partial V}{\partial K^P}V(X_t,\mathbf{K}_{it}) = \frac{\partial\overline{V}}{\partial K^P}(X_t,\mathbf{K}_{it}), \tag{40}$$

The similar equation holds for the new amount of intangible capital. Previously, we denote the $q^P_{it}(X_t) = E_t\left[M_{t+1}\cdot\frac{\partial V}{\partial K^P}(X_{it+1},\mathbf{K}_{it+1})\right]$, substituting the equation (40) yields $q^P_{it} = E_t\left[M_{t+1}\cdot\frac{\partial\overline{V}}{\partial K^P}(X_{it+1},\mathbf{K}_{it+1})\right]$, shadow price of physical capital is the expected marginal value for total firm valuation. Replacing the expected marginal value of capital, The expected total firm valuation is written as

$$
\begin{aligned}
E_t\left[M_{t+1}\cdot\overline{V}(X_{it+1},\mathbf{K}_{it+1})\right] &= E_t\left[M_{t+1}\cdot(\tfrac{\partial\overline{V}}{\partial K^P}(X_{it+1},\mathbf{K}_{it+1})\cdot K^P_{it+1}+\tfrac{\partial\overline{V}}{\partial K^I}(X_{it+1},\mathbf{K}_{it+1})\cdot K^I_{it+1})\right] \\
&= q^P_{it}(X_t)\cdot K^P_{it+1}+q^I_{it}(X_t)\cdot K^I_{it+1}
\end{aligned},
$$

Recall the total firm valuation is equity plus the debt, we arrive to the expected equity value $E_t\left[M_{t+1}\cdot(V(X_{it+1},\mathbf{K}_{it+1})\right]$ prior to dividend payout,

$$
\begin{aligned}
E_t\left[M_{t+1}\cdot\overline{V}(X_{it+1},\mathbf{K}_{it+1})\right] &= E_t\left[M_{t+1}\cdot(V(X_{it+1},\mathbf{K}_{it+1})+r^B_{it+1}B_{i,t+1})\right] \\
&= E_t\left[M_{t+1}\cdot(V(X_{it+1},\mathbf{K}_{it+1})\right]+E_t\left[M_{t+1}\cdot r^B_{it+1}B_{i,t+1}\right]
\end{aligned},
$$

The model considers the one-period debt. The new amount of debt equals the expected repayment in next period, $B_{i,t+1} = E_t\left[M_{t+1}\cdot r^B_{it+1}B_{i,t+1}\right]$. Equity value of current period is the payout and the expected equity value of next period, $V_{it} = D_{it} + E_t\left[M_{t+1}\cdot V(X_{it+1},\mathbf{K}_{it+1})\right]$. Combining these equations, we conclude, if profit function $\Pi(.)$ and cost function $C(.)$ are Constant Return to Scale w.r.t $\mathbf{K}_{it}$, firm's value maximization implies that

$$
V_{it}+B_{it+1} = D_{it}+q^P_{it}(X_{it})\cdot K^P_{it+1}+q^I_{it}(X_{it})\cdot K^I_{it+1}, \tag{41}
$$

Let $P_{it}\equiv V_{it}-D_{it}$ be the ex-dividend equity value, the equation is further simplified as

$$
P_{it}+B_{it+1} = q^P_{it}(X_{it})\cdot K^P_{it+1}+q^I_{it}(X_{it})\cdot K^I_{it+1}, \tag{42}
$$

Q.E.D.

F Data Appendix

F.1 Construction of Data

F.1.1 Summary of Data

1. Firm Fundamental
   - Data Source: Compustat Global, Compustat North America
   - Main data fields: Capital Stock, Capital Expenditure, Depreciation
   - Granularity: Firm
2. Stock Price
   - Data Source: Compustat Global-Security Daily, Compustat-CRSP linked
   - Main data fields: Capital Stock, Capital Expenditure, Depreciation
   - Granularity: Firm
3. Deflator
   - Data Source: CPI in OECD statistic
   - Main data fields: Capital Price
   - Granularity: Country
4. Tax Rate of Corporate Income
   - Data Source: Tax Foundation, Compustat Global -Economic Indicators
   - Main data fields: Corporate Tax
   - Granularity: Country

F.1.2 Main Measure

Variable	Measure	Alternative Measure
Price, Physical Capital	OECD CPI	UN stat
Price, Intangible Capital	OECD CPI	UN stat
Quantity, Physical Capital	Compustat, PPENT	-
Quantity, Intangible Capital	Compustat, XSGA	-
Value of Equity	Compustat-Security Daily	Datastream
Value of Debt	Compustat, Book Debt	
Home Country	Headquarter	Incorporation

F.1.3 Harmonization

- Currency specification

Home Country	Currency
All	USD

- Currency definition in each data source

Dataset	Currency
Compustat-Fundamental	Currency Reported
Compustat-Security Daily	Currency Reported

- Currency Crosswalk

Dataset	From	To
Compustat Global-Exchange Rate	Currency Reported	USD

- Region Crosswalk

Dataset	From	To
UNSD-M49 standard	ISO code	Sub-region code

F.2 Detailed Construction of Variable

F.2.1 Firm-level Data

We use Compustat Global from Capital IQ to collect the accounting information of listed firms incorporated in United Kindom and Continental European countries. We use the information in the annual financial report.

Definition of Country: We use the location of incorporation as the country of a firm. For robustness check, we also consider defining the location of firm as the location of headquarter.

Sample Quality Control: we remove firms in financial service industry (SIC:6000-6999), utility industry (SIC: 4900-4999), and public service industry (SIC: 9000-9999). For firms with both international version of financial report (DATFMT as HIST) and domestic version of financial report (DATFMT as Standard) in the same fiscal year, we use the international-version of financial report. For firms with restatement of financial reports, we use the most recent version of financial report.

Industry Code: The primary industry code is NAICS 6-digit code. For firm-year observations without the historical industry information `NAICSH`, we impute it with the nearby industry information, if none of these information is available, we use the current industry information `NAICS`. We also consider the production input market linked by SIC 4-digit code. Similarly, we use the historical industry information imputed with the nearby industry information.

Corporate Event: We check the firm-year observations with major acquisition event, using the footnote variables `SALE_FN`. For firms with major merge and acquisition event, the `SALE_FN` is flagged as AC. Based on this criteria, this situation is rare for the European countries, hence, we didn't implement this filter.

F.2.2 Currency Conversion

We conduct conversion of currency for all nominal variables. We use the sub-dataset Exchange Rate provided by Compustat Global to convert the currency of financial reports into nominal USD amount.

We use the 12-month (backward) moving-average exchange rate to convert the currency. For example, if a firm reports its income statement on Dec-31st-2010, we use the average month-end exchange rate during Jan-2010 and Dec-2010.

We use the sub-dataset Security Daily provided by Compustat Global to calculate the market value of outstanding common stock issued by the firms. Each firm in Compustat Global has the unique identifier `GVKEY`, a unique identifier `PRIROW` for the primary issued common stock. Each common stock in Security Daily has a unique identifier `IIN` and a unique firm identifier `GVKEY`. We require the security `IIN` matched with the firm `PRIROW`, and the identical firm identifier `GVKEY`.

We calculate the market value as the market-close price multiplied by the outstanding shares $\mathrm{V} = \mathrm{PRCCF} \cdot \mathrm{CSHOC}$.

We use the month-end market value in the month of financial report date. We convert the market value into the nominal USD amount, in the similar method with the firm fundamental variables.

F.3 Classification of Geographic Areas

The United Nations Statistics Division (UNSD) classifies 5 large regions (17 sub-regions): Africa (Northern Africa, Sub-Saharan Africa), Americas (Northern America, Latin America and the Caribbean), Asia (Eastern Asia, Southern Asia, South-eastern Asia, Melanesia, Micronesia, Polynesia, Central Asia, Western Asia),Oceania (Australia and New Zealand), Europe (Southern Europe, Eastern Europe, Northern Europe, Western Europe). For ease of description, we refer the 5 large regions as the ***continents***. We decide geographic areas in each continent following the procedure below:

- We impose the basic quality requirement for the firm-level observations, summarize the sample by each country.
- When the number of firm-level observation inside the country surpasses 9 observations, we start to include the country in our sample.
- If the average number of firm-level observations surpass 200 observations, we label the country as an independent large economy. The remaining countries are then classified as the constituent country in the rest of the continent.
- Due to the extreme years of hyper-inflation, the sample of Egypt and the sample Zimbabwe are discontinued after the preliminary sample requirement of firm investment rates. We remove the two countries to ensure the stationary sample.

After implementing above procedure, we end up with 17 large countries and 4 regions.

The 17 large economies are Australia, Canada, China, Germany, France, UK, Hong Kong, India, Indonesia, Japan, South Korea, Malaysia, Poland, Singapore, Thailand, Taiwan, USA.

For the region as Oceania, we don't have valid observations of listed firms locating. The large economy such as Australia is considered separately. Subsample of New Zealand has small number of firms. Estimation doesn't have the sufficient observations.

After these steps, we arrive to the 4 regions: Rest of Asia, Rest of Europe, Latin America, and Africa.

In summary, our world-wide sample contains 5 continents. Each continent contains the large countries within and the region of remaining area. Each region contains the countries of medium size and sub-regions of remaining area. Definitions of these geographic areas are in hierarchical relationships.

F.4 Sample Requirement

The sample requirement refers (Belo et al, 2022). Additional requirement for firm-level observations is included, to address the firm-level noise in economies of small sample. We decide the qualified firm-year observations following the criteria and procedure below: In the 1st stage, we require non-missing firm variables and nominal amount of capital stock surpassing the minimal threshold.

- We require non-missing and positive sale $Y_{i,t}$, previous-period sale $Y_{i,t-1}$, 2-period lagged sale $Y_{i,t-2}$, similarly for physical capital $K^P_{i,t}$ and intangible capital $K^I_{i,t}$.
- We require non-missing firm valuation $Q_{i,t}$ (equity valuation plus net debt value), investment rate in physical capital $i^P_{i,t}$, investment rate in intangible capital $i^I_{i,t}$, corporate income tax rate $\tau_{i,t}$.
- We require the physical capital greater than 1 million USD dollars, the intangible capital greater than 1 million USD dollars, to avoid the extreme firm-year observations among tiny firms.

In the 2nd stage, we exclude extreme firm-year observations based on the distribution of firm variables within each country.

- We require the change of firm sale $\frac{Y_{i,t}-Y_{i,t-1}}{Y_{i,t-1}}$ within the percentile $(2\%, 98\%)$ with respect to its country-year panel, to avoid the extreme firm-year observations.

- We require the firm size (physical capital and intangible capital together) within the percentile $(2\%, 100\%)$ with respect to its country-year panel, to avoid the high idiosyncratic noise among tiny firms. In particular, the firm size is required to be within the $(30\%, 100\%)$ with respect to its country-year panel among Japan and South Korea. We check the coverage of aggregate sale, physical capital and intangible capital, removal of tiny-small firms generates small impact. The firm size is required to be within the $(30\%, 100\%)$ with respect to its country-year panel in China, and the same requirement for the amount of intangible capital. This avoids the tiny firms especially the firms with tiny amount of intangible capital. The sample of China covers the main fraction in its aggregate sale, physical capital and intangible capital.

- We require the ratio of firm valuation $\frac{Q_{i,t}}{K^P_{i,t}+K^I_{i,t}}$ within the percentile $(2\%, 98\%)$ with respect to its country-year panel, to avoid the extreme observations of firm valuation in the left-tail and right-tail.

- We require firm-year observations with non-zero intangible investment rate in the current year and previous year. We remove abnormal firm-year observation reporting zero XSGA-expense in continuously recent two years (around 1%).

Aside from above general requirement of sample quality. We adopt country-specific requirement for countries with small size of sample, in Latin America, Africa, Western Europe and Eastern Europe.

F.4.1 Data Cleaning Statistics

Table C.23: Statistics of Sample Construction

This table reports statistics of constructing the sample for the benchmark estimation. Column (2) and Column (3) report the number of observations, the number of firms in the initial sample of data constructed with Compustat Global and Compustat North-America. Column (4) and Column (5) report the number of observations, the number of firms in the formal sample of data, after requirement of reporting XSGA, PPENT and other sample requirement. Description of sample requirement is in Appendix F. **Sale, Asset, Physical** and **Intangible** report the coverage of nominal dollar amount of sale, Compustat Item-AT, physical capital stock, intangible capital stock, during the 2nd stage of sample preparation, where extrene firm-year observations are excluded from the sample. All ratios are in percentage (%).

Country/Region	Sample Size				Coverage in 2nd-stage (%)			
	Compustat Sample		Qualified Sample		Sale	Asset	Physical	Intangible
(1)	(2) Obs	(3) Firm	(4) Obs	(5) Firm	(6)	(7)	(8)	(9)
China	64919	5668	23999	2733	80.32	77.95	91.96	83.46
Hong Kong	20977	1474	9966	1106	96.53	94.76	97.10	97.45
Indonesia	8121	652	4990	478	90.42	89.75	86.62	93.36
India	66824	3879	21309	2316	88.99	88.01	87.79	93.48
Japan	82035	4489	41668	2531	86.37	84.87	82.13	85.72
Malaysia	18959	1176	9190	930	94.48	93.74	94.96	95.94
Singapore	11966	811	5407	625	93.55	91.96	86.95	96.39
South Korea	21149	2185	9057	1114	94.43	93.18	96.40	94.49
Thailand	10533	713	7030	603	96.56	95.74	95.90	96.90
Taiwan	31682	2297	19640	1897	95.18	93.01	96.17	95.11
Rest of Asia	33722	2451	16272	1797	94.24	93.28	93.10	89.88
France	16354	1217	4622	535	94.10	92.75	94.22	96.85
Germany	16047	1112	5050	572	92.95	93.62	91.11	93.75
Poland	9773	829	3586	444	88.97	81.36	86.75	94.00
UK	40655	3313	15139	1855	94.47	94.96	94.91	95.81
Rest of Europe	65886	5256	22584	2750	95.45	93.50	93.76	96.07
Canada	39981	3621	10187	1382	96.56	94.18	96.53	94.06
USA	166234	15860	82283	8982	97.05	95.28	93.72	97.04
Latin America	16432	1136	7868	804	93.51	93.50	95.62	94.08
Australia	33676	2690	6130	1139	94.88	89.09	88.00	98.29
Africa	10977	754	4151	533	75.47	66.19	82.82	74.03

Table C.24: Statistics of Sample Construction for Other Countries within Regions

The table below reports the descriptive statistics of listed corporations for individual countries in the region of remaining area of each continent. Column (1) reports the name of the geographic area (region). Column (2) reports the country (or territory). Columns (3) to (10) report the statistics identical with Table C.23 for each country. Table continues in the next page.

Region	Country	Sample Size				Coverage in 2nd-stage (%)			
		Compustat Sample		Qualified Sample		Sale	Asset	Physical	Intangible
(1)	(2)	(3) Obs	(4) Firm	(5) Obs	(6) Firm	(7)	(8)	(9)	(10)
Africa	Cote Divoire	291	22	136	19	97.40	94.81	91.77	99.60
	Ghana	203	15	87	13	100.00	100.00	100.00	100.00
	Kenya	584	37	256	31	100.00	100.00	100.00	100.00
	Morocco	1060	60	519	50	97.80	98.46	99.57	97.46
	Mauritius	391	38	69	18	81.99	65.06	68.64	92.87
	Nigeria	1692	113	747	96	93.50	96.68	97.51	93.18
	Tunisia	676	49	362	42	81.26	80.89	79.99	79.08
	South Africa	5837	406	1919	252	69.50	57.34	76.11	68.43
Latin America	Zambia	243	14	56	12	95.93	95.53	94.63	68.18
	Argentina	1244	78	613	59	96.75	97.09	97.28	94.10
	Brazil	6146	432	2597	285	90.23	91.74	94.49	90.94
	Cayman Islands	858	123	269	72	92.19	78.67	84.84	85.73
	Chile	2832	152	1601	133	90.78	89.87	90.60	89.19
	Colombia	658	45	332	32	100.00	100.00	100.00	100.00
	Jamaica	514	50	205	30	99.74	98.16	99.75	99.43
	Mexico	2581	166	1362	114	97.50	96.37	98.25	98.15
	Peru	1599	90	889	79	96.74	96.85	97.93	98.08
Rest of Asia	U.A.E.	892	73	477	54	84.88	93.10	92.25	70.59
	Bangladesh	2149	218	781	129	96.88	91.82	96.23	91.91
	Bahrain	296	18	152	16	100.00	100.00	100.00	100.00
	Cyprus	1078	81	505	59	95.03	90.55	88.12	96.85
	Israel	7774	616	2617	356	89.01	82.50	70.10	88.05
	Jordan	2035	120	797	89	98.27	98.16	97.91	96.74
	Kuwait	1448	97	662	82	96.40	95.18	95.72	97.65
	Sri Lanka	3039	201	1580	152	78.81	89.27	93.80	84.84
	Oman	1086	69	570	51	85.98	90.71	96.26	92.68
	Pakistan	6044	348	2834	262	91.47	87.78	85.26	83.49
	Philippines	3133	182	1157	131	99.43	98.77	99.01	98.96
	Palestine	202	16	95	15	100.00	100.00	100.00	100.00
	Qatar	280	21	175	16	100.00	100.00	100.00	100.00
	Saudi Arabia	1963	161	1252	120	97.68	96.79	96.41	97.06
	Turkey	4751	352	2962	278	88.97	73.77	62.32	81.16
	Viet Nam	5326	494	2273	343	85.83	79.22	86.84	84.05

Table C.25: Statistics of Sample Construction for Other Countries within Regions (Table Continued)

Region	Country	Sample Size				Coverage in 2nd-stage (%)			
		Compustat Sample		Qualified Sample		Sale	Asset	Physical	Intangible
(1)	(2)	(3) Obs	(4) Firm	(5) Obs	(6) Firm	(7)	(8)	(9)	(10)
	Austria	1876	134	609	65	90.67	90.49	92.86	91.97
	Belgium	2615	175	870	98	97.45	98.99	99.43	99.06
	Bulgaria	741	68	304	45	89.57	81.21	75.09	88.13
	Switzerland	5160	320	2187	202	93.91	91.68	84.92	95.11
	Denmark	3477	270	1389	136	99.69	98.13	93.89	99.49
	Spain	3267	225	979	122	93.55	89.26	83.60	97.57
	Estonia	332	26	160	17	100.00	100.00	100.00	100.00
	Finland	3297	231	1075	129	96.15	94.25	90.06	97.82
	Greece	4369	294	2599	241	95.47	90.51	94.08	89.02
	Croatia	1336	92	560	65	94.18	91.69	87.77	93.73
	Hungary	458	41	190	21	100.00	100.00	100.00	100.00
	Ireland	2469	168	1076	99	97.88	94.57	89.97	97.33
	Iceland	295	25	80	12	100.00	100.00	100.00	100.00
Rest of Europe	Italy	5708	527	1728	254	93.43	91.54	94.23	93.40
	Lithuania	504	38	325	33	100.00	100.00	100.00	100.00
	Luxembourg	796	81	342	42	88.87	91.06	94.45	82.16
	Latvia	502	34	173	20	100.00	100.00	100.00	100.00
	Malta	233	20	60	13	100.00	100.00	100.00	100.00
	Netherlands	4232	307	1335	168	94.77	87.48	97.00	94.55
	Norway	4739	487	1105	183	94.25	86.05	90.37	97.73
	Portugal	1173	82	354	42	99.42	98.65	97.83	99.98
	Romania	1979	139	504	98	98.36	98.54	99.17	97.14
	Russia	2847	226	1169	165	99.66	99.62	99.63	99.52
	Serbia	251	38	114	20	100.00	100.00	100.00	100.00
	Slovenia	521	31	144	20	99.07	95.29	91.57	99.08
	Sweden	12428	1154	3036	420	95.25	95.43	94.49	95.81
	Ukraine	281	23	117	20	100.00	100.00	100.00	100.00