Information Technology, Multinational Premium and the Competition Premium*

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Abstract

I provide evidence on the impact of Information Technology and Foreign Competition on firms' profitability and equity valuations. Using an index of industry-level IT intensity, I uncover several empirical regularities in the cross section of equity returns over the past three decades: 1. Controlling for other commonly used factors, portfolios with exposure to industries with high IT intensity have on average 8-9% higher annual stock returns, suggesting industry-level IT intensity affects industry risk in a systematic way, 2. The risk premium are driven by firms in industries with a large presence of foreign multinationals, 3.These excess returns are not driven by High Tech sectors or the dot.com bubble. Building on the literature of Multinational Firms, I formalize these empirical regularities through a two-country general equilibrium model with industries that differ in the magnitude of multinational firms' competition and IT adoption. Multinational firms in the model and in the data, operating outside of their headquarters country, are large and more productive and as a result adopt IT to operate more efficiently. The productivity enhancements of multinational firms due to IT increases competition for domestic producers and displace sales of unproductive incumbents. This displacement risk is priced in the cross section. In particular, consistent with the model, the risk premium is higher for smaller domestic firms and the size-related risk premium is amplified in industries with a larger share of foreign multinationals.

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1 Introduction

The impact of commercial IT adoption in the United States and other developed countries has received renewed interest as these countries experienced a large increase in the share of large (multinational) firms, as measured using the sales share of top firms within industries or the entry of foreign multinationals in the United States. During the digital transformation of the past decades, the United States economy witnessed a large increase in sales of foreign multinationals. Firms engaging in foreign operations, enabled by lower communication frictions due to the IT revolution, entered new markets and expanded their operations.

Analyzing sales data of domestic and foreign firms across industries globally and in the United States, I show that the increase in the IT intensity of sectors at the national level is accompanied by a large increase of the sales share of foreign firms. The growth in large domestic and multinational firms undertaking large IT investments,[1] affects the level of competition faced by smaller less productive domestic firms[2]. These trends in IT adoption and the growing importance of large firms may affect the valuation of firms, due to a systematic exposure to more competition. This paper answers the question, is it true that differential costs in the adoption of IT across industries affects small firms negatively, due to displacement of their market share?[3] If so, how do lower IT costs affect investors and the valuation of public firms in these sectors? Can we use variation from readily available firms' segments statistics and different industries' occupational mix to understand the effect of IT on displacement and stock returns?

I contribute to the literature studying the impact of the IT revolution, first by providing evidence on the relationship of industry level IT intensity and foreign operations of multinational firms and second by showing empirically that the level of IT intensity of an industry systematically predicts a larger equity risk premium in the cross section. I rationalize the empirical findings by incorporating the decision to invest in IT and operate foreign establishments in a production based asset pricing model. Controlling for factors that may drive industry and cross sectional returns, I document that industries that use IT intensively have on average larger than 8-9% annual stock returns (depending on how the portfolios is formed) in excess of the returns of industries that do not use IT intensively and that this risk premium in increasing in the level of foreign competition. This fact is not sufficient to determine the pricing of industry risk faced by investors exposed to IT intensive industries and foreign competition. A model incorporating the decision to adopt IT by multinational firms is consistent with the evidence on the increasing share of foreign firms and provides testable

[1]Business software and big data centers are prominent examples of technologies with declining prices, enabling firms to expand geographically. The growth of such IT inputs in firms' production has been exponential. Software investments during this decade account for 18% of corporate investments, while they were only 3% in 1980 (BEA).

[2]IT investments are mostly implemented by large firms due to the presence of large fixed costs, and thus productivity gains from IT are not shared more broadly beyond the top firms. At least, in the first decades of the IT revolution. For example, similarly, in contemporaneous work, Bessen and Righi (2020) provides evidence that the share of the top 4 incumbent firms in an industry is larger in industries that use IT more intensively.

[3]See for example `https://www.schroders.com/de/sysglobalassets/digital/insights/2019/pdfs/2019_nov_rise-of-the-superstar-firms_cs2060.pdf` for a market analysis of the recent trends in concentration and their implications for investors.

implications that help pin down if the excess returns are due to higher risk of displacement of relatively less productive domestic firms. I test the predictions of the model and provide evidence that excess returns are even larger for smaller firms and more competitive sectors, consistent with a mechanism emphasizing the risk of displacement.

In detail, first I measure the level of IT intensity at the occupation level based on information of IT use in the description of different occupations. Then, I combine the occupation IT intensity with the employment intensity of those occupations across industries in the United States. In particular, I create a measure of IT intensity based on the description of occupations and the labor - occupation-composition in each industry using data from the U.S. Occupational Employment Statistics. Using this measure of IT intensity, which reflects the extend to with which industries employ workers that use frequently IT, I provide evidence on the impact IT has on foreign multinationals' market share globally and in the US, and public firms' profitability. I then explore the effect of IT intensity on asset prices. I sort stocks into five portfolios, based on the extend of the IT intensity at the corresponding industry each year, as measured by my index.[4] I find that an investment strategy with a long position in the high IT quintile and a short position in the low IT quintile had on average large annual excess returns the last thirty years. Investors command a risk premium of approximately 5% and a Sharpe ratio of 0.3. Controlling for common industry factors, these expected returns become larger than 8-9% [5], implying that common industry factors do not explain the sizable risk premium driven by IT intensity at the industry level.

Splitting the sample into manufacturing and service industries, removing industries related to the production of IT and high technology goods and excluding NASDAQ does not affect the impact of IT adoption on excess returns. Using different sub-samples over time shows that the risk premium remains significant over the sample period 1991-2010, with the exception of the period 2011-2019, implying that the nature of the risk related to IT adoption, may have changed in the recent decade. Lastly, I sort stocks both based on the extend of the IT intensity at the corresponding industry each year and the sales share of foreign firms at each industry and I find that the IT related risk premia are increasing in the level of concentration by foreign multinationals, as proxied by the top multinational firms market share at the industry level. Lastly, Using different sub-samples over time shows that the risk premium remains significant over the sample period 1991-2010, even during the period 2011-2019, implying that the nature of the risk related to IT adoption and MNE operations drives in part the IT related risk premia.

The empirical analysis raises the question: why are the excess returns related to IT increasing in the level of multinationals' market share, and why, in the absence of arbitrage, investors require higher premia for holding stocks in these industries? If IT amplifies the reaction of the sales share of large multinational firms in the US due to aggregate productivity shocks in the source country, this implies that the use of IT systematically affects the displacement risk for smaller, domestic only, firms within the more IT intensive industries. As a result, IT also systematically increases the risk

[4] The portfolios are formed according to quintiles of a measure of IT intensity.
[5] The size of the excess returns is large independently of the formation of the portfolio, equally or value weighted.

faced by investors holding equity in these firms. To investigate the economic mechanism driving the differences in risk premia across industries, I formalize this intuition developing a production based asset pricing model with endogenous multinational entry across two regions, and a choice for firms to use IT technology to enhance their productivity in a foreign country. I derive predictions for the effect of aggregate foreign and domestic productivity shocks on profits of small and large firms in the US, along with the effect on consumption and wealth effects that determine the discount factor. Based on the reaction of profits[6] and consumption to aggregate shocks, the model provides empirical tests that help identify how investors perceive the IT-related displacement risk. In particular, the difference in excess returns across industries with different IT intensity should be higher for smaller, domestic and less productive firms, which are the firms hit the hardest by foreign multinational operations. In addition, smaller firms' returns should be higher, when they are sorted in industries with both High IT adoption and large share of foreign multinationals. Using these model predictions, the empirical evidence are consistent with the production asset pricing theories emphasizing the risk faced by investors due to the threat of entry and competition (Barrot et al. (2019)).

The structure of the paper is as follows. Section 2 is a literature review. Section 3 introduces the data and the measurement strategy. Section 4 employs the IT intensity measure to document how IT adoption in production and management of firms affected the risk faced by investors. Section 5 introduces a production-based framework to provide an explanation of these facts, based on the recent discussion on declining local concentration. Section 6 uses the implications of the model along with the IT intensity measure to assess the mechanism of the model. Section 7 concludes.

2 Literature Review

This paper relates to three main strands of the literature. First, the paper relates to the extended literature that studies the IT revolution and its implications on product markets. In the international trade literature, a large number of papers document the importance of IT on the internationalization of firms. Keller and Yeaple (2013) provide evidence on the impact IT has on the organization of the international operation of firms.

Several recent papers in macroeconomics, document also the contribution of IT on the increase in sales concentration and profitability of large firms. Crouzet and Eberly (2020) show that intangibles affect the productivity of leading U.S. public firms. Bessen (2017); Bessen et al. (2020) find that sectors experiencing a greater increase in concentration use more intensively intangible capital and Information Technology. Firm-level evidence on how IT affects sales of firms by increasing scale economies at the firm level, is provided in Lashkari et al. (2020) and De Ridder (2020).

I contribute empirically to this literature relating the intensity with which IT is used across industries with the displacement risk for smaller firms and excess returns for investors, while I provide novel facts on the relationship of foreign multinationals' operations in the United States and the employment of IT intensive occupations across different industries. In addition, theoretically

[6] In the model, profits and dividends move one to one, since firms do not make dynamic decisions.

I model a two-country economy with firm heterogeneity and differential IT use at the industry level and test the theoretical asset pricing implications. In contemporaneous work, Aghion et al. (2020) present a model where the rise of IT complements managerial productivity, and thus ex-ante productive firms grow larger. In contrast, firms in my model grow larger because of productivity enhancements in operation of different establishments. Similarly, they emphasize how as IT becomes cheaper, firms become more likely to face productive competitors. In a similar vein, De Ridder (2020) shows that the IT revolution gains are concentrated among a small group of high-intangible firms, that grow larger.

There is a much smaller literature in Empirical Finance related to asset prices that this paper relates to, due to the emphasis on the risk faced by investors with exposure on industries with high IT intensity. This literature developed after the early waves of IT adoption and examines the asset pricing implication of IT capital deepening. Greenwood and Jovanovic (1999) claim that in the early years of the IT revolution, young firms gained competitive advantage due to differences in vintage capital and the lower adjustment costs they faced. Consistent with this view, Hobijn and Jovanovic (2001) provide empirical support, showing that the stock-market incumbents of the day were not ready to implement IT. As a result, entering firms that would bring in the new technology after the mid-1980s would displace incumbent firms. In contrast, I emphasize a different channel due to the adoption of IT by large firms and the profit displacement it caused to smaller domestic firms. The paper that is most closely related to mine is Chun et al. (2008). As in my empirical analysis, they show that traditional U.S. industries that use Information Technology (IT) more intensively have larger average firm-level stock returns. I complement these facts by analysing the relationship of IT and excess returns at a more dis-aggregated level than they do and empirically showing that the risk premia are not driven by unexpected events or pricing errors of investors, but by the displacement risk that smaller firms face in these industries. In addition, I provide evidence that the risk premia associated with IT are amplified by the level of foreign competition. In contrast to the mechanism put forth in my paper, they argue that the risk is driven by small and young firms adopting IT and displacing established incumbents. In contrast, I explore a mechanism where IT requires large operating costs and thus mostly large incumbents adopt adding more establishments and displacing smaller incumbents. Consistent with the model mechanism, I provide evidence that the IT risk premia are larger for smaller firms.

Last but not least, the empirical facts and the theoretical framework in my model is related to a fast-growing literature on competition, entry and asset prices at the intersection of finance and international macroeconomics. Examples of papers studying the implications of production across locations on asset prices, include Fillat and Garetto (2015b) and Fillat et al. (2015). These papers explore the cross sectional returns of firms in models that incorporate endogenous decisions by firms on whether to engage in multinational production, similar to the choice to operate multiple establishments in this paper. One of the main findings in these papers is that multinational corporations earn higher excess returns than non multinationals. This literature emphasizes the impact that the sunk costs of multinational entry has as a source of increasing riskiness for firms operating in multiple markets. In contrast, in my framework, production across locations leads to higher displacement risk for firms that have concentrated sales geographically, as the span of control for managers in large firms increases. In that sense, the paper is related among others with an emerging production asset pricing literature with emphasis on firm entry and displacement risk, see Loualiche (2020), Corhay et al. (2020) and Bustamante and Donangelo (2016). This literature shows that the risk coming from firm entry is priced in the cross-section of expected returns. In a recent and closely related paper, Barrot et al. (2019) focus on risks associated with import competition and find that firms more exposed to import competition command a sizeable positive risk premium. They create a methodology to uncover if the risk from globalization is priced positively or negatively by investors. I follow their methodology to show that the pricing of risk associated with the industry level IT intensity is negative and is related to displacement of smaller firms by large firms.

3 Data and Measurement

This section provides a short summary of variables used for the analysis of equity returns. More details can be found in the Appendix.

3.1 Firm-level Data

3.1.1 Measuring IT Intensity across industries

To analyse the impact IT had in the level of competition and displacement risk for smaller firms across industries in the United States, measures of Information Technology adoption at the firm level would be required. This would allow to have a measure of exposure to the differential adoption of Information Technology across industries using firm level variation. Such a measure[7] is not available for a large panel of firms in the United States. In addition, using firm level IT investment would lead to questions of reverse causality. This paper, following an extensive literature in International and Labor Economics, that employs occupation-level data (see for example Gallipoli and Makridis (2021)), provides a measurement strategy to account for the differential use of IT across industries, using the relative employment share of occupations within each industry that use IT more frequently. This measure is comprehensive and a viable alternative to firm level measures of IT adoption, if the identity of the adopter within an industry is not an issue.

The primary source used to measure the intensity that different occupations use IT is the O*NET survey. The O*NET survey is conducted by the U.S. Department of Labor and incorporates information on occupational tasks, skills, and work environment characteristics.[8]. The survey is a questionnaire trying to understand the importance and frequency of certain knowledge, skill or tasks in an occupation. For the measure of IT intensity at the occupation-task level, then I use the

[7]For example, prices of intangible inputs like software is not measured in observed financial and census data for United States in a systematic way for a large sample of firms.

[8]This survey has been used extensively in previous work to measure the risk of automation for workers across industries, or the risk associated with globalization (see for example Zhang (2019) measuring the routine intensity at the industry level, or Bretscher (2018) measuring the share of tasks that can be off-shored across industries)

product of the importance and frequency level to generate an overall intensity index for each task, knowledge, and skills within an occupation. Then, I classify certain tasks, skills or knowledge as IT-specific. I aggregate the task (knowledge,skill) - intensity at the occupation level to create an index of IT intensity at the five digit occupation level. [9].

This index is matched to the Occupational Employment Statistics (OES) national time series. These time series provide information on employment by occupation matrices which is used to create a measure of IT intensity at the industry level. In particular, I aggregate occupation scores at the industry level by their relative employment. This can be done since occupations in the OES data are measured at a five-digit level of aggregation, which is matched directly with the index constructed from O*NET. In particular, I aggregate occupation IT intensity, at the industry level as follows:

$$IT_{i,t} = \sum_j it_j \times \frac{\text{emp}_{i,j,t}}{\sum_j \text{emp}_{i,j,t}}$$

where $\text{emp}_{i,j,t}$ is the employment in industry i occupation j and year t from the BLS database. Lastly, $IT_{i,t}$ is standardized in each year, using z-scores, in order to account for aggregate time series trends in the use of IT, driven by the relative price of IT. Thus, the cross sectional variation I am using, captures the extend it which IT is adopted at the industry level within a year and not across years.

3.1.2 Foreign multinationals operations Data

The level of foreign competition at the industry level is calculated using sales (and employment) data from Segments data in Compustat for US (North American) firms and Worldscope for non US firms [10]. The segment data in Compustat and Worldscope are sourced primarily from firm disclosures of their sales/receipts in different regions. As a result, the data is information available to investors but there is a caveat compared to data obtained from confidential surveys on multinational firms by national statistical offices. In particular, in both Compustat and Worldscope, firms do not provide a country-level measure of their sales, but they choose to report individually either at the country level, region level (North America, South America, Europe, etc.) or a combination of the two. As a result across firms there is no systematic way to measure the sales value of each firm at the country level. Due to the disclosure of information of domestic segments in comparison to non domestic segments, it is possible however to determine the value of non domestic sales,i.e. sales associated with foreign operations.

[9]The Appendix describes in detail this process. In addition in the Appendix, I complement the analysis presented in section 4 using other measures based on measures of IT intensity, based on a 0,1 IT score of an occupation, i.e. an occupation would be identified as either being related solely to IT or not. The measure of IT intensity is highly correlated with IT investment data and the size of industry level IT employment.

[10]A large literature in Economics and Finance refers to Worldscope Fundamental data as Datastream Fundamental (see Dai et al.(2021)). In addition, the segments data in Wordscope is comparable to FactSet Revere Geographic Exposure data(see Bae et al. 2019), since the data in Factset are based primarily on Worldscope(see Dai(2012): "In 2008, FactSet acquired a copy of Worldscope and a forwarding right of reuse to develop and brand it as FactSet Fundamentals (FactSet). Due to this twin feature, the FactSet Fundamentals database shares a great deal of similarity with the Thomson Reuters' Worldscope.").

Although, there is no systematic information on sales of firms in specific countries, I outline a systematic approach I have followed to use data on geographic segment information on sales from this global sample of firms over the period 1991â2019 to calculate measures of industry-level multinational firms operations in the United States and globally. In particular, the level of multinational operations for all firms in the sample, is calculated as the sum of segment sales, excluding the value of sales related to a domestic segment or sales associated with inter segment, inter firm, sales. Many of the firms do not disclose sales in the segment data or they only disclose positive sales for the domestic market. These firms are treated as purely domestic, while firms with positive sales in geographic segments other than the domestic market are treated as multinational firms. In addition, using the names of geography segments, I classify segments as US segments if they are associated with United States or North America and as non US segments, if not. [11] The result of this process is a derived dataset for all firms in the Compustat and Worldscope samples, with information on multinational operations, and sales figures at the firm level, foreign sales figures and sales in the United States (independently of the location of headquarters of the firm). [12]

I measure foreign competition, by the multinationals' sales share, at the global level and in the United States market, using the segments data descibed above. The main measure used to form indices of foreign competition at the industry level (4-digit sic classification) globally and in the US domestic market is defined generally as:

$$\omega_{it}^{F} = \sum_{f \in F(i)} \frac{\text{sales}_{\ ft}}{\text{Total Sales}_{\ it}} = \sum_{f \in F(i)} \frac{S_{ft}^{F}}{S_{it}}$$

where $F(i)$ denotes the set of either, top 4 multinational firms[13] operating in a industry i (4-digit SIC) and S_{ft}^{F} their total sales associated with the firms' foreign operation in industry i and S_{it} is the value of total sales in industry i.

Observe that this measure corresponds to the relative share of sales of top firms that are classified as sales associated with foreign operations compared to the size of sales at the industry. It does not correspond to measures of competition in the literature, since those are the sales of top firms irrespective of them being multinational firms or not, but it provides a measure of the relative

[11] In what follows, I treat all firms in the North American Compustat sample, located in the US or Canada, as operating in a domestic single market, North America and I use the words US and North America interchangeably. Many segments sales are reported as aggregates in combination of markets in North America and other regions, e.g. Mexico. In that case, I allocate sales in the North American segment based on the size of the NA region relative to the other regions included in the segment. See Appendix for more details.

[12] In the online Appendix, the measures of multinational firms' operations calculated from the combined segments data from Compustat and Worldscope are compared at the industry level to the same measures calculated using sales and employment data from the FDIUS data (BEA's surveys of foreign direct investment (FDI) in the United States) and USDIA (BEA's surveys of foreign direct investment (FDI) by US owned multinational firms). The published FDIUS database report data on the sales among other statistics at the primary industry (approximately 3-digit SIC code or 4-digit NAICS code) for foreign multinational firms operating in the US for each year from 1977 through 2018. I combine this information with information on the sales of all firms across industries in manufacturing and services from BLS Multifactor productivity (MFP) database and I create measures of the foreign market share in the United States across industries.

[13] Based on the size of their foreign operations.

importance of multinational operations in an industry. Closer to measures of foreign competition, I have constructed measures of foreign firm sales shares $\omega_{it}^{F,US}$ at the 4-digit SIC level for the United States similarly as before:

$$\omega_{it}^{F,US} = \sum_{f \in F^{US}(i)} \frac{\text{sales}_{ft}^{US}}{\text{Total Sales in the US}_{it}} = \frac{S_{it}^{F,US}}{S_{it}^{US}}$$

where in contrast to the global measure, $F^{US}(i)$ is the set of the top 4 foreign owned firms in the United States economy [14], $S_{ft}^{F,US}$ their total sales associated with the firms' foreign operation in industry i in the United States and S_{it} is the value of total sales in industry i in the United States. This is closer to measures of competition, calculated for the United States, using Compustat or Census data, with the exception that the sales of top 4 (or 20 in the Online Appendix) firms are the sales of the top 4 firms with headquarters not in the North American region. As a result in what follows I often use the following notation to show $\text{CR}_{4,it}^{US,F}$ that this measure corresponds to a concentration ratio, with the superscript F to distinguish it with $\text{CR}_{4,it}^{US}$ a measure of concentration, where the top 4 firms are picked independently of if their Headquarters are in the United States or elsewhere.

The purpose of these measures is to study how large are the operations of multinational firms in an industry, compared to the size of the industry. They provide a measure as it will be described below of the level of displacement risk faced by purely domestic firms in the event of a positive productivity shock to multinational firms. To explore the correlation of the IT intensity of an industry and the intensity of multinational firm operations', I merge these measures using the 4-digit SIC classification. I complement the data at the industry level, with balance sheet and equity returns data. as described below.

3.1.3 Financial and Accounting Data

For the empirical analysis of returns across industries, I use monthly stock prices for US public firms from the Center for Research in Security Prices (CRSP) and annual balance sheet information from Compustat. The sample of firms includes all NYSE-, AMEX-, and NASDAQ-listed securities that are ordinary common shares (with share codes 10 and 11) for the period between January 1991 and December 2019. Following the empirical finance literature, firms in highly regulated (SIC codes between 4900 and 4999) industries and financial (SIC codes between 6000 and 6999) firms are excluded from the sample. I also exclude observations with negative or missing sales and book assets. Firm-level accounting data and returns are winsorized at the 1% level in every sample year. All nominal variables are normalized at the price level of 1991, using a standard GDP price deflator. Historical segment data and foreign income information is used from COMPUSTAT to classify firms as conglomerate and multinational firms, similar to Fillat and Garetto (2015b).

Finally, I construct the following data on stock characteristics from the CRSP-Compustat merged

[14] Based on the size of their operations in the US

database. Market Equity(ME) is the average portfolio market capitalization over the sample period converted into 1991 constant billions dollars. BE/ME is book-to-market equity, defined as book value of equity (item CEQ) divided by market value of equity (item CSHO $\times$ item PRCC_F). Return on assets (ROA) is defined as operating income after depreciation and amortization (item OIBDP−item DP) divided by total assets. I/K is capital expenditures (item CAPX) divided by property, plants, and equipment (item PPENT). Market leverage is total debt (item DLC + item DLTT) divided by the sum of total debt and market value of equity. A detailed overview of the variable definitions can be found in the Appendix. In addition to stock returns, I use data on analysts' annual earnings forecasts from the Institutional Brokers Estimates System (I/B/E/S) database. [15] These data will be used to form equally and value weighted stock portfolios of firm equity returns based on the level of IT intensity and the foreign market share (in the previous year of operation) in firms' main industry operation.

3.2 Summary Statistics

Table 1 in the Appendix provide summary statistics related with the measure of IT intensity, along with characteristics of the firms and information on the share of foreign firms in the United States using segment data. The table confirms that there is a relationship of IT with operating costs of firms. In particular, firms that each year operate in industries with higher IT intensity are those with a higher share of administrative and operating costs on sales and a lower share of cost of goods sold over sales. The level of IT intensity, within manufacturing industries, is unrelated with other industry characteristics such as the level of labor reallocation, industry employment, or value added calculated using the data from the BLS-Multi Factor Productivity database, obtained from the Dispersion Statistics data [16]. The only notable difference across industries, other than the share of administrative costs in firms' total costs is the share of foreign operations and the share of IT specific employees, where IT occupations are defined as occupation that in their description they mention the words "computers", "information" or "communication", in other words in these industries there is a larger share of firms with IT departments and a larger share of sales is done through FDI and foreign operations.

Lastly, in Figures 1, and 3 in the Appendix, I plot the average level of the foreign sales shares of industries with different levels of IT intensity (High and Low) . It is confirmed by these graphs that industries with high IT intensity tend to be the ones that consistently have the largest foreign firms' sales share over the past 30 years. In particular, the sales share, of segments defined as foreign, is higher irrespective if the market is defined globally or we concentrate on firms' segments associated with the United States economy. In addition, the foreign segments' sales share is higher for both manufacturing and services industries, as seen in 2 and 4, Overall, the summary statistics present a picture where industries with a higher level of IT intensity tend to be dominated by large multinational firms and firms within these industries have large shares of operating costs, and a lower

[15] Earnings and forecasts are all split-adjusted.

[16] The data are available here: https://www.bls.gov/lpc/productivity-dispersion.htm

level of production costs in their sales, consistent with IT requiring large fixed cost investments.

4 Empirical Evidence

In this section, the empirical results related with IT intensity and asset prices are presented. First, it is documented that average portfolio excess returns are increasing in the use of IT intensity across industries. To do so, equally-weighted and value-weighted stock portfolios are formed based on quintiles of IT intensity in the previous year.[17] Second, the returns are analysed across different subsamples of the data and it is documented that the effect of IT intensity is not driven by High Tech industries, the inclusion or not of public firms with stocks traded in NASDAQ and is not concentrated in manufacturing industries. In addition, it is not driven by multinational firms or by manufacturing industries with lower shipping costs, and thus is not driven by the increasing threat of foreign competition due to trade and the China shock. Lastly, I show that the risk premia are increasing in the level of foreign competition as measured by the average, across products, employment share of foreign firms (FCI).

4.1 Portfolio Analysis

For each year, I assign industry IT intensity in the previous year to each individual stock based on each firm's industrial classification, where industries are defined at a consistent way across years at the 4-digit NAICS level between 1991 and 2019 [18]. In addition, I follow Zhang (2019) and Bretscher (2018) and calculate unlevered returns as

$$r_{i,t}^{un} = r_t^f + \left(r_{i,t} - r_t^f\right) \times (1 - lev_{i,t-1})$$

where $r_{i,t}$ are the stock returns of firm i each year-month t and $lev_{i,t-1}$ is the leverage ratio[19] of the firm the year ending before the month when the different portfolios are formed. In every year, I sort industry returns into five portfolios based on IT industry quintiles. Finally, the industry returns of each portfolio are reported either equally- or value- weighted. The weights assigned to compute the portfolios are based on market capitalization. In the analysis below, industry excess returns and excess returns are used interchangeably.

Table 2 summarize the excess returns along with other characteristics of firms of the 5 portfolios formed based on the level of IT intensity across industries. Without controlling for other factors, there is a 5 percent return premium and 0.3 sharpe ratio, for a zero cost portfolio which is long the firms in industries with high IT intensity and short the low IT intensity industries. Table 3

[17] The fact that the quintiles are measured each year implies that the industries are sorted across different quintilies every year. As is common in the empirical asset pricing literature, I apply this method to make sure that I measure the exposure of investors on IT adoption in the cross section of stock returns. If an industry changes quintilie of IT intensity in a year, then it should belong on a different portfolio.

[18] I use the industry correspondence tables developed by Eckert et al. (2199).

[19] The leverage ratio of the firm is defined as the book value of debt over the sum of book value of debt plus the market value of equity at the end of year.

summarizes the excess returns related to the use of IT intensity across industries. The table reports the equally- and value-weighted excess returns of the five portfolios, where the last column H-L represents the portfolio consisting of industries which is long the firms in industries with high IT intensity and short the low IT intensity industries, while the first 5 columns represent the 5 portfolios that consist of firms sorted in the 5 different quintiles. As is common in linear factor regression models, to make sure that the spreads do not reflect the differential exposure of industries to other risk factors that are unrelated to the ability of firms across industries to employ IT, the estimated regression includes several commonly used factors and developed by Fama and French in a series of papers. The two panels report the results for a five and a three factor model.

In each table, the first row is associated with the α of each portfolio. The estimated alphas for the different industry quintiles do show a monotonic pattern for both equally- and value- weighted returns. Moreover, the strategy of investing in the high IT intensive firms, and going short the low IT intensive firms yields irrespective of the weighting method statistically significant α. Firms operating within industries with high intensity in the use of IT have on average large equally-weighted and value-weighted annualized monthly excess returns, 6-9 percent, while industries that correspond to the low IT intensive industries do not have statistically significant α. The corresponding excess returns are large independently of the measure of IT intensity. [20] Overall, t-tests using Newey-West standard errors confirm that the H-L spread is statistically significant both in equally- and value-weighted portfolios.

Robustness Table 4 in the Appendix reports the excess returns of the HL portfolio when the sample is restricted in industries/firms with specific characteristics. The excess returns (α) of the portfolio are calculated based on a 5-factor model, as described in the previous section. In particular, one may worry given the emphasis on IT, these differential returns are driven by the High Tech giants or by the firms traded in the NASDAQ index and is thus associated with the technology bubble of the early 2000s. When I restrict the analysis to firms with stocks not traded in NASDAQ or those firms that are associated with the production of IT and High Tech products.[21] the returns across the different portfolios still yields irrespective of the method (value-weighted or equally weighted) a statistically significant positive return (see row $\alpha_1 - \alpha_3$).

In the online Appendix, I confirm that the expected returns follow almost identical patterns, if one uses a different labor based measure of IT intensity. In particular, using the industry-occupation matrices provided by the Bureau of Labor Statistics, I measure IT intensity across 4-digit SIC industries, as the share of workers in an industry that work in occupations, that in their occupation titles contain the words: "Computer", "Software","Communication" and "Information". This narrower measure is then used to construct portfolios similarly to the methodology described above. The same patterns arise using this measure instead.

[20] These results are confirmed in robustness tests where IT intensity is based solely on the share of employees on purely IT related occupations.

[21] The industries are defined as High Tech based on their industrial description and a set of keywords associated with the use of Information Technology: "software", "communications", "internet", "telephone", "computer",...

IT intensity and multinational operations in the United States In this section, I relate the IT premium to the risk of being displaced by large multinational competitors similarly to the trade related displacement risk emphasized in Barrot et al. (2019). Intuitively, due to the effect of IT on communication frictions and the effect on the expansion strategy of large firms, emphasized in the literature in international economics, industries with a larger intensity of IT, will be dominated by large multinational firms. This makes smaller firms more vulnerable to movements in foreign productivity.

Motivated by the evidence in the literature on IT and multinational firms (see Bloom et al. (2012)), I examine how the results on the premia related to IT are affected by the level of foreign competition. Table 5, reports conditional double sorts on foreign penetration and IT intensity. I find that the HL α increases with foreign firms' market shares which is consistent with the interpretation that the ability to use IT is affecting risk faced by investors more, in industries that are exposed to foreign competition from multinational firms.

A potential concern, given the emphasis on multinational firms' operations could be that the differences in returns across industries with different IT intensity are driven by differential exposure of risks in foreign exchange markets and they are not due to differences in the structure of product markets. To address this concern, I re-estimate the specification three times, every time including both the 5 Fama-French factors and either the dollar factor, the carry factor (both from Verdelhan (2018)) [22] or the excess return of high interest rate currencies minus low interest rate currencies (from Lustig et al. (2011)). The inclusion of FX-factors does not change the results (see Appendix Table 6): the IT premium is positive and statistically significant independent of the inclusion of other risk factors. In addition, the level of excess returns in manufacturing industries is not affected, by the inclusion of the trade related displacement risk factor emphasized in Barrot et al. (2019).

Expected returns versus ex-post realized returns. In this section, given the unexpected nature of technological progress across industries that have different levels of IT adoption, I deal with the potential concern that the observed excess returns across the different IT quintiles could be due to unforeseeable components, related to the IT revolution and the effects uncertainty had on the performance of firms. Technological uncertainty would mean that these returns may be driven by the different investors' perceptions of the evolution of those industries and not due to the threat of entry of multinationals. This then implies that the excess returns would be related with pricing errors and would not reflect systematic displacement risk faced by equity holders of those firms. In Tables 7 and 8, the evidence imply that the excess returns are not driven by pricing errors due to the fact that first the returns of the high and low IT portfolios are not concentrated around earnings announcements and so the information re-veiled in those announcements did not cause a large change in the perception of investors, and second as can be seen in equity analysts forecasts', analysts correctly estimated the effect that IT intensity had on firms earnings per share between 1991 and 2019.

[22] When I include the carry factor, the returns of the HL portfolio increase, this is due to different sample selection (exluding years close to 2019)

Subperiods Table 79 reports the results of the portfolio sorts for different time subsamples. The results are given for value-weighted returns. The returns remain large across the subsamples 1991-2000, and 2001-2010, with the exception of the period 2011-2019, where the risk premia change sign. A cleared pattern arises looking at figure 5. This figure plots the monthly evolution over time of a dollar invested in the value-weighted H-L portfolio. Cumulative returns are high during the 90s until the burst of the bubble, but they recover fast until 2010. After 2010, there is a drop in excess returns, but overall during the sample period, the portfolio has sizable excess returns.

5 Theory

This section describes a two-country general equilibrium model of multinational production with firm and industry heterogeneity, as in the theory developed by Helpman et al. (2004), augmented to include dynamics as in Barrot et al. (2019). The model economy consists of two countries. The firms have headquarters in one of the two countries. Firms differ in their idiosyncratic productivity, which is fixed, and in addition each country is affected by aggregate productivity shocks. This means the two countries are different in the pool of establishments operating in the domestic economy(in terms of productivity). Firms may operate establishments across both countries and supply goods locally.

In each country, there is a representative consumer. The consumer enjoys the consumption of goods supplied by establishments locally. The model abstracts from trade in differentiated goods, and thus all local consumption across sectors is being produced by either firms headquartered in the domestic market or branches-establishments of firms from a different country. There is establishment exit and entry across periods, due to fixed costs of operating establishments in a foreign country. Productivity of these establishments is impacted by borders. If a firm wants to operate in a country, not where its headquarters is located, it has to transfer technology in the foreign country, which in the model will affect firm productivity and so productivity differs across establishments of the same firm. These efficiency costs associated with multinational productions may be reduced if a firm adopts IT in each period by paying a fixed cost and thus the firm trades off the efficiency gains of IT with a fixed cost of employing IT. Modelling these efficiency costs, thus links this model with theories of multinational production as in Cravino and Levchenko (2017).

The basic description of the model is provided in the next Section, then predictions about the relation of IT fixed costs and IT intensity across industries are derived, along with predictions on the effect of higher IT adoption at the industry level on asset prices, profits and industry risk. Lastly, the empirical facts presented in the last section are compared with the predictions of the model and new model-based empirical tests are presented.

5.1 Demand Side

The model consists of two countries. The two countries will be referred as “home” and “foreign”. The “home” country will represent the United States and the “foreign ” country will represent the Rest of the World (ROW). These countries face aggregate “home” and “foreign” shocks. In what follows, I denote variables in the "foreign" country by *. Each country is populated by infinitely lived, atomistic households of measure L and L^*. Households maximize a continuation utility J_t over sequences of the consumption index C_t,

$$J_t = \left[(1-\beta)C_t^{1-\psi} + \beta\left(\mathrm{R}_t\left(J_{t+1}\right)\right)^{1-\psi}\right]^{\frac{1}{1-\psi}}$$

where β is the time-preference parameter, ψ is the inverse of the inter-temporal elasticity of substitution (IES) and

$$\mathrm{R}_t\left(J_{t+1}\right) = \left[\mathbf{E}_t\left\{J_{t+1}^{1-v}\right\}\right]^{1/(1-v)}$$

is the risk-adjusted continuation utility, v the coefficient of relative risk aversion.[23]

The aggregate consumption bundle in each region is given by C_t[24]. The consumption bundle is an aggregate of individual consumption of goods produced in each of the $\mathcal{J}+1$ sectors. Sector 0 provides a single homogeneous good, as in Chaney (2199). The other $\mathcal{J}$ sectors are made of a continuum of differentiated goods. If quantity c_0 of the homogeneous good is consumed, along with $c_J(\omega)$ units of each variety ω in sector J, the consumption aggregate is given by:

$$C = c_0^{1-a_0}\left[\sum_J \left(\int_{\Omega_J} c_J(\omega)^{\frac{\sigma_J-1}{\sigma_J}} d\omega\right)^{\frac{\sigma_J}{\sigma_J-1}\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}a_0}$$

where $0 < a_0 < 1$ represents the expenditure share on the differentiated goods sector, $\theta > 1$ is the elasticity of substitution across sectors, σ_J is the elasticity of substitution across varieties within asector J (which is assumed to be higher than θ) and Ω_J is the set of establishments producing in the domestic economy in sector J, which is determined in equilibrium. Households get revenues from their inelastic labor supply in quantity L and from ownership of a mutual fund that redistributes profits of both "home" and "foreign" firms. Their budget constraint is then given by:

$$p_0 c_0 + \sum_J \int_{\Omega_J} p_J(\omega)c_J(\omega)d\omega \leq wL + \Pi$$

where $p_J(\omega)$ is the price of variety ω in industryJ, w is the wage, and Π is the profit redistributed to domestic consumers through ownership of the equity shares.

5.2 Supply Side

The homogeneous good 0 is freely traded and is used as the numeraire in each region. It is produced under constant returns to scale with one unit of labor producing 1 units of good and its price is set equal to 1.[25] This assumption greatly simplifies the discussion of the model and its implications

[23] In the case of time-separable preferences with constant relative risk aversion (CRRA), the IES is equal to the inverse of the coefficient of risk aversion. The only role of Epstein and Zin (1989) preferences is to allow for a separate role of the IES and the coefficient of risk aversion in the calibration exercise.

[24] In the description I remove the t subscript from any static choice that follows, for notational simplicity.

[25] This assumption is made so that the two regions have the same level of wages. More generally one can assume that one unit of labor produces w units of good, in which case the wages differ across regions. This assumption is

but it is not crucial for the results.

5.2.1 Differentiated Varieties

Each firm in the differentiated sectors $J \in \mathcal{J}$ produces a variety ω. The quantity produced is denoted $q_J(\omega)$. Production of goods requires labor inputs. Labor is the only factor of production in the model, and its use by a firm producing variety ω is $l_J(\omega)$. Firms are heterogeneous in productivity and produce each variety with an efficiency parameter denoted by φ. This productivity is the firm's idiosyncratic efficiency at the headquarters' country. Idiosyncratic productivity at HQ is fixed overtime but is randomly assigned across firms. As in Helpman et al. (2004), the distribution of idiosyncratic productivity in each industry is Pareto with tail parameter $\gamma_J > \sigma_J - 1$. The probability of a firm's productivity being below a given level φ in industry J is $Pr\{\tilde{\varphi} < \varphi\} = G_J(\varphi) = 1 - \left(\varphi/\underline{\varphi}_J\right)^{-\gamma_J}$. The lower bound of idiosyncratic productivity for sector J is $\underline{\varphi}_J$. A larger γ_J corresponds to a more homogeneous sector, in the sense that more output is concentrated among the smallest and least productive firms.[26] Each country is also characterized by an aggregate productivity parameter, that is denoted by A_t. Hence, a local firm with idiosyncratic productivity φ produces $A_t\varphi$ units of variety ω per unit of labor in year t. Productivity in each region, (A, A^*), follow an AR(1) process as follows, $\log A_{t+1} = \mu_A + \rho_A \log A_t + \varepsilon^A_{t+1}$ and $\log A^\star_{t+1} = \mu_{A^*} + \rho_{A^\star} \log A^\star_t + \varepsilon^{A^\star}_{t+1}$. [27]

5.2.2 Firm establishments

Firms may operate establishments on both their headquarters country and the "foreign" country. Operations of an establishment located in a foreign country requires that the firm pays an operating fixed cost f_J measured in "domestic" labor efficiency units paid every period. Given fixed costs of entry, this determines a firm-specific threshold productivity level below which firms do not operate establishments, other than the HQ. This threshold moves around with aggregate economic conditions. The second assumption in contrast to models with sunk costs, is that this cost makes the operation of a second establishment a period-by-period decision.

I provide now details related to the adoption of IT and the efficiency costs of operating an establishment in a different country. In particular, the efficiency losses in equilibrium will be given by $\exp(-\kappa \mathbb{I}_a(\varphi \geq \underline{\varphi}_{ITJ}))$ where $\mathbb{I}_a(\varphi \geq \underline{\varphi}_{ITJ})$ determines if firm productivity is above of below the cutoff of IT adoption by a firm. In particular, the efficiency costs are zero, if a firm adopts IT and κ otherwise. This means, the firm each period can increase its "foreign" productivity, but this requires a fixed cost f_{ITJ} that differs across sectors. When deciding whether or not to adopt IT, firms trade off benefits from lower efficiency costs against higher operating costs. Operating costs

extended in the Appendix and will not affect the results of the paper.

[26] The assumption of a Pareto distribution for productivity induces a size distribution of firms that is also Pareto, which fits well the empirical distribution.

[27] There are different levels of productivity across countries, due to the differences in the mean of aggregate productivity, μ_A and μ_{A^*} and shocks ε^A_{t+1} and $\varepsilon^{A^*}_{t+1}$. Most theoretical predictions are derived with respect to a shock in a "foreign" location on "domestic" firms.

are associated with the costs of creating, for example, an IT services office that provides support to the main function of the firm.[28]

5.2.3 Profits

Establishments set prices under monopolistic competition. Given a constant elasticity of substitution, prices are a constant markup over marginal cost. An establishment of a firm with productivity φ sets the following price if it operates in firms' headquarters:

$$p_J(\varphi) = \frac{\sigma_J}{\sigma_J - 1}/(A\varphi)$$

and the following price when it does not operate in firms' headquarters:

$$p_{NJ}(\varphi) = \frac{\sigma_J}{\sigma_J - 1}/\left(A^{1-\zeta}A^{*\zeta}\varphi\exp(-\kappa\mathbb{I}_a(\varphi < \underline{\varphi}_{ITJ})\right)$$

The productivity of establishments in the two different countries differ by assumption. In particular, the establishment productivity is a weighted average of the productivity of the firm at the headquarter's country $A\varphi$ and at the establishment location $A^*\varphi$. Under the assumption that $\zeta = 0$ the establishment inherits the productivity of the firm at the headquarters [29] $A\varphi$ with an efficiency cost $\exp(\kappa\mathbb{I}_a(\varphi < \underline{\varphi}_{ITJ}))$. This cost represents costs of technology transfer or more generally any efficiency losses due to managing an establishment in a distant environment. Efficiency costs depend on the IT decision, given by the indicator function $\mathbb{I}_a(\varphi \geq \underline{\varphi}_{ITJ}) = 1 - \mathbb{I}_a(\varphi < \underline{\varphi}_{ITJ})$.[30] In what follows, I will be using the following expression for prices set by domestic multinational firms in the "foreign" country:

$$p_{NJ}(\varphi) = K_J(\varphi)p_J(\varphi),$$

where

$$K_J(\varphi) \equiv \exp(\kappa\mathbb{I}_a(\varphi < \underline{\varphi}_{ITJ}))$$

Firms earn total profits $\pi_J(\varphi)$ from their sales of establishments in the "home" country, and if they operate in the "foreign" country they earn $\pi_{NJ}(\varphi)$ in profits. Sales in the "home" region do not require a fixed cost of investment. Thus, profit functions are defined as:

$$\pi_J(\varphi) = \frac{1}{\sigma_J}\left(\frac{p_J(\varphi)}{P_J}\right)^{1-\sigma_J} P_J C_J$$

where P_J is industry's J price index and C_J is the industry composite good, aggregated from the set

[28] Alternatively, these costs can also represent any intangible fixed investment that increases the ability of firm to expand geographically. Allowing firms to choose the production location and decide whether or not to trade from the HQ location is realistic but increases model complexity substantially and is not relevant for the interpretation of the results.

[29] This assumption is made for simplicity here presenting the theoretical results. In the Appendix of the paper, a more general specification of the productivity process $(A\varphi)^{\zeta}(A^*\varphi^*)^{1-\zeta}$ is used as in Cravino and Levchenko (2017)

[30] The IT adoption dummy $\mathbb{I}_a(\varphi \geq \underline{\varphi_{ITJ}})$ equals 1 when the firm adopts IT and 0 otherwise.

of differentiated goods. Profits from the second establishment are calculated after operating costs, which include the cost of operating IT, if the firm chooses to do so[31]. Hence, the level of profits of a second establishment are given by:

$$\pi_{NJ}(\varphi) = \frac{1}{\sigma_J} \cdot \left(\frac{p_{NJ}(\varphi)}{P_J^*}\right)^{1-\sigma_J} \cdot P_J^* C_J^* - \frac{f_J}{A} - \frac{f_{ITJ}\mathbb{I}_a(\varphi \geq \underline{\varphi}_{ITJ})}{A}$$

Profits from operating a second establishment are increasing in idiosyncratic productivity, and hence there exists a productivity cutoff in each industry under which a firm decides to create a second establishment. Similarly, there is a cutoff related to the decision to adopt IT. I make the relevant parametric assumptions such that the cutoff for IT adoption is always larger than that of operating a second establishment.

5.2.4 Decision to operate internationally and adopt IT

In this section, I describe the cutoffs that determine the decisions of the firms. I define the following cutoff level for firms that operate a second establishment in a foreign country as

$$\underline{\varphi}_{NJ} = \min_{\varphi}\{\varphi \mid \varphi \text{ implies that firm is operating in a foreign country}\}.$$

Similarly, for firms that choose to use IT, I have:

$$\underline{\varphi}_{ITJ} = \min_{\varphi}\{\varphi \mid \varphi \text{ is adopting IT}\}.$$

I impose the relevant restrictions such that there is always a positive mass of firms, operating a second establishment but do not adopt IT. The derivation of cutoffs for IT adoption and for multinational production is included in the Appendix. A very useful property in models where productivity is drawn from a Pareto distributions, is that relative ratio of the cutoffs of firms adopting IT and being multinational will be constant. In particular, the two cutoffs satisfy:

$$\underline{\varphi}_{ITJ}/\underline{\varphi}_{NJ} = \left(\frac{1}{\exp(\kappa)^{\sigma_J - 1} - 1}\right)^{1/(\sigma_J - 1)} (f_{ITJ}/f_J)^{1/(\sigma_J-1)} \equiv \Gamma_J$$

The relevant parametric assumptions are imposed to ensure that $\Gamma_J > 1$. From the expression above, it is evident that the two cutoffs move proportionally with the fluctuations in the economy which is an important property useful to derive the analytical results below.

Instead of keeping track of the distribution of productivity and prices, it is sufficient for the analysis of the aggregate economy and asset prices to keep track of the average productivity of the three different groups of firms. First for the whole domestic market, the average productivity of producers is $\bar{\varphi}_J$, second for the subset of firms with two establishments it is $\bar{\varphi}_{NJ}$ and third for the subset of firms that adopt IT $\bar{\varphi}_{ITJ}$. These quantities are sufficient to define the equilibrium and

[31] By assumption, then, the firm will IT only if the firm runs a second establishment.

are given by:

$$\bar{\varphi}_J := \left[\int_{\underline{\varphi}_J}^{\infty} \varphi^{\sigma_J-1} \mathrm{d}G_J(\varphi)\right]^{\frac{1}{\sigma_J-1}} = \nu_J \cdot \underline{\varphi}_J$$

$$\bar{\varphi}_{NJ} := \left[\int_{\underline{\varphi_{NJ}}}^{\infty} \varphi^{\sigma_J-1} \mathrm{d}G_J(\varphi)\right]^{\frac{1}{\sigma_J-1}} = \nu_J \cdot \underline{\varphi}_{NJ}$$

$$\bar{\varphi}_{ITJ} := \left[\int_{\underline{\varphi_{ITJ}}}^{\infty} \varphi^{\sigma_J-1} \mathrm{d}G_J(\varphi)\right]^{\frac{1}{\sigma_J-1}} = \nu_J \cdot \underline{\varphi}_{ITJ}$$

where ν_J, the average of firm productivity under a Pareto distribution, is given by $\nu_J = \left(\frac{\gamma_J}{\gamma_J-(\sigma_J-1)}\right)^{\frac{1}{\sigma_J-1}}$ and depends only on the elasticity of substitution, and the tail parameter of the productivity distribution. Observe here that given the fact that

$$\underline{\varphi}_{ITJ}/\underline{\varphi}_{NJ} \equiv \Gamma_J$$

then the average productivity of firms is also proportional and it satisfies:

$$\bar{\varphi}_{ITJ}/\bar{\varphi}_{NJ} \equiv \Gamma_J.$$

The fraction of firms operating multiple plants is denoted by ζ_{NJ} and the fraction of firms adopting IT is ζ_{ITJ}. Similarly, due to the Pareto distribution it is easy to show that these variables satisfy:

$$\zeta_{ITJ}/\zeta_{NJ} \equiv \Gamma_J^{-\gamma_J}$$

5.2.5 Industry aggregation

If total industry profits for "home" firms in a sector J are defined as the sum of the profits of firms in the "home" and the "foreign" market:

$$\Pi_J := N_J \left[\int_{\underline{\varphi}_J}^{\infty} \pi_J(\varphi_J)\, \mathrm{d}G_J(\varphi) + \int_{\underline{\varphi}_{NJ}}^{\infty} \pi_{NJ}(\varphi_J)\, \mathrm{d}G_J(\varphi)\right]$$

Using the expressions for the profit functions and the cutoffs, aggregate profits can be written [32] as:

$$\Pi_J := N_J \left[\pi_J(\bar{\varphi}_J) + \zeta_{NJ}\pi_{NJ}(\bar{\varphi}_{NJ}) + \zeta_{NJ}\Gamma_J^{-\gamma_J}\Delta\pi_{NJ}(\Gamma_J\bar{\varphi}_{NJ})\right]$$

This implies that I need to keep track only the cutoff for the operation of a second establishment and not that for the IT adoption. The same aggregation property simplifies the expression for the

[32] The following function is defined, representing additional profits from the decision to adopt IT:

$$\Delta\pi_{NJ}(\varphi) \equiv \pi^1_{NJ}(\varphi) - \pi^0_{NJ}(\varphi) = \frac{B_J^{*-1}}{A}\left[(\varphi)^{-1+\sigma_J} - K_J^{1-\sigma_J}(\varphi)^{-1+\sigma_J}\right] - \frac{f_{ITJ}}{A}$$

where $B_J^* = \sigma_J\left(\frac{\sigma_J}{\sigma_J-1}\right)^{\sigma_J-1} \cdot A^{-\sigma_J} \cdot (P_J^*)^{-\sigma_J}(C_J^*)^{-1}$ and $K_J = exp(\kappa)$.

sectoral price index P_J :

$$P_J = \Big(N_J \cdot p_J\left(\bar{\varphi}_J\right)^{1-\sigma_J} + \zeta^*_{NJ} N^*_J \cdot p^*_{NJ}\left(\bar{\varphi}^*_{NJ}\right)^{1-\sigma_J} + \zeta^*_{NJ} \Gamma_J^{*-\gamma_J} N^*_J \Delta p^*_{NJ}\left(\Gamma^*_J \bar{\varphi}^*_{NJ}\right)^{1-\sigma_J}\Big)^{\frac{1}{1-\sigma_J}}$$

where the following function is used, determining the difference in the price of a firm with a productivity φ, in the case it adopts Information Technology or not:

$$\Delta p^*_{NJ}(\varphi) = (1 - \exp(\kappa^*)) p^*_{NJ}(\varphi)$$

As a result in equilibrium:

$$P_J = \Big(N_J \cdot p_J\left(\bar{\varphi}_J\right)^{1-\sigma_J} + \zeta^*_{NJ} N^*_J \cdot p^*_{NJ}\left(\bar{\varphi}^*_{NJ}\right)^{1-\sigma_J} H^*_J\Big)^{\frac{1}{1-\sigma_J}}$$

where $H^*_J \equiv H\Bigg(\exp(\kappa)^*, \Gamma^*_J, \gamma_J, \sigma_J\Bigg)$ which is a variable determining the impact of IT on the price index through the sales share of large foreign firms in the "home" market.

5.3 Equilibrium

In equilibrium, the aggregate budget constraint of the representative household is given in terms of the aggregate price index P, composite consumption C, labor income L and a share of revenues from each location and sector J, Π_J and Π^*_J :

$$PC \leq L + (1-\chi)\Pi_{\text{AUT}} + \chi \Pi_{\text{RS}}$$

The definition of aggregate profits $\Pi(\chi)$ that are returned as dividents to investors is as follows. The exogenous parameter $\chi \in [0,1]$ controls the level of risk sharing across locations in the economy. The degree of risk-sharing from financial autarky, $\chi = 0$, to full risk-sharing, $\chi = 1$.[33]

If $\chi = 0$, then households receive only dividends from "home" headquartered firms, such that

$$\Pi_{\text{AUT}} = \sum_J \Pi_{J.}$$

Under perfect risk-sharing, $\chi = 1$, households receive a share of "home" sectoral profits relative to their capital endowments

$$\Pi_{\text{RS}} = \sum_J \frac{N_J}{N_J + N^\star_{\text{J}}} \cdot (\Pi_J + \Pi^\star_J)$$

The mass of firms N_J in each sector is assumed to be fixed. There is no entry or exit of firms. However, the set of producers in a given market, Ω_J, does vary over time due to entry and exit of establishments across countries. The number of varieties across countries fluctuates, since ζ_{NJ}

[33] The parameter that determines risk sharing χ is assumed to be constant and exogenous. Evidence for limited risk sharing for portfolios of US investors can be found in Lewis (2011) and the literature therein.

fluctuates over time. An equilibrium in this economy is a collection of prices $(p_J, p_{M,J}, P_J, P_T, P)$, output $q_J(\varphi)$, consumption $c_J(\varphi)$, and labor demand $l_J(\varphi)$ such that (i) each firm maximizes profit given consumer demand and operating costs, (ii) consumers maximize their intertemporal utility given prices, and (iii) markets for goods and for labor clear. In sum, there are $2\cdot(\mathcal{J}+1)$ endogenous variables in the model: the aggregate consumption level in each location, $(C, C^{\star})$, and the industry-level cutoffs, $(\varphi_{NJ}, \varphi^{\star}_{NJ})$. Knowing these quantities is sufficient to solve for the equilibrium at each point in time. [34]

5.4 Asset Prices

The representative household in each country owns a portfolio that consists of equity of firms in the economy. By assumption, they are assumed to own all equity of the firms in their "home" country. The equities, then are priced using the stochastic discount factor (SDF) of the "home" household.[35] Due to the static nature of the firms, [36] all profits are distributed as dividends. In this section, I derive predictions for all asset prices of firms across different industries. The representative household maximizes utility subject to the budget constraint, which includes shares $x_{J,t}(\varphi)$ in firms of sector J of variety φ at price $v_{J,t}(\varphi)$, which is equal to the value of the firm. Then, optimality conditions for the consumer leads to the following consumption-CAPM equation that determines each firm's valuation:

$$v_{J,t}(\varphi) = \mathbf{E}_t \left\{ M_{t,t+1} \left(v_{J,t+1}(\varphi) + \pi_{J,t+1}(\varphi) \right) \right\}$$

where $M_{t,t+1}$ is the one-period-ahead stochastic discount factor. To understand pricing by investors in this economy the impact of IT on the correlation between productivity shocks and the marginal utility of investors is considered in the next subsection. In particular, first some results are summarized related to IT intensity across industries, and later the reaction of cash flows to these shocks is considered as the economy faces aggregate shocks in productivity in the two countries.

5.5 Mechanism

In this section, the link between the IT intensity of a sector, and the impact of shocks to aggregate productivity on firms' cash flows, the marginal utility of investors and asset prices is determined theoretically. In particular, the differential response of firms to these shocks across the size distribution and across industries with different degrees of foreign firm share is emphasized. This determines the mechanism behind the excess premia presented above. As expected, the joint dynamics of cash flows and aggregate consumption determine the risk across industries and how investors price the risk of firms in these different industries in the economy. Before describing the implications of the model for asset prices, some further results are discussed that help with the interpretation of the dynamics of the economy. The proofs of the predictions discussed here can be found in the Appendix where more details on the theory and several additional predictions are included.

[34] The fact that I do not need to keep track of$(\varphi_{ITJ}, \varphi^{\star}_{ITJ})$ comes from the proportionality property $\varphi_{ITJ} = \Gamma_J \varphi_{NJ}$

[35] There is an implicit assumption here about the specific form of market segmentation that leads to this result.

[36] There is no capital and investment in the model or sunk costs of operation.

Lemma 1. *IT intensity, measured by the share of IT labor within a sector, is decreasing in IT adoption costs* f_{ITJ} *with an elasticity* $(\gamma_J - \sigma_J + 1)/(\sigma_J - 1)$.

As expect as the fixed cost of IT increases, there should be a reduction in IT intensity in each industry. However, this result is not immediate given that fixed costs are expressed in terms of labor. The reason driving this negative relationship is due to the extensive margin of adjustment as in the models of international trade or multinational operations. The extensive margin of adjustment also determines the differential response of IT adoption at the industry level, if two sectors face the same decline in IT fixed costs.

Foreign firms' multinational operations I first define competition from foreign firms as

$$\mathcal{I}_J = \frac{\zeta_J^* N_J^* \cdot p_{NJ}^* \left(\bar{\varphi}_{NJ}^*\right)^{1-\sigma_J} H_J}{P_J^{1-\sigma_J}}$$

This represents the marginal impact of large foreign multinational firms operating an establishment in a region away from the firms' HQ on the local price index for a given industry. Given the definition of P_J,this measure is bounded: $\mathcal{I}_J \in [0, 1]$.

Lemma 2. *All else equal, the level of* $\mathcal{I}_J$ *is decreasing with fixed costs* f_{ITJ}^*. *This means that this level is increasing in IT intensity. All else equal, the level of* $\mathcal{I}_J$ *is decreasing with fixed costs* f_J^*. *This means that this level is lower as the fixed costs of foreign operations in the US increases.*

The lemma above, is a result of the fact that in high fixed costs (f_{ITJ}^*) costs industries, large multinational firms set a less competitive price. As a result the impact of global production, the price index is lower in these industries with higher average efficiency costs and the displacement of small "domestic" firms higher. In addition, in industries with a lower fixed cost of foreign operations, there is a larger number of foreign multinationals. Now given these results, the analysis of the effect on asset prices follows. Proposition 1 and 2 summarize differences in firms' profit elasticity across industries with different IT intensity levels. In addition, the differential exposure of industries with different underlying fixed costs of foreign operations is discussed along with results for firms with different size. The analysis follows Barrot et al. (2019) to provide testable predictions that would help rationalize the observed excess returns.

5.5.1 Effect on cash flows

An elasticity of variable x is denoted by $\mathcal{E}^*(x)$ and are with respect to an aggregate shock A^*, that is defined as $\mathcal{E}^*(x) = \frac{d \log x}{d \log A^*}$. The elasticities derived here are approximate and do not account for general equilibrium effects through the effects on aggregate demand [37]. After defining the index level of multinational firms $\mathcal{I}_J$, I consider the effect of an increase in productivity in the rest of the economy on domestic only firms. The effect of a shock to labor productivity in the rest of the world

[37] Using a calibrated version of the model, it is confirmed that the general equilibrium effect through aggregate demand is small and the results are qualitatively in the same directions as the results described here.

affects both demand for individual varieties and total industry expenditures. The entry-growth of foreign multinational firms lowers the industry price index, thus increases the expenditures at the industry level. By assumption, the within industry substitution elasticity is larger than the elasticity across industries, the productivity shock in the rest of the economy reduces demand for locally produced goods. In addition, the aggregate productivity shocks affect aggregate demand, through the effect on wealth of consumers in the local economy. In particular, these channels determine the effect on aggregate consumption and as a result the price of assets in equilibrium.

Here, I present the results for the elasticity of profits to a productivity shock in the rest of the economy[38]:

Lemma 3. *The elasticity of profits generated in the home market for a home firm with productivity* ϕ *to a productivity shock* A^* *is:*

$$\mathcal{E}^*\left(\pi_J(\varphi)\right) = -\left(\sigma_J - \theta\right) \cdot \left(-\mathcal{E}^*\left(P_J\right)\right) + \frac{1 - a_0 - \theta}{a_0} \cdot \left(-\mathcal{E}^*(P) + \mathcal{E}^*(C)\right)$$

Ignoring for now the second term, related to aggregate variables, the profits and cash flows are affected by the shock through industry prices as follows:

$$\mathcal{E}^*\left(\pi_J(\varphi)\right) = -\left(\sigma_J - \theta\right) \cdot \mathcal{I}_J \cdot \left[1 + \left(\frac{\gamma_J}{\sigma_J - 1} - 1\right)\left(-\mathcal{E}^*\left(\underline{\varphi_{NJ}^*}\right)\right)\right]$$

This term summarizes the threat firms face from increasing competition which depends on the following variables: (a) the level of elasticity determines the impact of competition; (b) the foreign firms competition index that represents how much firms in the rest of the world affect local firms. It is larger when IT costs are smaller and thus a large number of firms operate multiple establishments.

In contrast, large multinational firms operating establishments with HQ in the “home” country may benefit from such a shock. Here I summarize this effect. If a firm is large enough to be a multinational firm then profits react as follows[39]:

$$\mathcal{E}^*\left(\pi_{NJ}(\varphi)\right) = \left(\mathcal{E}^*\left(C_J^*\right) - \sigma_J\left(-\mathcal{E}^*\left(P_J^*\right)\right)\right) \cdot \left(1 + \ell_J(\varphi)\right)$$

The sign depends both on how demand reacts and the level of competition, through the price index. The effect of the first variable is positive, while the effect of the second negative. In addition, the firms that are closer to the cutoff will face a stronger effect. In particular this reaction comes from the fact that operating leverage as in every model with these type of fixed costs, amplifies the effect of these productivity shocks. In summary, the average effect to the industry cash flows depends on the relative size of these effects on smaller "home" firms and larger multinational firms.

Across industries, as firms have higher level of IT intensity [40], the share of multinational firms will be larger and as a result exposure of investors to sales risk due to global competition, can

[38] For simplicity of notation, I assume $\zeta = 0$ but results follow more generally, see Online Appendix.

[39] Remember here the assumption on the inherited productivity of an establishment. These results are generalized in the Appendix in the case that the productivity term is a weighted average of productivity in the “home” and “foreign” economy.

[40] which is the case if industries have lower fixed costs of operating IT

be understood better by studying the reaction of asset prices of firms with different size. Looking across the size distribution, in the model, and in particular looking at the reaction of asset prices for smaller firms that can not pay the fixed costs and become multinational firms is informative about the reaction of firms with a lower level of sales. Observing the reaction of the excess returns for these firms only, it is possible to isolate the IT effect on industry risk. In particular, the following proposition summarises this intuition.

Proposition 1. *Consider two industries J_1 and J_2 in the same region, affected by a shock to productivity in the rest of the world. If industries differ only in the fixed cost of IT, with industry 2 having a lower fixed cost of adoption, then multinational firms share is greater in industry J_2 than J_1, or $\mathcal{I}_2 > \mathcal{I}_1$. (ii) The elasticity of profits for small firms (only local) firms is more negative in industry J_2. (iii) The difference in the elasticity of profits between large multinational and small local firms to this shock to productivity is greater in industry J_2. Lastly, fixing the cost of adopting IT now, If industries differ only in the fixed cost of foreign operations, then: (i) the elasticity of average profit to a shock to productivity in the rest of the economy is greater in the industry with a lower fixed cost of foreign operations and (ii) The elasticity of profits for small firms (only local) firms is more negative in that industry.*

Both the results, follow from the effect of the fixed costs, on I_J, the variable that summarizes the size of foreign operation in the domestic market. The second statements are specific to smaller firms facing more competition. Lower establishment entry costs go with higher sales shares for large multinational firms, the same is true for lower IT costs that increase the efficiency of foreign establishments. Then, the effects if one considers solely domestic profits follows from Lemma 3.

5.5.2 Effect on SDF

To assess how aggregate shocks affect equity prices of the firms in the economy, the risk channel should be evaluated to understand also how marginal investors react after a potential productivity shock impacts firm profits. In particular, the reaction of prices will depend on their marginal utility. To understand then the effect on the marginal utility of investors, I study the effect of a productivity shock on aggregate consumption. So first the elasticity of consumption is discussed.

Lemma 4. *The elasticity of consumption to a productivity shock A^* is:*

$$\mathcal{E}^*(C) = -\mathcal{E}^*(P) + \frac{\Pi}{L + \Pi} \cdot \mathcal{E}^*(\Pi)$$

Thus to determine the effect on aggregate consumption, there are two competing effects, a price effect where a positive shock outside of the HQ increases competition through the price index, due to lower prices and entry of varieties. In addition, there is a wealth effect, since household receive the profits from the operation of firms in the form of dividends. The sign of the wealth effect is ambiguous and depends on the share of firms that do not operate in the "foreign" country and are owned by "home" households and on the effect of the shock on total profits for only local(non multinational) firms. The price of the industry risk then depends on the size of the price and wealth effects.

As in Barrot et al. (2019), this paper does not analyze explicitly the sign of the price of risk, but inference about investors' pricing behavior is based on the following intuition similar to models with international trade(Barrot et al. (2019)). If the price of risk is positive, firms in industries where the multinational firms' entry margin and the profits react more to this productivity shocks will require a higher positive risk premium and will lead to higher excess returns.

Again, then the focus is on productivity shocks, in the rest of the world, as the only shock affecting dynamics in the economy. Now, asset prices are determined by the investment decision of households, through the Euler equation household. The Euler equation prices all the relevant risk factors in the model, and the expected returns are equal to the price of consumption risk multiplied by the relative riskiness of profits (exposure to IT adoption) of each firm, i.e. the IT intensity of an industry and the foreign share of multinational firms.

As a result, the empirical results can not help determine the price of the risk exposure associated with a larger sales share of multinational firms. For example, if investors consider the risk exposure as a factor that should be priced positively, then the firms in high IT intensity industries should be the ones with strongly pro cyclical returns (if there is only one shock for the aggregate economy affecting consumption, the aggregate "foreign" shock) and thus the ones affected positively by such a shock. The opposite is true if the price of risk is negative. Then, the following idea, from Barrot et al. (2019) is used to understand if the expected returns of the high-low IT portfolio are driven by industries more likely to benefit or lose by aggregate productivity shocks outside the "home" country. In particular, the following prediction will be used to test for the two different channels.

Proposition 2. *After a foreign shock, if the profits of "home" multinational firms generated outside in the "foreign" country react positively, then the price of the risk for investors is negative:1. If expected returns differ more comparing smaller firms to large firms as the IT intensity of the industry increases. 2. If expected returns differ more comparing smaller firms to large firms as the sales share of foreign firms of the industry increases.*

In particular, the intuition for this result is based again on the discussion above. Firms that do not operate in both regions are relatively more exposed (negatively) if the level of IT adoption in the industry is higher. In addition the large multinational firms' profits do not fall from operations outside of the HQ location. Finally, a greater share of price competition from multinational, as calculated using the foreign firms' sales share means that cash-flows react more because the industry price level is affected by foreign shocks.

Again, analyzing the expected returns of high-minus-low IT portfolios in high and low foreign sales' share industries would be informative of the drivers of risk premia.

6 Testing Model Predictions

The identification strategy to determine whether the price of the risk related to the adoption of IT is positive or negative relies on testing the prediction of the model, and the heterogeneity in firms' response to shocks to the foreign economy. First, as predicted by the model regarding, the level of foreign competition and IT, I have shown that the level of information technology is associated with entry or expansion of foreign multinationals in the U.S. economy and in the global economy (Figure 1). Research also finds support on the cross-sectional heterogeneity in industries' adoption of IT and firms' propensity to be displaced by large productive firms entering markets across the United States. Bessen (2017) tests the prediction that proprietary Information Technology is used by systematically larger and more productive firms. In addition, Rossi-Hansberg et al. (2018) document recent facts about the dynamics of local and national concentration providing support to the mechanism related to the adoption of IT by large firms.

6.1 Size and expected returns

I then take the additional predictions for equity returns of the model to the data. Whether the expected returns are driven by small firms will determine the sign the investors assign to the risk exposure to foreign shocks, due to the differential level of multinational operations and IT intensity. Table 10 in the Appendix provides direct evidence that the effect is more important when portfolio formation is done using only the sample of small firms, compared to the one using the sample of large firms[41]. As predicted by the model, the expected returns are declining with size. In the lower panel of Table 10, the results are reported where now portfolios are double-sorted based both on the level of Information Technology and size, but only industries with an high share of multinational firms in the United States are considered. The risk premia associated with small firms in IT intensive industries are even larger when one considers only industries with a high share of multinational firms. In summary, consistent with the model, all these results together imply that the excess returns are concentrated among the smaller firms, and for those, returns are amplified by foreign competition.

The same pattern arises looking at Figure 6. This figure plots the monthly evolution over time of a dollar invested in the value-weighted H-L portfolio, unconditionally and conditionally on the share of foreign multinational firms in the US. Cumulative returns are high during the 90s for all IT portfolios, For later year it is obvious that the recovery in returns of the IT intensive portfolio is driven by industries with a high share of MNEs. After 2010, even though there is a drop in excess returns for the HL IT portfolio, conditional on firms operating only in industries with a large sales' share of Multinationals, the returns remain positive and sizable. As a result, I conclude, that the mechanism presented in the model is still operating in later years, and the reversal of returns in the low FDI industries, is drivem by other factors unrelated to the mechanism presented in this paper.

[41] Size is measured with the level of the market capitalization, at the end of the previous calendar year of the month considered.

7 Calibration and Model Dynamics

This section is preliminary.

7.1 Model Parameters

For the calibration, I associate the Home country with the United States and the Foreign Country with the other OECD countries+China[42] which have the biggest share of foreign direct investment to the U.S.. The calibration of the primitives then follows from statistics of aggregate variables in 2012. In detail, L and L^* are determined by the ratio of the working age population in the U.S. and the set of the other economies, 154 million and 1.2 billion. The number of firms operating in each economy, N and N^*, is chosen to match the ratio of the market capitalization for the U.S. economy of 90 percent that of the the market capitalization of the other countries [43]. Wage costs are normalized to 1.

The headquarter productivity transmission parameter in the two industries, ζ, is set to 0.5, following Cravino and Levchenko (2017) . This parameter, given the baseline calibration, implies that a shock to the foreign country is such that the competition effect from multinational firms dominates the demand effect. Elasticity across industries $\theta = 1.2$ from Barrot et al. (2019) and within industries $\sigma = 3.8$, across goods from Broda and Weinstein (2006). The firm distribution Pareto parameter is set equal to 3.4, as in Ghironi and Melitz (2007). The subjective discount factor is 0.99, and the inter temporal elasticity of substitution is 1.5, as in Broda and Weinstein (2006). The risk aversion parameter is set to match the U.S. equity premium. Finally, parameters related to aggregate productivity in the Home and Foreign country are chosen to reflect GDP in the U.S. and ROW).

It remains to calibrate the IT and multinationals' cost parameters (f_J, f_{ITJ}) along with the knowledge transmission cost parameter κ. These parameters are set to match the average foreign market shares observed in the data and the difference in IT intensity and multinationals' shares across industries. In addition, the calibration tries to match the earnings-to-price ratios and the returns that the model generates to the data. The calibrated values for the parameters are summarized in Table 11.

Given the calibration, the interaction of country size, fixed cost parameters, and the stochastic properties of country shocks determine the share of firms' foreign affiliates. In turn, these patterns affect how IT intensity and multinationals jointly affect the risk premium. I use this calibrated version of the model to perform exercises that highlight the effect of IT and foreign operations on equity returns. In Table 12, I report the results of the simulations. The calibration does not

[42] I restrict the set of countries that consist the "foreign" economy to be the following OECD members: Australia, Austria, Belgium/Luxemburg, Canada, Chile, Colombia, Czech Republic, Denmark, Estonia, Spain, Finland, France, United Kingdom, Germany, Greece, Hungary, Italy, Israel, Iceland, Mexico, Japan, South Korea, Netherlands, Norway, New Zealand, Poland, Portugal, Sweden, Switzerland, Slovenia, Slovakia. These countries account for 99% of operations of foreign multinationals in the United States

[43] The market capitalization data come from the World Bank and are calculated based on market values of firms with headquarters in each country.

specifically target firms' cash flows across industries and returns but does fit qualitatively and quantitatively the patterns in the data. With the exception of the variability in consumption, the model fits well the patterns in aggregate and sectoral data.

8 Conclusion

Using a novel measure of IT intensity, I find that industries that use intensively IT, have large and sizable risk premia. I confirm that IT systematically has been a determinant of industry risk in recent decades. The IT risk premia are increasing in the level of multinational firms' sales share in an industry. A framework incorporating the decision to adopt IT and the decision to operate multiple establishments provides a theoretical explanation for the risk premia, which are consistent with the trends in IT driven concentration, and the threat of competition from large multinational firms. Intuitively, large firms being able to operate modern Information Technology , makes smaller firms more exposed to competition. The model provides testable predictions that are used to understand whether the mechanism in the model is present in the data. The predictions of the model are confirmed in the cross section of stock returns. In contrast to common belief that IT benefited small young firms, I provide evidence that IT in the last decades benefited large productive multinational incumbents in the expense of small local firms.

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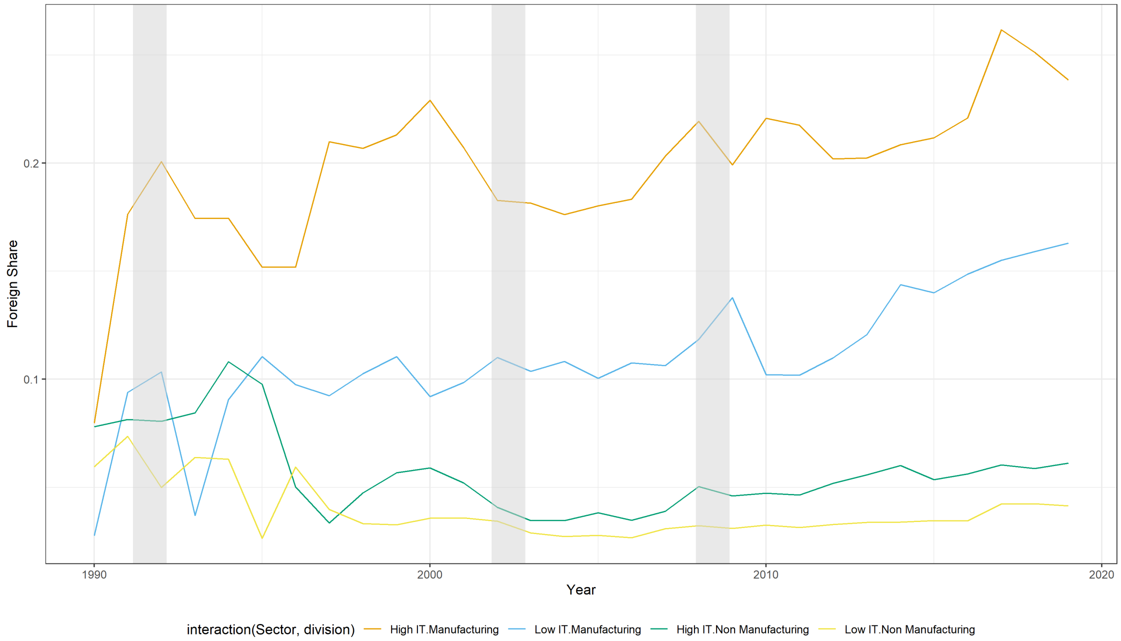
This Appendix includes the tables and figures related to the empirical and theoretical analysis in the main body of the paper, the full derivations of the model and the theoretical proposition presented in the paper (Appendix B), the computational approach(Appendix C), details about measurement and data construction (Appendix D).

A Figures and Tables

Figure 1: Evolution of International Sales Share for different levels of IT

Notes: This figure shows the dynamics of the relative share of sales, that are classified as international in an industry, using segment sales data of all publicly traded firms in Compustat and Worldscope, for two different samples, a high IT sample and a low IT sample, based on the Information Technology employment share of the associated 4-digit SIC industry.

Figure 2: Evolution of International Sales Share for different levels of IT

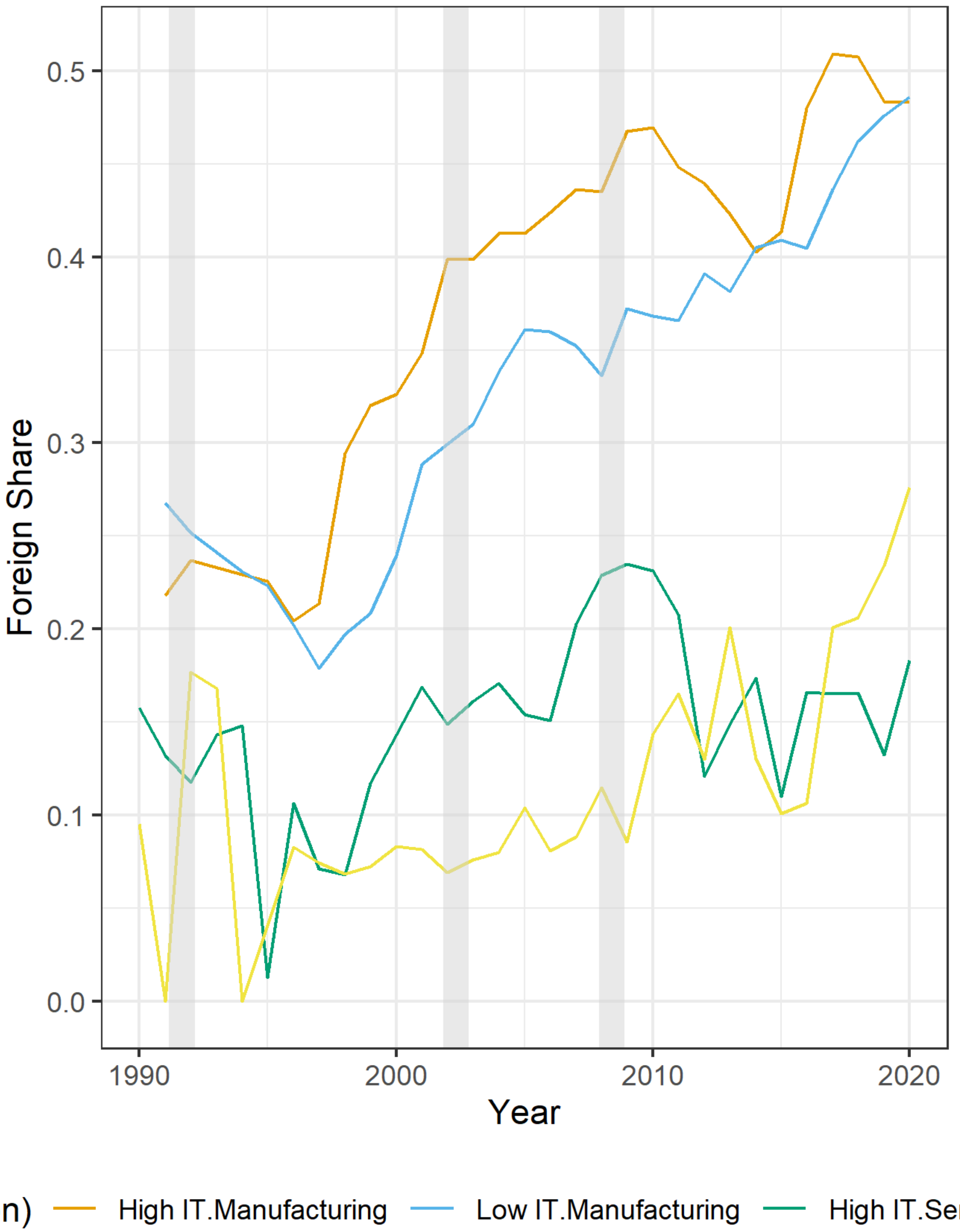


Notes: This figure shows the dynamics of the relative share of sales, that are classified as international in an industry, using segment sales data of all publicly traded firms in Compustat and Worldscope, for two different samples, a high IT sample and a low IT sample, based on the Information Technology employment share of the associated 4-digit SIC industry. The variables are plotted separately for Manufacturing, versus services firms.

Figure 3: Evolution of US Foreign Competition for different levels of IT

Notes: This figure shows the dynamics of the relative share of sales in the United States, that are due to foreign operations of MNEs in an industry, using segment sales data of all publicly traded firms in Compustat and Worldscope, for two different samples, a high IT sample and a low IT sample, based on the Information Technology employment share of the associated 4-digit SIC industry.

Figure 4: Evolution of US Foreign Competition for different levels of IT

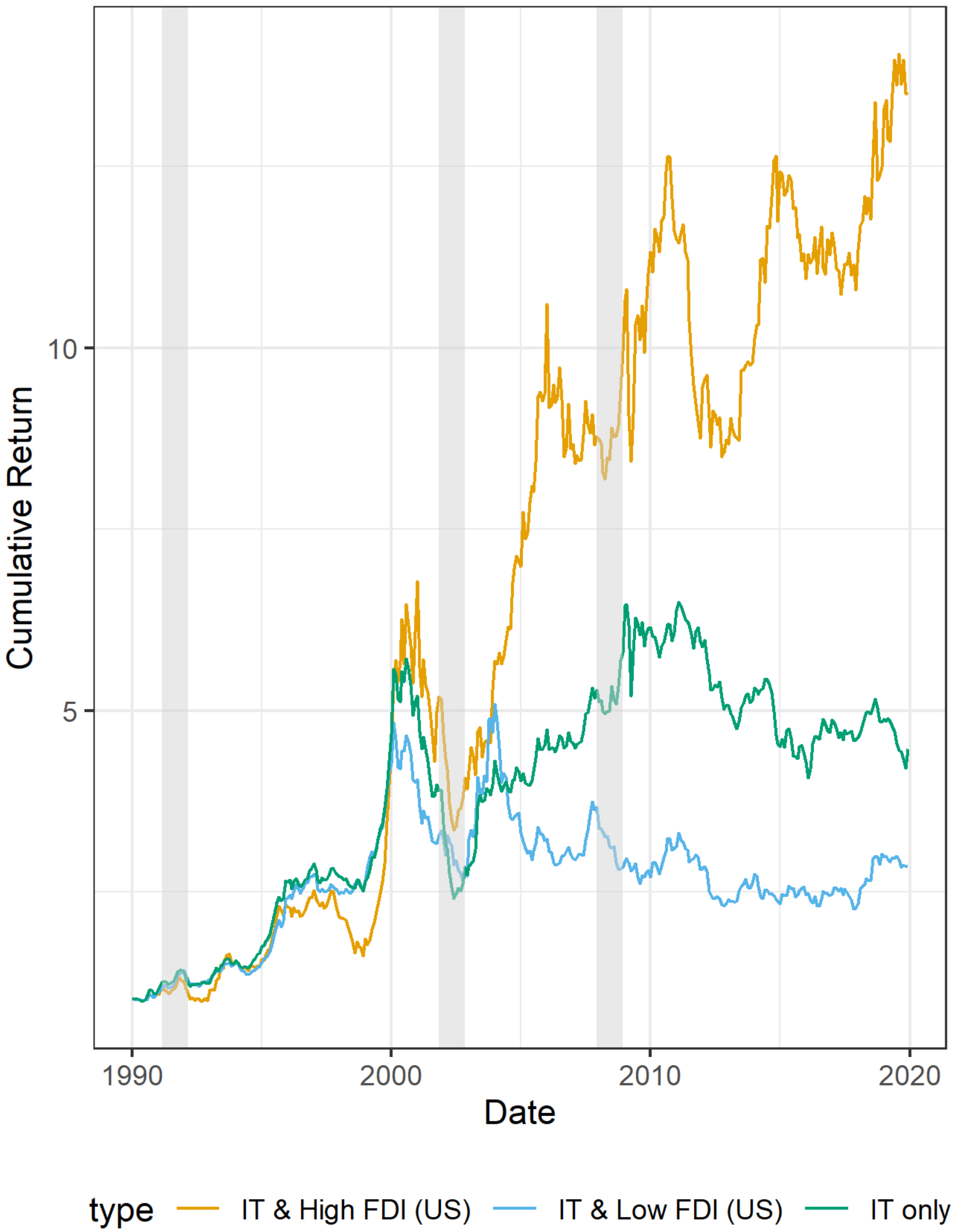


Notes: This figure shows the dynamics of the relative share of sales in the United States, that are due to foreign operations of MNEs in an industry, using segment sales data of all publicly traded firms in Compustat and Worldscope, for two different samples, a high IT sample and a low IT sample, based on the Information Technology employment share of the associated 4-digit SIC industry. The variables are plotted separately for Manufacturing, versus services firms.

Figure 5: Evolution of IT Risk Premia

Notes: Cumulative excess abnormal returns of the H-L IT portfolio of a value-weighted portfolio, controlling for other risk factors, in a 5-factor model. This figure plots the monthly evolution over time of a dollar invested in the value-weighted H-L portfolio. The sample period is July 1991 to June 2019.

Figure 6: Evolution of IT Risk Premia



Notes: Cumulative excess abnormal returns of the H-L IT portfolio of a value-weighted portfolio for US firms in industries with different level of foreign competition in the United States, controlling for other risk factors, in a 5-factor model or a 4-factor model. The figure plots separately the monthly evolution over time of a dollar invested in the value-weighted H-L portfolio, a dollar invested in the value-weighted H-L portfolio consisting only of firms operating in low competition industries, and a dollar invested in the value-weighted H-L portfolio consisting only of firms operating in high competition industries. Competition is calculated as the US sales share of top multinational firms with foreign operations in the United States. The sample period is July 1991 to June 2019.

Table 1: Cross-Sectional Statistics

	Full Sample	Low IT	High IT
IT Share	0.08	0.04	0.12
Balance Sheet			
Book-to-market	0.81	0.91	0.72
Gross profitability	0.37	0.39	0.35
SGA/Sales	0.34	0.25	0.43
COGS/Sales	0.53	0.59	0.48
Industry Controls			
Industry Employment	3.91	3.73	4.04
Industry Value Added	8.78	8.39	9.05
Industry Total Factor Productivity	1.07	1.02	1.10
Foreign Affiliates Global Sales Share	0.26	0.23	0.29
CR $_{4,it}$	0.66	0.66	0.65
Job Creation Rate	13.41	13.43	13.82
Job Destruction Rate	13.36	13.12	13.85

Notes: This table presents summary statistics for the firm-year sample covering public firms in 670 industries (excluding FIRE, and highly regulated industries), out of which approximately 450 are in manufacturing industries (with four-digit SIC codes between 2000 and 3999). Each column corresponds to the two samples, split according to the level of IT intensity every year. Information Technology intensity is measured at the industry-year level as described in the data and measurement section. Industly variables are obtained from the BLS-MFP data sets for industry level data on value added and reallocation. Using the segment data from Compustat and Worldscope, top 4 concentration ratio foreign affiliates sales share are measured at the industry(SIC4)-year level. All variables are winsorized at the first 99th percentiles. The sample period is 1991 to 2019.

Table 2: Portfolio Statistics

	Low	2	3	4	High	H-L
ME	13.006	13.105	12.794	13.024	13.148	
BE/ME	0.711	0.696	0.706	0.629	0.600	
Market Leverage	0.255	0.262	0.312	0.214	0.206	
ROA	0.085	0.077	0.004	−0.049	−0.033	
I/K	0.243	0.227	0.262	0.356	0.329	
Mean excess return	13.404	13.978	17.298	17.166	18.398	4.994
Sharpe ratio	0.696	0.717	0.983	0.760	0.817	0.379

Notes: This table presents summary statistics for portfolio sorted based on measures of Information Technology . The sample period is 1991 to 2019.

Table 3: IT intensity Premia

Equally Weighted	Low (1)	2 (2)	3 (3)	4 (4)	High (5)	H-L (6)
α	1.916	2.033	10.156***	8.725***	10.959***	9.043***
	(1.901)	(1.444)	(1.945)	(2.664)	(2.782)	(2.897)
β^{MKT}	0.999***	1.057***	0.979***	1.073***	1.013***	0.013
	(0.063)	(0.060)	(0.037)	(0.057)	(0.076)	(0.067)
β^{HML}	0.335***	0.346***	0.419***	0.001	0.115	−0.220
	(0.083)	(0.070)	(0.091)	(0.130)	(0.123)	(0.140)
β^{SMB}	0.865***	0.798***	0.699***	0.736***	0.714***	−0.151*
	(0.069)	(0.065)	(0.054)	(0.078)	(0.089)	(0.079)
β^{RMW}	0.388***	0.250***	−0.195**	−0.273**	−0.433***	−0.821***
	(0.095)	(0.087)	(0.089)	(0.122)	(0.116)	(0.105)
β^{CMA}	−0.155	0.060	−0.155	0.101	−0.101	0.054
	(0.159)	(0.122)	(0.100)	(0.173)	(0.132)	(0.153)

Value Weighted	Low (1)	2 (2)	3 (3)	4 (4)	High (5)	H-L (6)
Constant	0.742	0.877	8.750***	7.081***	9.099***	8.357***
	(1.789)	(1.351)	(1.816)	(2.489)	(2.472)	(2.744)
β^{MKT}	0.938***	1.002***	0.888***	1.052***	1.034***	0.096
	(0.045)	(0.027)	(0.039)	(0.055)	(0.065)	(0.078)
β^{HML}	0.305***	0.325***	0.425***	−0.008	0.106	−0.199
	(0.078)	(0.066)	(0.092)	(0.123)	(0.114)	(0.132)
β^{SMB}	0.827***	0.764***	0.668***	0.681***	0.664***	−0.163**
	(0.066)	(0.062)	(0.049)	(0.072)	(0.082)	(0.075)
β^{RMW}	0.419***	0.281***	−0.182**	−0.246**	−0.402***	−0.820***
	(0.092)	(0.083)	(0.089)	(0.114)	(0.108)	(0.097)
β^{CMA}	−0.133	0.076	−0.158	0.106	−0.104	0.030
	(0.146)	(0.108)	(0.096)	(0.161)	(0.120)	(0.146)

Equally Weighted	Low (1)	2 (2)	3 (3)	4 (4)	High (5)	H-L (6)
α	−0.475	1.491	3.595	5.002**	7.006**	7.481**
	(1.737)	(1.280)	(2.249)	(2.495)	(2.801)	(3.492)
β^{MKT}	0.710***	0.791***	0.885***	1.025***	1.127***	0.417***
	(0.053)	(0.041)	(0.049)	(0.071)	(0.069)	(0.092)
β^{HML}	0.337***	0.260***	−0.092**	−0.342***	−0.607***	−0.944***
	(0.075)	(0.069)	(0.045)	(0.057)	(0.094)	(0.133)
β^{SMB}	0.485***	0.498***	0.780***	0.799***	0.950***	0.465***
	(0.102)	(0.078)	(0.064)	(0.063)	(0.070)	(0.123)

Value Weighted	Low (1)	2 (2)	3 (3)	4 (4)	High (5)	H-L (6)
α	5.558***	7.556***	8.760***	7.398***	11.486***	5.928*
	(1.386)	(1.219)	(1.368)	(1.449)	(3.070)	(3.022)
β^{MKT}	0.667***	0.670***	0.671***	0.937***	1.103***	0.436***
	(0.041)	(0.029)	(0.048)	(0.073)	(0.041)	(0.051)
β^{HML}	0.168*	0.158***	0.079	−0.261***	−0.670***	−0.838***
	(0.089)	(0.060)	(0.073)	(0.046)	(0.094)	(0.145)
β^{SMB}	−0.043	−0.023	−0.148***	0.054	0.077	0.120
	(0.078)	(0.049)	(0.051)	(0.068)	(0.057)	(0.102)

Notes: This table presents excess returns (α) over a five-factor Fama-French model and over a three-factor Fama-French model of portfolios sorted based on measures of Information Technology. Returns are calculated using data on U.S. public firms' stocks traded on the Amex, NASDAQ, or NYSE. Monthly Unlevered returns are multiplied by 12 to make the magnitude comparable to annualized returns. IT intensity is measured and normalized yearly at the industry-year level. In any given month, stocks are sorted into five portfolios based on their IT quintile in the 12-month period before. A given portfolio's return is regressed in excess of the risk-free rate on the market portfolio minus the risk-free rate, the size factor (small minus big), the value factor (high minus low), the profitability factor (robust minus weak), and the investment factor (conservative minus aggressive), all obtained from Kenneth French's website. Standard errors are in parentheses and estimated using Newey-West with 12 lags. ***, **, and * indicate significance at the 0.1%, 1%, and 5% level, respectively. The sample period is 1991 to 2019.

Table 4: Industry Subsamples

Equally weighted

	Low (1)	2 (2)	3 (3)	4 (4)	High (5)	H-L (6)
α_1	-3.848^{**}	-1.345	-0.055	3.421^{*}	5.400^{**}	9.248^{***}
	(1.539)	(1.365)	(1.445)	(1.892)	(2.624)	(2.464)
α_2	-1.737	0.911	5.399^{**}	7.300^{***}	7.468^{***}	9.206^{***}
	(1.768)	(1.569)	(2.325)	(2.403)	(2.801)	(2.474)
α_3	-1.737	0.911	5.387^{**}	6.868^{***}	9.236^{***}	10.264^{**}
	(1.768)	(1.569)	(2.327)	(2.436)	(3.437)	(3.990)

Value weighted

	Low (1)	2 (2)	3 (3)	4 (4)	High (5)	H-L (6)
α_1	2.537^{*}	3.460^{***}	3.737^{***}	3.987^{***}	9.219^{***}	6.683^{**}
	(1.378)	(1.053)	(0.982)	(1.426)	(3.294)	(3.101)
α_2	2.999^{**}	4.484^{***}	6.746^{***}	7.779^{***}	11.719^{***}	8.720^{**}
	(1.377)	(1.077)	(1.226)	(1.792)	(4.144)	(3.808)
α_3	2.999^{**}	4.484^{***}	6.746^{***}	7.407^{***}	8.139^{*}	5.777
	(1.377)	(1.077)	(1.226)	(1.831)	(4.803)	(4.602)

Notes: This table presents excess returns (α) over a five-factor Fama French model of portfolios sorted based on measures of Information Technology. Returns are calculated using data on U.S. public firms' stocks traded on the Amex, NASDAQ, or NYSE. Monthly Unlevered returns are multiplied by 12 to make the magnitude comparable to annualized returns. IT intensity is measured and normalized yearly at the industry-year level. In any given month, stocks are sorted into five portfolios based on their IT quintile in the 12-month period before. A given portfolio's return is regressed in excess of the risk-free rate on the market portfolio minus the risk-free rate, the size factor (small minus big), the value factor (high minus low), the profitability factor (robust minus weak), and the investment factor (conservative minus aggressive), all obtained from Kenneth French's website. Standard errors are in parentheses and estimated using Newey-West with 12 lags. ***, **, and * indicate significance at the 0.1%, 1%, and 5% level, respectively. The sample period is 1991 to 2019. Each row represents a different sub-sample α_1,α_2,α_3: Excluding Nasdaq, or High Tech firms or both.

Table 5: The impact of Foreign Competition

	ω_L	ω_M	ω_H
α^{IT}	-1.005	9.884^{**}	10.43^{**}
	(-0.42)	(3.06)	(2.77)
β^{MKT}	0.00596	0.0131	-0.0337
	(0.12)	(0.20)	(-0.40)
β^{HML}	-0.230^{**}	-0.182	-0.286^{*}
	(-2.60)	(-1.05)	(-2.27)
β^{SMB}	-0.385^{***}	-0.117	0.0233
	(-4.92)	(-1.30)	(0.26)
β^{RMW}	-0.505^{***}	-0.613^{**}	-1.131^{**}
	(-5.70)	(-5.11)	(-8.74)
β^{CMA}	0.183	-0.039	-0.006
	(1.37)	(-0.20)	(-0.03)

Notes: This table presents excess returns (α) over a five-factor Fama-French model of a H-L IT portfolios conditional on the level of foreign firms' sales share from low ω_L to high ω_H competition in the US. Returns are calculated using data on U.S. public firms' stocks traded on the Amex, NASDAQ, or NYSE. Monthly unlevered returns are multiplied by 12 to make the magnitude comparable to annualized returns. IT intensity is measured and normalized yearly at the industry-year level. In any given month, stocks are sorted into five portfolios based on their IT quintile in the 12-month period before. A given portfolio's return is regressed in excess of the risk-free rate on the market portfolio minus the risk-free rate, the size factor (small minus big), the value factor (high minus low), the profitability factor (robust minus weak), and the investment factor (conservative minus aggressive), all obtained from Kenneth French's website. Standard errors are in parentheses and estimated using Newey-West with 12 lags. ***, **, and * indicate significance at the 0.1%, 1%, and 5% level, respectively. The sample period is 1991 to 2019.

Table 6: The impact of International Risk Factors
Panel A: International Risk Factors

Six-factpr Models	(1)	(2)	(3)	(4)
α^{IT}	9.507***	9.651***	13.975***	9.832***
	(2.966)	(2.958)	(2.903)	(2.829)
β^{MKT}	−0.046	−0.045	−0.050	−0.034
	(0.067)	(0.060)	(0.075)	(0.065)
β^{HML}	−0.247*	−0.256*	−0.313**	−0.265**
	(0.137)	(0.140)	(0.139)	(0.126)
β^{SMB}	−0.189**	−0.188**	−0.211**	−0.195**
	(0.084)	(0.085)	(0.096)	(0.083)
β^{RMW}	−0.820***	−0.819***	−0.837***	−0.834***
	(0.106)	(0.109)	(0.122)	(0.121)
β^{CMA}	0.041	0.045	0.082	0.040
	(0.163)	(0.166)	(0.186)	(0.170)
β^{FX}	0.056			
	(0.069)			
β^{Dollar}		−0.060		
		(0.072)		
β^{Carry}			−0.023	
			(0.090)	
β^{Trade}				−0.026
				(0.060)

Notes: This table presents excess returns (α) over a six-factor (The six factor is one of the common factors related to foreign markets, FX, dollar, carry or trade cost factors+ Fama-French) model of portfolios double-sorted based on measures of Information Technology and the level of foreign firms' sales share. Returns are calculated using data on U.S. public firms' stocks traded on the Amex, NASDAQ, or NYSE. Monthly unlevered returns are multiplied by 12 to make the magnitude comparable to annualized returns. IT intensity is measured and normalized yearly at the industry-year level. In any given month, stocks are sorted into five portfolios based on their IT quintile in the 12-month period before. A given portfolio's return is regressed in excess of the risk-free rate on the market portfolio minus the risk-free rate, the size factor (small minus big), the value factor (high minus low), the profitability factor (robust minus weak), and the investment factor (conservative minus aggressive), all obtained from Kenneth French's website. Standard errors are in parentheses and estimated using Newey-West with 12 lags. ***, **, and * indicate significance at the 0.1%, 1%, and 5% level, respectively. The sample period is 1991 to 2019.

Table 7: Forecast errors

	Actual	Forecast	Error	Actual	Forecast	Error
IT intensity	0.232***	0.238***	−0.000*	0.171***	0.166***	−0.000
	(0.079)	(0.083)	(0.001)	(0.055)	(0.057)	(0.001)
β				−0.049***	−0.047***	−0.002
				(0.012)	(0.013)	(0.002)
Size				0.025***	0.018***	0.007***
				(0.006)	(0.006)	(0.001)
B-M Ratio				0.002	0.007	−0.005
				(0.010)	(0.010)	(0.004)
Leverage				0.031	0.050	−0.019
				(0.031)	(0.032)	(0.013)
I /K				−0.012	−0.013	0.000
				(0.014)	(0.014)	(0.002)
Observations	30424	30424	30424	30424	30424	30424
R^2	0.002	0.002	0.006	0.006	0.004	0.007

Notes:This table reports the coefficients from panel regressions of the forecast error in earnings per share, EPS, (defined as actual I/B/E/S EPS minus mean I/B/E/S consensus forecast of annual EPS) normalized by the stock price at the end of the last fiscal year. The 1-year horizon consensus forecast is measured as the average of the last forecast of each analyst covering the stock in the 8 months (from 1 year and 8 months to 1 year) before the end of the fiscal year. Columns 2-6 (8-12) report results for a 1-year (2-year) forecast horizon. IT is industry IT intensity at the end of the previous fiscal year. Standard errors are clustered at the industry and year level and reported in parentheses. R2 is adjusted for degrees of freedom. Significance levels are denoted by * = 10%, ** = 5%, and *** = 1%. The sample period is 1991-2019.

Table 8: Announcement Returns

	Equally weighted						Value weighted					
	Low	2	3	4	High	H-L	Low	2	3	4	High	H-L
(-5,1)	0.068***	0.068***	0.068***	0.068***	0.066***	0.002	0.070***	0.070***	0.074***	0.072***	0.069***	0.001
	(0.019)	(0.018)	(0.018)	(0.017)	(0.017)	(0.002)	(0.018)	(0.018)	(0.019)	(0.018)	(0.018)	(0.003)
(10,1)	0.119***	0.119***	0.120***	0.119***	0.117***	0.002	0.124***	0.124***	0.128***	0.127***	0.124***	0.001
	(0.032)	(0.032)	(0.032)	(0.031)	(0.030)	(0.003)	(0.031)	(0.031)	(0.033)	(0.032)	(0.032)	(0.004)

Notes:This table reports returns around earnings announcements of stocks sorted into five IT intensity portfolios. The returns are cumulative excess returns (stock return minus the risk-free rate) over a 6-day (11-day) window from 5 days (10 days) prior to the quarterly earnings announcement day to 1 day after the announcement day, i.e. the (-5,1) (and (-10,1)) window. These announcement returns are either equal-weighted (columns 2-7) or value-weighted (columns 8-13) - using the stock market capitalization measured at the end of the calendar quarter prior to the earnings announcement. Standard errors reported in parentheses are adjusted for heteroscedasticity and autocorrelation (Newey-West with 12 lags).

Table 9: Returns for different sub periods

	Low	2	3	4	High	H-L
1991 : 07 − 2000 : 06	-5.685^{***}	-0.469	10.365^{***}	12.264^{**}	15.347^{**}	21.033^{***}
	(1.835)	(2.636)	(3.752)	(4.764)	(5.991)	(6.878)
2000 : 07 − 2010 : 06	3.520	8.510^{***}	9.341^{***}	10.120^{**}	17.729^{***}	14.209^{***}
	(3.676)	(2.987)	(2.730)	(4.646)	(4.119)	(5.186)
2010 : 07 − 2019 : 06	4.048^{***}	-3.219^{**}	5.884^{**}	15.879^{***}	-4.825	-8.873^{*}
	(1.385)	(1.339)	(2.504)	(3.707)	(4.288)	(4.770)

Notes: The table reports portfolio sorts controlling for other industry characteristics for different time periods. Columns 1:7 tabulate results for value-weighted returns. H-L is an investment strategy that is long the portfolio of firms with high IT intensity and short the portfolio of firms with low IT intensity. Standard errors are adjusted for heteroscedasticity and auto-correlation (Newey-West). Significance levels are denoted by * = 10%, ** = 5%, and *** = 1%. The sample covers the period July 1991 to June 2019.

Table 10: Conditional on Size

All industries	T_1	T_2	T_3
α^{IT}	11.25**	4.512*	6.692**
	(2.76)	(2.04)	(2.66)
β^{MKT}	−0.0356	−0.0524	−0.0503
	(−0.35)	(−1.06)	(−0.86)
β^{HML}	−0.409*	−0.181	−0.0906
	(−2.19)	(−1.57)	(−0.82)
β^{SMB}	−0.177	−0.387**	−0.0485
	(−1.51)	(−5.80)	(−0.68)
β^{RMW}	−0.998*	−0.429**	−0.437*
	(−5.55)	(−3.89)	(−4.34)
β^{CMA}	0.130	0.0189	−0.165
	(0.59)	(0.10)	(−1.04)

ω_H only	T_1	T_2	T_3
α^{IT}	14.10**	6.381*	5.612*
	(3.46)	(2.04)	(2.51)
β^{MKT}	0.00694	−0.0496	−0.0560
	(0.07)	(−0.80)	(−1.00)
β^{HML}	−0.340	−0.175	−0.0849
	(−1.69)	(−1.32)	(−0.74)
β^{SMB}	−0.103	−0.0747	−0.191*
	(−0.86)	(−0.87)	(−2.60)
β^{RMW}	−0.714*	−0.931*	−0.829*
	(−4.07)	(−9.15)	(−7.91)
β^{CMA}	0.298	−0.0957	−0.110
	(1.47)	(−0.59)	(−0.69)

Notes: This table presents excess returns ($\alpha^I T$) of a high-low IT portfolio over a five-factor Fama-French model of information technology portfolios based on U.S. public firms' stocks traded on the Amex, NASDAQ or NYSE. Monthly returns are multiplied by 12 to make the magnitude comparable to annualized returns. Returns are normalized based on the level of leverage of the previous calendar year to ensure that the results are not driven by leverage. IT intensity is measured and normalized yearly at the industry-year level. In any given month, stocks are sorted into five portfolios based on their Information Technology intensity in the 12-month period before. A given portfolio's return is regressed in excess of the risk-free rate on the market portfolio minus the risk-free rate, the size factor (small minus big), the value factor (high minus low), the profitability factor (robust minus weak), and the investment factor (conservative minus aggressive), all obtained from Kenneth French's website. Standard errors are in parentheses and estimated using Newey-West with 12 lags. ***, **, and * indicate significance at the 0.1%, 1%, and 5% level, respectively. The sample period is 1991 to 2019. The table reports in the upper panel the returns of the H-L portfolio conditional on the size of firms (T_1:small-sized,T_1:medium-sized,T_1:large firms). The table reports in the lower panel the returns of the H-L portfolio conditional on the size of firms (T_1:small-sized,T_1:medium-sized,T_1:large firms) for firms operating only in industries with a high sales share of foreign firms.

Table 11: Calibration

Parameter		Value	Target
Industry Parameters:			
Expenditure share	a_0, a_0^*	$0.1, 0.9$	Barrot et al. (2019)
Elasticity across industries	θ	1.2	Loualiche (2021)
Elasticity across varieties	σ_J	3.8	Broda and Weinstein (2006)
Pareto tail parameter	γ_J	3.6	
Headquarter transmission parameter	ζ	0.5	Cravino and Levchenko (2017)
Production			
Labor supply	L, L^*	$1, 7$	ratio of w.age pop. in US, and ROW
Mass of firms	N_J, N_J^*	$1, (5, 2)$	ratio of market cap in US, ROW
Horizontal FDI Costs			
Knowledge Transfer Costs	K_J	1.2	Normalization
Fixed FDI costs	$(f_1, f_2), (f_1^*, f_2^*)$	$(1, 8), (0.01, 0.08)$	fraction of multinationals
Fixed IT costs	f_{ITJ}	$(1, 8), (0.01, 0.08)$	
Aggregate Productivity:			
United States	μ_A	7	US GDP
	σ_A, ρ_A	$1.7\%, 0.98$	US GDP
Rest of the World	μ_A^*	1	ROW GDP
	σ_A^*, ρ_A^*	$6.8\%, 0.99$	
Preferences (Dynamics):			
Discount factor	β	0.99	Bansal and Yaron (2004)
Intertemporal Elasticity of Substitution	ψ	1.2	Bansal and Yaron (2004)
Risk aversion parameter	ν	20	match U.S. equity premium

Notes: This table presents the calibration of the model.

Table 12: Simulated Moments

Panel A: Targeted Moments

	model	data
Share Market Capitalization ROW	0.90	0.90
Share Working Age Population ROW	0.14	0.14
Avg MNE Share ROW - Mean	18.32%	16.89%
Avg Foreign Penetration ROW - Std	10.67%	8.13%

Panel B: Macro Moments

	Agg. Consumption		Risk-free Rate	
	model	data	model	data
Mean			3.08%	2.82%
Std. dev	20.81%	2.63%	0.60%	2.21%

Panel C: Sectoral Moments

	Foreign Share		Domestic Industry Profits		Excess Returns(Local)		Excess Returns(MNE)	
	Low	High	Low	High	Low	High	Low	High
Mean	10.57%	27.91%	0.41	0.50	1.60	2.34	0.83%	0.89%
Std. dev	6.13%	14.36%	0.13%	0.10%	8.5%	12.02%	5.18%	5.45%
β_A	-0.05	-0.7	0.15	0.19	0.01	0.02	0.00	0.00
β_{A^*}	0.14	0.32	-0.46	-0.69	-0.03	-0.05	-0.21	-0.23
$\mathcal{E}_C$	-0.31	-0.71	1.01	1.53	0.07	0.11	0.05	0.05

Notes: This table presents the simulated moments from the model.

B Theory Appendix

In this section, I derive formally the competitive equilibrium of the model with J industries and 2 countries. I extend the model in the main paper, to incorporate a different level of wages in the two locations, the fact that the productivity of an establishment may depend on the process of both "home" and "foreign" productivity. First, I solve the static allocation before setting up the aggregate optimization program for the participants in the economy: Households and Firms.

B.1 Model Equilibrium derivation

Most of the model derivations do not involve dynamic choices and thus in what follows I drop the t subscript if they are no dynamic considerations. In addition, the following expressions are derived for one of the two countries, "home" (for the other country, choices; cutoffs and relevant elasticities are symmetric).

B.1.1 Static Consumption Choices

Given the nested demand, I derive the optimal allocations and decisions in three steps. First, I derive demand for the bundle C_D of differentiated good sectors and the homogeneous good sector, c_0. The upper tier optimization program for consumers is

$$\max_{C_D, c_0} c_0^{1-a_0} \cdot C_D^{a_0}, \quad \text{s.t.} \quad P_D C_D + p_0 c_0 \leq Y$$

where C_D is the consumption index from consumption in the $\mathcal{J}$ industries, P_D the relevant price index, p_0 the price of the homogeneous good, and Y the total income of consumers. From the first order conditions I derive the aggregate price index P and demand for each type of goods:

$$\begin{aligned}
P &= \left(\frac{P_D}{a_0}\right)^{a_0} \left(\frac{p_0}{1-a_0}\right)^{1-a_0} \\
c_0 &= (1-a_0)\,\frac{PC}{p_0} \\
C_D &= a_0 \frac{PC}{P_D}
\end{aligned}$$

Given the allocation above, the consumer optimizes over the allocation across the $\mathcal{J}$ industries. Given the constant elasticity of substitution θ, the optimization problem yields the usual expression for consumption under CES preferences:

$$\max_{\{C_J\}} \left(\sum_J C_J^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} \qquad \text{s.t} \qquad \sum_J P_J C_J \leq P_D C_D$$

where $\{P_J\}$ represents the price level for each sector J. The optimal allocations are given by

$$C_J = \left(\frac{P_J}{P_D}\right)^{-\theta} \cdot C_D$$

and total expenditures in sector J are

$$P_J C_J = \left(\frac{P_J}{P_D}\right)^{1-\theta} a_0 \cdot PC$$

This means that the price index for the differentiated goods is

$$P_D = \left[\sum_J P_J^{1-\theta}\right]^{\frac{1}{1-\theta}}$$

Finally, within each sector, the variety-level demand is given by $c_J(\omega)$, where $c_J(\omega)$ optimizes the following problem given the aggregated sectoral level consumption and prices in industry J :

$$\max_{c_J(\omega)} \left[\int_{\Omega_J} c_J(\omega)^{\frac{\sigma_J - 1}{\sigma_J}} d\omega\right]^{\frac{\sigma_J}{\sigma_J - 1}} \qquad \text{s.t.} \qquad \int_{\Omega_J} p_J(\omega) c_J(\omega) d\omega \leq P_J C_J$$

From first-order conditions, individual variety expenditures and the price index across all varieties Ω, with a price $p(\omega)$ of each variety, satisfies:

$$p(\omega) c_J(\omega) = p(\omega) \left(\frac{p(\omega)}{P_J}\right)^{-\sigma_J} \cdot C_J$$

$$P_J = \left[\int_{\Omega} p(\omega)^{1-\sigma_J} d\omega\right]^{\frac{1}{1-\sigma_J}}$$

In the following sections I describe the determination of the number of varieties Ω and prices $p(\omega)$ that determine the dynamics of the sales shares of firms and their correlation with aggregate consumption processes.

B.1.2 Supply Side

Sector 0 By assumption, sector 0 produces a homogeneous good with linear technology in labor and unit productivity. The homogeneous good 0 is freely traded and is used as the numeraire in each country. It is produced under constant returns to scale with one unit of labor producing w units of good and its price is set equal to 1. Then each country has a different wage w and w^*. This generalizes the case presented in the main body of the paper.

Differentiated Sectors Firms in the other sectors operate under monopolistic competition and thus their prices are equal to the markup times the marginal cost. Given isoelastic demand in each industry, where the constant elasticity is given by σ_J, the markup is given by $\sigma_J/(\sigma_J-1)$. An establishment of a firm with efficiency parameter φ sets the following price if it operates in firms' headquarters, given the discussion on firm productivity:

$$p_J(\varphi) = \frac{\sigma_J}{\sigma_J - 1} w/(A\varphi)$$

and the following price when it does not operate in firms' headquarters:

$$p_{NJ}(\varphi) = \frac{\sigma_J}{\sigma_J - 1} w^*/\Big((A\varphi)^{1-\zeta}(A^*\varphi)^{\zeta}\exp(-\kappa\mathbb{I}(\varphi < \underline{\varphi}_{ITJ})\Big)$$

The productivity of establishments in the two different locations differ by assumption. In particular, the establishment productivity is a weighted average of the productivity of the firm at the headquarter's location $A\varphi$ and at the establishment location $A^*\varphi$ times an efficiency cost term $\exp(-\kappa\mathbb{I}_a(\varphi < \underline{\varphi}_{ITJ}))$. The idiosyncratic parameter of the productivity does not differ across locations. The efficiency cost represents costs of technology transfer or more generally any efficiency losses due to managing an establishment in a distant environment. Efficiency costs depend on the IT adoption decision $\mathbb{I}(\varphi \geq \underline{\varphi}_{ITJ})$ of the firm. In what follows, I will be using the following expression for prices:

$$p_{NJ}(\varphi) = K(\varphi)\frac{w^*}{w}(\frac{A}{A^*})^{\zeta} p_J(\varphi),$$

where

$$K(\varphi) \equiv \exp(\kappa\mathbb{I}(\varphi \geq \underline{\varphi}_{ITJ}))$$

These efficiency losses affect productivity and thus prices. Firm profits depend on chosen prices and quantities produced, and the number of establishments operated by the firms, along with the IT adoption decision. The local HQ - establishment profits are given by

$$\begin{aligned}
\pi_J(\varphi) &= \frac{1}{\sigma_J}\cdot\left(\frac{p_J(\varphi)}{P_J}\right)^{1-\sigma_J}\cdot P_J C_J \\
&= \frac{p_J(\varphi)}{\sigma_J}\cdot\left(\frac{p_J(\varphi)}{P_J}\right)^{-\sigma_J}\cdot\left(\frac{P_J}{P_D}\right)^{1-\theta}\cdot a_0\cdot PC
\end{aligned}$$

The level of profits (or losses) of a second location are given by:

$$\pi_{NJ}(\varphi) = \frac{1}{\sigma_J}\cdot\left(\frac{p_{NJ}(\varphi)}{P_J^*}\right)^{1-\sigma_J}\cdot P_J^* C_J^* - \frac{f_J}{A} - \frac{f_{ITJ}\mathbb{I}(\varphi \geq \underline{\varphi}_{ITJ})}{A}.$$

Profits are increasing in idiosyncratic productivity, and hence there exists a productivity cutoff in each industry under which a firm decides to create a second establishment. Similarly, there is a cutoff related to the decision to adopt IT. The assumption for the fixed costs are such that the cuttof for IT adoption is always larger than that of operating a second establishment.

B.1.3 Decision to operate second establishment and adopt IT

In this section, I describe the cutoffs that determine the decisions of the firms. I define the following cutoff level for firms that operate a second establishment as

$$\underline{\varphi}_{NJ} = \min_{\varphi}\{\varphi \mid \varphi \text{ implies that firm is operating a second establishment}\}.$$

Similarly, for firms that choose to use IT, I have:

$$\underline{\varphi}_{ITJ} = \min_{\varphi}\{\varphi \mid \varphi \text{ is adopting IT}\}.$$

I impose the relevant restrictions such that there is always a positive mass of firms, operating a second establishment but do not adopt IT. Now let's derive the cutoffs. The cutoff productivity for IT adoption is given by the lower bound of φ such that:

$$\frac{1}{\sigma_J}\cdot\left(\frac{\frac{w^*}{w}(\frac{A}{A^*})^{\zeta}p_J(\varphi)}{P_J^*}\right)^{1-\sigma_J}\cdot P_J^*C_J^* - \frac{f_J}{A} - \frac{f_{ITJ}}{A} >$$

$$\frac{1}{\sigma_J}\cdot\left(\frac{\exp(\kappa)\frac{w^*}{w}(\frac{A}{A^*})^{\zeta}p_J(\varphi)}{P_J^*}\right)^{1-\sigma_J}\cdot P_J^*C_J^* - \frac{f_J}{A}$$

which is true if:

$$\frac{B_J^{*-1}}{A}\left[(\varphi)^{-1+\sigma_J} - K^{1-\sigma_J}(\varphi)^{-1+\sigma_J}\right] - \frac{f_{ITJ}}{A} \geq 0$$

where $K = \exp(\kappa)$ and B_J^* is the following helpful expression summarising the aggregate state of the economy:

$$B_J^* = \sigma_J\left(\frac{\sigma_J}{\sigma_J - 1}\frac{w^*}{w}(\frac{A}{A^*})^{\zeta}\right)^{\sigma_J - 1}\cdot A^{-\sigma_J}\cdot(P_J^*)^{-\sigma_J}(C_J^*)^{-1}$$

Then, the cutoff is such that:

$$(\underline{\varphi}_{ITJ})^{\sigma_J - 1} = \frac{B_J^* f_{ITJ}}{1 - K^{1-\sigma_J}}$$

Similarly, the cutoff productivity for operating an establishmentis given by

$$\left(\underline{\varphi}_{NJ}\right)^{\sigma_J - 1} = B_J^* f_J (K)^{\sigma_J - 1}$$

A very useful property in models where productivities are distributed Pareto, is that the relative ratio of the cutoffs will be constant. In particular, the two cutoffs satisfy:

$$\underline{\varphi}_{ITJ}/\underline{\varphi}_{NJ} = \left(\frac{1}{K^{\sigma_J - 1} - 1}\right)^{1/(\sigma_J - 1)}(f_{ITJ}/f_J)^{1/(\sigma_J - 1)} \equiv \Gamma_J$$

so the two cutoffs move proportionally with the aggregate productivity, A, which is an important property used to derive the results below. This property in particular implies that given that by assumption the parameters are assumed to be fixed, then the relationship between the cutoffs is constant over time and the only fluctuations in IT adoption and establishment entry are due to aggregate productivity shocks. For what follows, the following equation will be useful

$$f_{ITJ} = f_J \Gamma_J^{\sigma_J - 1}(K^{\sigma_J - 1} - 1)$$

To derive an expression for the local sectoral price index I need to determine the mass of multianational firms operating in industry J, that their HQs are not in the "home" economy, N_{NJ}^{*}. These variables then summarize the supply side of the economy and given the aggregate productivity shocks A and A^{*} are essentially static. Lastly, total industry profits for "home" firms in a sector J are defined as:

$$\Pi_J := \left[\int_{\Omega_J}^{\infty} \pi_J\left(\varphi_J\right) \mathrm{d}G_J(\varphi) + \int_{\Omega_{NJ}^{*}}^{\infty} \pi_{NJ}\left(\varphi_J\right) \mathrm{d}G_J(\varphi) \right]$$

The set of "home" products $\Omega_{NJ}^{\star}$ sold in the foreign country is determined by the cutoff in the previous section.

B.1.4 Households Dynamic Problem.

The representative household has recursive Epstein - Zin preferences. Every period, the continuation utility J_t is affected by the future sequence of consumption and the current aggregate consumption index C_t :

$$J_t = \left[(1-\beta) C_t^{1-\nu} + \beta \left(\mathrm{R}_t\left(J_{t+1}\right) \right)^{1-\nu} \right]^{\frac{1}{1-\nu}}$$

where β is the time preference parameter, ν is the inverse of the inter-temporal elasticity of substitution (IES) and ψ is the coefficient of relative risk aversion. $\mathrm{R}_t\left(J_{t+1}\right) = \left[\mathbf{E}_t \left\{ J_{t+1}^{1-\psi} \right\} \right]^{1/(1-\psi)}$ is the risk adjusted continuation utility. The representative household is subject to his sequential budget constraint as presented in the description of the model and repeated here for completeness. If there is risk sharing with parameter χ, I have:

$$C_t + \sum_J \int_{\Omega_J^D} x_{J,t+1}(\varphi) v_{J,t}(\varphi) \mathrm{d}\varphi \leq w_t L + \sum_J \int_{\Omega_j^D} x_{J,t}(\varphi) \left(v_{J,t}(\varphi) + \pi_{J,t}(\varphi) \right) \mathrm{d}\varphi + \chi \Pi_M$$

Each household chooses $x_{J,t}$ equity holdings for domestically owned firms as described in the body of the paper. In addition, they own shares in a non- traded security that provides profits Π_M and affects the degree of risk sharing. Households investment decision determines market prices for the firms in their own country: $v_{J,t} x_{J,t}$. They also receive dividends from their ownership in these firms as income, $x_{J,t}\left(v_{J,t} + \pi_{J,t}\right)$ for consumption goods. Π_M are the profits shared through the global mutual fund as described in the main body of the paper.

Here I describe the solution to the dynamic problem. The respective Lagrange multipliers for each equation is given by κ_t. Optimization conditions on respectively C_{t+1}, C_t, and $x_{J,t+1}$ are such that :

$$\kappa_{t+1} = \partial J_t / \partial C_{t+1}, \kappa_t = \partial J_t / \partial C_t$$

$$\kappa_t v_{J,t}(\varphi) = \mathbf{E}_t \left\{ \kappa_{t+1} \left(v_{J,t+1}(\varphi) + \pi_{J,t+1}(\varphi) \right) \right\}$$

B.1.5 Dynamic Equilibrium.

An equilibrium is a set of prices and allocations

$$\left(p_{Jt}, p_{NJt}, P_{Jt}, P_{Tt}, P_t \right), q_{Jt}(\varphi), c_{Jt}(\varphi), l_{Jt}(\varphi)$$

such that: (a) given prices, allocations maximize the households program; (b) given prices allocations maximize firms profits; (c) labor markets, good markets and asset markets clear.

To characterize the equilibrium, I derive the aggregate production function, firms' valuation and their dynamics through the Euler equation. But first I calculate the equilibrium profit of the differentiated varieties producers in each industry. Home demands and profits are given in equations as in the main body of the paper.

B.1.6 Industry Aggregation

As in Helpman et al. (2004), and Barrot et al. (2019) for the solution of the equilibrium, it is enough to keep track only the mass and the average productivity for firms that choose to operate the same number of establishments, and that have the same technologies, i.e. they have adopted IT or not. This means for the aggregation, the theoretical predictions and for the numerical implementation of the model, I need at each period to keep track of:

1. The fraction of firms in industry J that engage in production ζ_J, the mass of firms that operate in two locations ζ_{NJ} and the mass of firms that have adopted IT ζ_{ITJ}.

2. Derive average productivity levels for these different groups: 1) $\bar{\varphi}_J$, for all firms; 2) $\bar{\varphi}_{NJ}$, for firms that operate in two locations and 3) $\bar{\varphi}_{ITJ}$, for firms that adopt IT . Similarly I need to keep track the same cutoffs for the other region

3. Industry-wide profits and price indices can be calculated using probability masses and average productivity levels.

As I show below, the aggregation of industry variables is simplified even further since the relative cuttofs $\bar{\varphi}_{ITJ}$ and $\bar{\varphi}_{NJ}$ are given by a constant, as well as the ratio of the mass of firms ζ_{NJ} and ζ_{ITJ}.

B.2 Aggregation

B.2.1 Multinational firms and IT adoption

Given the productivity cutoff for entering the foreign country φ_{NJ}, the fraction of ME firms, denoted ζ_{NJ}, is given by

$$\zeta_{NJ} := Pr\left\{\tilde{\varphi} > \underline{\varphi}_{NJ}\right\} = \left(\frac{\underline{\varphi}_{NJ}}{\underline{\varphi}_{J}}\right)^{-\gamma_J}$$

Given the cutoffs described above, the fraction of firms that choose to adopt IT then satisfies:

$$\zeta_{ITJ} = Pr\left\{\tilde{\varphi} > \underline{\varphi}_{ITJ}\right\}$$

Due to the Pareto distribution assumption, the average productivity of firms with productivity higher than a cutoff value $\underline{\varphi}_{ITJ}$ would be equal to:

$$\overline{\varphi}_{ITJ} = \left[\frac{\int_{\underline{\varphi}_{ITJ}}^{\infty} \varphi^{\sigma_J - 1} dG_J(\varphi)}{1 - G\left(\underline{\varphi}_{ITJ}\right)}\right]^{\frac{1}{\sigma_J - 1}} = \nu_J \underline{\varphi}_{ITJ}$$

where ν_J is defined as $\nu_J := \left(\gamma_J / \left(\gamma_J - (\sigma_J - 1)\right)\right)^{1/(\sigma_J - 1)}$ and so it depends only on the elasticity of substitution and the tail parameter of the distribution, which leads to the formulas described in the paper. The average productivity of firms with productivity higher than cutoff value $\underline{\varphi}_{NJ}$ also satisfies:

$$\bar{\varphi}_{NJ} = \nu_J \underline{\varphi}_{NJ}$$

where ν_J is defined as $\nu_J := \left(\gamma_J / \left(\gamma_J - (\sigma_J - 1)\right)\right)^{1/(\sigma_J - 1)}$ and so it depends only on the elasticity of substitution and the tail parameter of the distribution. Then, the local price indices for sector J are given by:

$$P_J = \left(N_J \int_{\underline{\varphi}_J} p_J(\varphi)^{1-\sigma_J} d\varphi + (\zeta_{NJ}^* N_J^*) \int_{\underline{\varphi}_{NJ}^*} p_{NJ}^*(\varphi)^{1-\sigma_J} d\varphi\right)^{\frac{1}{1-\sigma_J}}$$

where the price of goods from an establishment of a firm not located in the same county satisfies the following expression:

$$p_{NJ}^*(\varphi) = \begin{cases} K^* \frac{w}{w^*} (\frac{A^*}{A})^{\zeta} p_J^*(\varphi) & \text{if } \underline{\varphi}_{NJ} < \varphi \leq \underline{\varphi}_{ITJ} \\ \frac{w}{w^*} (\frac{A^*}{A})^{\zeta} p_J^*(\varphi) & \text{if } \varphi > \underline{\varphi}_{ITJ} \end{cases}$$

Note that the price index of different industries reflects the decline in the price level from the IT adoption and thus the increase in competition, in industries of which the fixed cost of adoption is lower. Now the price index in industry J reflects the effect of an increase in competition from the IT intensive firms leading to lower industry level prices.

B.2.2 Aggregation

Instead of keeping track of the distribution of production and prices, it is sufficient to analyze average producers, first for the whole domestic market $\bar{\varphi}_J$ and second for the subset of multinational firms $\bar{\varphi}_{NJ}$. The following quantities are sufficient to define the equilibrium:

$$\bar{\varphi}_J := \left[\int_{\underline{\varphi}_J}^{\infty} \varphi^{\sigma_J - 1} \mathrm{d}G_J(\varphi)\right]^{\frac{1}{\sigma_J - 1}} = \nu_J \cdot \underline{\varphi}_J$$

$$\bar{\varphi}_{NJ} := \left[\int_{\varphi_{NJ}}^{\infty} \varphi^{\sigma_J - 1} \mathrm{d}G_J(\varphi)\right]^{\frac{1}{\sigma_J - 1}} = \nu_J \cdot \underline{\varphi}_{NJ}$$

$$\bar{\varphi}_{ITJ} := \left[\int_{\varphi_{ITJ}}^{\infty} \varphi^{\sigma_J - 1} \mathrm{d}G_J(\varphi)\right]^{\frac{1}{\sigma_J - 1}} = \nu_J \cdot \underline{\varphi}_{ITJ}$$

where ν_J, the average of firm productivity under a Pareto distribution, is given by $\nu_J = \left(\frac{\gamma_J}{\gamma_J - (\sigma_J - 1)}\right)^{\frac{1}{\sigma_J - 1}}$.

Average profits for "home" establishments in the "home" country in industry J are $\pi_J\left(\bar{\varphi}_J\right)$ and for the establishments in the foreign country are given by $\pi_{NJ}\left(\bar{\varphi}_{NJ}\right) + \Delta\pi_{NJ}\left(\bar{\varphi}_{ITJ}\right)$ where $\Delta\pi_{NJ}\left(\bar{\varphi}_{ITJ}\right)$ are the additional realized profits if a firms adopts IT and is defined explicitly below[44]:

$$\Delta\pi_{NJ}\left(\bar{\varphi}_{ITJ}\right) = \frac{B_J^{*-1}}{A}\left[\left(\bar{\varphi}_{ITJ}\right)^{-1+\sigma_J} - K^{1-\sigma_J}\left(\bar{\varphi}_{ITJ}\right)^{-1+\sigma_J}\right] - \frac{f_{ITJ}}{A}$$

and similarly for the prices, since we have:

$$p_{NJ}^*(\varphi) = \begin{cases} K^* \frac{w}{w^*}(\frac{A^*}{A})^\zeta p_J^*(\varphi) & \text{if } \underline{\varphi}_{NJ} < \varphi \leq \underline{\varphi}_{ITJ} \\ \frac{w}{w^*}(\frac{A^*}{A})^\zeta p_J^*(\varphi) & \text{if } \varphi > \underline{\varphi}_{ITJ} \end{cases}$$

and the realized reduction in the price in the case of IT adoption for a firm with productivity φ, we have $\Delta p_{NJ}^*(\varphi) = (1 - K^*)\frac{w}{w^*}(\frac{A^*}{A})^\zeta p_J^*(\varphi)$. In addition, given the definition of mean levels, across different groups I have:

$$\bar{\varphi}_{ITJ}/\bar{\varphi}_{NJ} = \left(\frac{1}{K^{\sigma_J - 1} - 1}\right)\left(f_{ITJ}/f_J\right)^{1/(\sigma_J - 1)} = \Gamma_J$$

The relative share of IT adopters also satisfies:

$$\zeta_{ITJ}/\zeta_{NJ} = \Gamma_J^{-\gamma_J}$$

which is independent of A and A^*. Using the expressions for the profit functions and the cutoffs,

[44]This expression summarizes the additional profits of IT adopters, compared to a case where this option is not available.

aggregate profits can be written as:

$$\Pi_J := N_J \left[\pi_J\left(\bar{\varphi}_J\right) + \zeta_{NJ}\pi_{NJ}\left(\bar{\varphi}_{NJ}\right) + \zeta_{NJ}\Gamma_J^{-\gamma_J}\Delta\pi_{NJ}\left(\Gamma_J\bar{\varphi}_{NJ}\right)\right]$$

where I have substituted the expressions for $\bar{\varphi}_{ITJ}$ and ζ_{ITJ} which makes it immediate to see that the IT cutoffs are not important for aggregation given the results presented above. This implies that I need to keep track only the cutoff for the operation of a second establishment $\bar{\varphi}_{NJ} = v_J \underline{\varphi}_{NJ}$. The same aggregation property simplifies the expression for the sectoral price index P_J :

$$P_J = \left(N_J \cdot p_J\left(\bar{\varphi}_J\right)^{1-\sigma_J} + \zeta^*_{NJ}N^*_J \cdot p^*_{NJ}\left(\bar{\varphi}^*_{NJ}\right)^{1-\sigma_J} + \zeta^*_{NJ}\Gamma_J^{*-\gamma_J}N^*_J\Delta p^*_{NJ}\left(\Gamma^*_J\bar{\varphi}^*_{NJ}\right)^{1-\sigma_J}\right)^{\frac{1}{1-\sigma_J}}$$

where $p^*_{NJ}\left(\bar{\varphi}^*_{NJ}\right) = K^*\frac{w}{w^*}(\frac{A^*}{A})^{\zeta}p^*_J(\bar{\varphi}^*_{NJ})$ and $\Delta p^*_{NJ}\left(\bar{\varphi}^*_{NJ}\right) = (K^*-1)\frac{w}{w^*}(\frac{A^*}{A})^{\zeta}p^*_J(\bar{\varphi}^*_{NJ})$.

So simplifying even further

$$P_J = \left(N_J \cdot p_J\left(\bar{\varphi}_J\right)^{1-\sigma_J} + \zeta^*_{NJ}N^*_J \cdot p^*_{NJ}\left(\bar{\varphi}^*_{NJ}\right)^{1-\sigma_J}\left[1 + (K^{*\sigma_J - 1} - 1)\Gamma_J^{*-\gamma_J+\sigma_J-1}\right]\right)^{\frac{1}{1-\sigma_J}}$$

or using the following definition
$H\left(K^*, \Gamma^*_J, \gamma_J, \sigma_J\right) \equiv [1 + (K^{*\sigma_J-1} - 1)\Gamma_J^{*-\gamma_J+\sigma_J-1}]$:

$$P_J = \left(N_J \cdot p_J\left(\bar{\varphi}_J\right)^{1-\sigma_J} + \zeta^*_{NJ}N^*_J \cdot p^*_{NJ}\left(\bar{\varphi}^*_{NJ}\right)^{1-\sigma_J} H\left(K^*, \Gamma^*_J, \gamma_J, \sigma_J\right)\right)^{\frac{1}{1-\sigma_J}}$$

B.3 IT intensity

Lemma 5. *Proof of Lemma 1*

In particular, I have that IT labor hours in the "home" market are equal to the product of the number of producers, the amount required to operate IT and the endogenous percentage of firms that choose to operate IT:

$$L_J^{IT} = N_J \times f_{ITJ} \times \zeta_{ITJ} = N_J f_{ITJ}\Gamma_J^{-\gamma_J}\zeta_{NJ} =$$

$$= N_J f_{ITJ}\left(\frac{1}{K^{\sigma_J-1}-1}\right)^{-\gamma_J/(\sigma_J-1)}\left(f_{ITJ}/f_J\right)^{-\gamma_J/(\sigma_J-1)}\zeta_{NJ}$$

$$L_J^{IT} = N_J\zeta_{NJ}\left(f_J(K^{\sigma_J-1}-1)\right)^{\gamma_J/(\sigma_J-1)}\left(f_{ITJ}\right)^{1-\gamma_J/(\sigma_J-1)}$$

Given the fixed number of firms N_J, and the fact that ζ_{NJ} is independent of f_{ITJ} and the coefficient of f_{ITJ} is $-\frac{\gamma_J-\sigma_J+1}{\sigma_J-1}$, the proof of Lemma 1 is immediate.

The level of IT fixed costs reduces the number of IT workers and thus the IT intensity of the industry. In addition, the level of the fixed costs and the efficiency losses $K = \exp(\kappa)$ interact to determine the overall level of IT intensity of an industry. Figure 12 summarizes these forces. In addition, this key equation shows that the more heterogeneity there is in an industry, then the larger the IT intensity, conditional on the fixed cost of IT. Also the level of heterogeneity, determines how a shock to the cost of IT adoption affects the reaction of IT intensity, through the level of the elasticity. In addition, it is important to observe that the level of the IT intensity of each industry, corresponds to the labor based measures of IT intensity as the ones used for the empirical exercise based on the IT employment of industries in the U.S.

B.4 Multinational firm's share

First let us define the multinational firm's effect on the price index (competition) as:

$$\mathcal{I}_J = \frac{\zeta_{NJ}^* N_J^* \cdot p_{NJ}^* \left(\bar{\varphi}_{NJ}^*\right)^{1-\sigma_J} H_J^*}{P_J^{1-\sigma_J}}$$

It is useful to remember also that

$$p_{NJ}^*(\bar{\varphi}_{NJ}^*) = K^* \frac{w}{w^*} (\frac{A^*}{A})^{\zeta} p_J^*(\bar{\varphi}_{NJ}^*)$$

This represents the marginal impact of multinational firms on the price index for a given industry. Given our definition of P_J, this variable is bounded: $\mathcal{I}_J \in [0,1]$.

Lemma 6. *The level of $\mathcal{I}_J$ is a decreasing function of the cost of adoption f_{ITJ}^* and a decreasing function of the cost of foreign operations f_J^*.*

The proof of this proposition is immediate since it is a simple matter of observing that f_{ITJ}^* appears only in the expression for H_J^* and that H_J^* is decreasing in f_{ITJ}^*.

B.5 Elasticities

All elasticitites $\mathcal{E}^*(X) \equiv \frac{\partial log X}{\partial log A^*}$ are with respect to an aggregate shock A^* and $\mathcal{E}(X) = \frac{\partial log X}{\partial log A}$ with respect to an aggregate shock A. Elasticities related to total and sector price indices:

$$\mathcal{E}^*(P) = a_0 \mathcal{E}^*\left(P_D\right)$$
$$\mathcal{E}^*\left(P_D\right) = \sum_J \left(\frac{P_D}{P_J}\right)^{\theta-1} \mathcal{E}^*\left(P_J\right)$$

Elasticities related to total, sector and industry consumption:

$$\mathcal{E}^*(C) = -\mathcal{E}^*(P) + \frac{\Pi}{wL+\Pi}\mathcal{E}^*(\Pi)$$
$$\mathcal{E}^*\left(C_D\right) = \mathcal{E}^*(C) - \left(1-a_0\right)\mathcal{E}^*\left(P_D\right) = \mathcal{E}^*(C) - \left(\frac{1}{a_0} - 1\right)\mathcal{E}^*(P)$$
$$\mathcal{E}^*\left(C_J\right) = -\theta\mathcal{E}^*\left(P_J\right) + \theta\mathcal{E}^*\left(P_D\right) + \mathcal{E}^*\left(C_D\right) = ...$$

$$-\theta\mathcal{E}^*\left(P_J\right) + \mathcal{E}^*(C) + \left[\theta - \left(1-a_0\right)\right]\mathcal{E}^*\left(P_D\right)$$

Productivity cutoff: Using the definition of φ^*_{NJ}, I have to a first-order approximation

$$\varphi^*_{NJ} \propto (A^*)^{\zeta - \frac{\sigma_J}{\sigma_J - 1}} \cdot P_J^{-1} \cdot (PC)^{-\frac{1}{\sigma_J - 1}}$$

where the coefficient of proportionality does not depend on A^*. Hence, the elasticity of the foreign productivity cutoff is given by

$$\mathcal{E}^* \left(\varphi^*_{NJ}\right) = \zeta - \frac{\sigma_J}{\sigma_J - 1} + \frac{\sigma_J}{\sigma_J - 1} \left(-\mathcal{E}^\star \left(P_J\right)\right) - \frac{1}{\sigma_J - 1} \mathcal{E}^\star \left(C_J\right)$$

where the first term increases the cutoff due to an increase in competition, and the second lowers it due to an increase in industry demand. The last term comes from aggregate demand and lowers the cutoff.

Now the derivation of the IT elasticity cutoff is simple, since in equilibrium we showed that the two cutoffs are proportional and the degree of proportionality is independent of the aggregate shocks, and this means we have:

$$\mathcal{E}^\star \left(\varphi_{NJ}\right) = \mathcal{E}^\star \left(\varphi_{ITJ}\right)$$

B.6 Model implications

Let's recall the definition of the following variable:

$$\mathcal{I}_J = \frac{\zeta^*_{NJ} N^*_J \cdot p^*_{NJ} \left(\bar{\varphi}^*_{NJ}\right)^{1-\sigma_J} H^*_J}{P_J^{1-\sigma_J}}$$

and

$$p^*_{NJ}(\bar{\varphi}^*_{NJ}) = K^* \frac{w}{w^*} (\frac{A^*}{A})^{\zeta} p^*_J(\bar{\varphi}^*_{NJ})$$

where the only effect of f^*_{ITJ} is through H^*_J. In addition, H^*_J is independent of the aggregate shocks, A and A^*.

Lemma 7. *The elasticity of firms' local cash flows to productivity shocks is*

$$\mathcal{E}^* \left(\Pi_{LJ}\right) = \frac{-\mathcal{I}_J \cdot \left(\left(\sigma_J - 1\right)\left(1 - \zeta\right) + \xi_J \sigma_J - \xi_J \zeta (\sigma_J - 1)\right) + \mathcal{E}^*(PC)}{1 + \xi_J \mathcal{I}_J}$$

where $\xi_J = \frac{\gamma_J}{\sigma_J - 1} - 1 > 0$ is a parameter defined for notational convenience and $\mathcal{I}_J$ is the level of global firms presence in industry J defined above. If the second term due to demand effects is small enough, local firms' cash flows respond negatively to productivity shocks A^*. The elasticity is bigger, the bigger is the value of $\mathcal{I}_J$.

Remember that profits of firms that operate establishments locally are given by

$$\Pi_{LJ} = N_J \int \pi_J(\varphi) d\varphi = N_J \pi_J(\bar{\varphi}_J) = \frac{1}{\sigma_J} \cdot \left(\frac{p_J(\bar{\varphi}_J)}{P_J}\right)^{1-\sigma_J} \cdot \left(\frac{P_J}{P_D}\right)^{1-\theta} \cdot a_0 \cdot PC$$

A shock to A^* leads to an increase in foreign establishment entry, that leads to an increase in variety demand and total expenditures. The elasticity of local profits is [45]

$$\mathcal{E}^*\left(\Pi_{LJ}\right) = \mathcal{E}^*\left(\pi_J(\bar{\varphi}_J)\right) = -\left(\sigma_J - 1\right)\cdot\left(-\mathcal{E}^*\left(P_J\right)\right) + \quad \mathcal{E}^*(PC)$$

In addition it is useful to observe that irrespective of the firm size the elasticity of local profits is equalized across the size distribution and thus

$$\mathcal{E}^*\left(\Pi_{LJ}\right) \quad = \underbrace{-\left(\sigma_J - \theta\right)\left(-\mathcal{E}^*\left(P_J\right)\right)}_{\text{competition effect}} + \underbrace{\mathcal{E}^*\left(C\right) + \frac{1 - a_0 - \theta}{a_0}\left(-\mathcal{E}^*(P)\right)}_{\text{expenditure effect}}$$

Now, the separate components affecting the elasticity are analyzed.

Competition effect. Observe that the competition effect differs across industries. The elasticity for the price index in industry J is:

$$\begin{aligned}\mathcal{E}^*\left(P_J\right) &= \frac{\zeta^*_{NJ} N^*_J \cdot p^*_{NJ}\left(\bar{\varphi}^*_{NJ}\right)^{1-\sigma_J} H^*_J}{P_J^{1-\sigma_J}} \cdot \left[(1-\zeta) + \frac{\partial \log p^*_{NJ}}{\partial \log \bar{\varphi}^*_{NJ}} \frac{\partial \log \bar{\varphi}^*_{NJ}}{\partial \log A^*} + \frac{1}{1-\sigma_J}\frac{\partial \log \zeta^*_{NJ}}{\partial \log A^*}\right] \\ &= -\mathcal{I}_J \cdot \left[1 - \zeta + \left(\frac{\gamma_J}{\sigma_J - 1} - 1\right)\left(-\mathcal{E}^*\left(\bar{\varphi}^*_{NJ}\right)\right)\right]\end{aligned}$$

where I use the following equality (from the definition of ζ^*_j)

$$\mathcal{E}^*\left(\zeta^*_{NJ}\right) = -\gamma_J \cdot \mathcal{E}^*\left(\varphi^*_{NJ}\right)$$

Productivity cutoff- Using the definition of $\underline{\varphi}^*_{NJ}$, I have to a first-order approximation

$$\underline{\varphi}^*_{NJ} \propto \left(A^*\right)^{\zeta - \frac{\sigma_J}{\sigma_J - 1}} \cdot P_J^{-1} \cdot (PC)^{-\frac{1}{\sigma_J - 1}}$$

where the coefficient of proportionality does not depend on A^*. Hence, the elasticity of the foreign productivity cutoff is given by

$$\mathcal{E}^*\left(\underline{\varphi}^*_{NJ}\right) = \zeta - \frac{\sigma_J}{\sigma_J - 1} + \frac{\sigma_J}{\sigma_J - 1}\left(-\mathcal{E}^\star\left(P_J\right)\right) - \frac{1}{\sigma_J - 1}\mathcal{E}^\star\left(C_J\right)$$

where the first term increases the cutoff due to an increase in competition, and the second lowers it due to an increase in industry demand. The last term comes from aggregate demand and lowers the cutoff. Combining, I obtain

$$\mathcal{E}^*\left(P_J\right) = -\frac{\mathcal{I}_J}{1 + \xi_J \mathcal{I}_J} \cdot \left[(1-\zeta) + \xi_J\left(\frac{\sigma_J}{\sigma_J - 1} - \zeta\right) + \frac{\xi_J}{\sigma_J - 1} \cdot \mathcal{E}^*(PC)\right],$$

[45]There are second-order effects of redistribution through the industry shares. I verify that they are small in the calibration and ignore them in the the derivation that follows.

Combining all the expressions together, I obtain the effect of foreign shocks on domestic profits:

$$\mathcal{E}^*\left(\Pi_{LJ}\right)=\frac{-\mathcal{I}_J\cdot\left(\left(\sigma_J-1\right)\left(1-\zeta\right)+\xi_J\sigma_J-\xi_J\zeta(\sigma_J-1)\right)+\mathcal{E}^*(PC)}{1+\xi_J\mathcal{I}_J}$$

QED.

Lemma 8. *The elasticity of firms' foreign cash flows to productivity shocks A^* is*

$$\mathcal{E}^*\left(\pi_{NJ}(\varphi)\right)=\left[-\left(\sigma_J-1\right)\cdot\frac{1-\mathcal{I}_J^*}{1+\xi_J\mathcal{I}_J^*}+\left(1-\zeta-\xi_J\frac{\mathcal{I}_J^*}{1+\xi_J\mathcal{I}_J^*}\right)\mathcal{E}^*\left(P^*C^*\right)\right]\cdot\left(1+o\ell_J(\varphi)\right)$$

with $o\ell_J(\varphi)=$ is the operating leverage of multi national firms, and depend on the choice of IT use. MNE profits are affected by two opposite forces. When firms become more productive, MNEs from the country now facing a relatively lower productivity lose market share - a business stealing channel similar to the one affecting local cash flows. However, as the other market grows with productivity, there is also a market size effect that counteracts the first effect. The last term captures an operating leverage channel driven by the fixed costs associated with MNE and IT operations.

Proof Profits for multinational firms are as follows in the foreign market:

$$\pi_{NJ}(\varphi)=\frac{1}{\sigma_J}\cdot\left(\frac{p_{NJ}(\varphi)}{P_J^*}\right)^{1-\sigma_J}\cdot P_J^*C_J^*-\frac{f_J}{A}-\frac{f_{ITJ}\mathbb{I}(\varphi\geq\underline{\varphi}_{ITJ})}{A}.$$

I also define the revenue function as

$$R_{NJ}(\varphi)=\pi_{NJ}(\varphi)+f_J/A+\frac{f_{ITJ}\mathbb{I}\left(\varphi\geq\varphi_{ITJ}\right)}{A}$$

First, elasticities are derived absent the fixed costs. Later, the implications of fixed costs are incorporated.

$$\mathcal{E}^*\left(R_{NJ}(\varphi)\right)=\zeta(\sigma_J-1)-(\sigma_J)\cdot\left(-\mathcal{E}^*\left(P_j^*\right)\right)+\mathcal{E}^*\left(P^*C^*\right)$$

The elasticity of the price index in industry J in the foreign country is:

$$\begin{aligned}\mathcal{E}^*\left(P_J^*\right)&=-\frac{N_J^*p_J^*\left(\bar{\varphi}_J^*\right)^{1-\sigma_J}}{\left(P_J^*\right)^{1-\sigma_J}}+\zeta\frac{N_J\zeta_{NJ}p_{NJ}\left(\bar{\varphi}_{NJ}\right)^{1-\sigma_J}H_J}{\left(P_J^*\right)^{1-\sigma_J}}-\\&-\left(\frac{\gamma_J}{\sigma_J-1}-1\right)\cdot\frac{N_J\zeta_{NJ}p_{NJ}\left(\bar{\varphi}_{NJ}\right)^{1-\sigma_J}H_J}{\left(P_J^*\right)^{1-\sigma_J}}\left(-\mathcal{E}^*\left(\bar{\varphi}_{NJ}\right)\right)\\&=-\left(1-(1-\zeta)\mathcal{I}_J^*\right)-\mathcal{I}_J^*\cdot\left(\frac{\gamma_J}{\sigma_J-1}-1+\zeta\right)\cdot\left(-\mathcal{E}^*\left(\bar{\varphi}_{NJ}\right)\right)\end{aligned}$$

where $\mathcal{I}_J^*$ is MNE penetration. The first term comes from the direct effect of foreign productivity on prices of goods produced by local establishments. The second term comes from the extensive margin and is also negative since $\gamma_J>\sigma_J-1$ and $\mathcal{E}^*\left(\bar{\varphi}_{NJ}\right)<0$ Moreover, since the productivity cutoff is

$$\bar{\varphi}_{NJ} \propto (A^*)^{-\zeta} (P_J^*)^{-1} \cdot (P^* C^*)^{-\frac{1}{\sigma_J - 1}} :$$

$$\mathcal{E}^* (\bar{\varphi}_{NJ}) = -\zeta - \mathcal{E}^* (P_J^*) - \frac{1}{\sigma_J - 1} \cdot \mathcal{E}^* (P^* C^*)$$

Then, the elasticity of the foreign price index in industry J :

$$\mathcal{E}^* (P_J^*) = -\frac{1 - (1 - \zeta + \zeta \xi_J^{'}) \mathcal{I}_J^*}{1 + \xi_J^{'} \mathcal{I}_J^*} - \frac{\mathcal{I}_J^*}{1 + \xi_J^{'} \mathcal{I}_J^*} \frac{\xi_J^{'}}{\sigma_J - 1} \mathcal{E}^* (P^* C^*)$$

Combining, I obtain the elasticity of multinational revenues:

$$\mathcal{E}^* (R_{NJ}(\varphi)) = -(\sigma_J - 1) \cdot \frac{1 - (1 - \zeta + \zeta \xi_J^{'}) \mathcal{I}_J^*}{1 + \xi_J^{'} \mathcal{I}_J^*} + \left(\frac{\mathcal{I}_J^*}{1 + \xi_J^{'} \mathcal{I}_J^*} \xi_J^{'} \right) \mathcal{E}^* (P^* C^*)$$

Now given the definition of $\mathcal{E}^* (R_{NJ}(\varphi))$ we have for non IT adopters

$$\mathcal{E}^* (\pi_{NJ}(\varphi)) = \mathcal{E}^* (R_{NJ}(\varphi)) (1 + o\ell_J(\varphi))$$

with $o\ell_J(\varphi) = \frac{1}{\left(\frac{\varphi}{\underline{\varphi}_{NJ}}\right)^{\sigma_J - 1} - 1}$ representing the operating leverage. QED.

B.7 Proof of Proposition 1

Let us first recall Proposition 1 : Consider two industries in the same country and a shock to foreign productivity $A^\star$. If fixed costs of IT adoption or/and fixed costs of foreign operations are lower in industry J_1 then: (a) The elasticity of profit to A^* for small firms is more negative in J_1 (b) The difference in the elasticity of profit comparing the two industries is larger (in absolute value) for smaller firms than for large firms: $(\mathcal{E}^* (\pi_{J_1}) - \mathcal{E}^* (\pi_{J_2}))_{\text{below cutoff}} < (\mathcal{E}^* (\pi_L) - \mathcal{E}^* (\pi_H))_{\text{above cutoff}}$.

Proof of (a). To recall the result from Lemma 2 that the level of MNEs $\mathcal{I}_J$ is decreasing with the cost of adoption f_{ITJ} (or and the fixed cost of foreign operations f_J), all else equal. Moreover, a shock in A^* has bigger impact on local profits if the share of large MNE firms is higher from Lemma 2. It then follows that the elasticity of domestic profits is also larger (in absolute value) in industries with a lower cost of operating IT f_{ITJ} (or and the fixed cost of foreign operations f_J).

Proof of (b). Observe first from the Lemmas above: $\mathcal{E}^* (\Pi_{LJ_1}) < \mathcal{E}^* (\Pi_{LJ_2}) < 0$. Moreover, we have from Lemma 4 that $\mathcal{E}^* (\Pi_{NJ_1}) > \mathcal{E}^* (\Pi_{NJ_2})$. It follows that:

$$\mathcal{E}^* (\Pi_{LJ_2}) - \mathcal{E}^* (\Pi_{NJ_2}) > \mathcal{E}^* (\Pi_{LJ_1}) - \mathcal{E}^* (\Pi_{NJ_1})$$

In addition, the difference between the elasticity of the profit of a firm below the cutoff φ_{NJ} and a multinational firm (above the cutoff) can be written as:

$$\mathcal{E}^* (\Pi_L) - \mathcal{E}^* (\Pi_L + \Pi_N)_{\text{above the cutoff}} = \alpha_N (\mathcal{E}^* (\Pi_L) - \mathcal{E}^* (\Pi_N))$$

where α_N the share of profits of large firms from foreign sales, so all else equal, $\alpha_{NJ_2} < \alpha_{NJ_1}$, as the share of foreign sales is smaller for firms. Using this inequality we conclude:

$$\mathcal{E}^*\left(\Pi_{NJ_1}\right) - \mathcal{E}^*\left(\Pi_{NJ_2}\right) < \mathcal{E}^*\left(\Pi_{LJ_1} + \Pi_{NJ_1}\right)_{\text{above cutoff}} - \mathcal{E}^*\left(\Pi_{LJ_2} + \Pi_{NJ_2}\right)_{\text{above cutoff}}$$

So the same inequality follows when comparing firms below the cutoff and above the cutoff, otherwise there is a contradiction.

B.8 Proofs of Proposition 2

Denote returns in low and high I_J industries, R_{J_2} and R_{J_1}, respectively. Suppose that as in the data $\mathbf{E}\{R_{J_1}\} > \mathbf{E}\{R_{J_2}\}$. As in Barrot et al. (2019), observing whether the difference in expected returns is lower or larger between firms below or above the cutoff (small vs large firms); and across industries if the expected returns for small firms is higher in high I_J industries, allows to infer the sign of the price of risk. Specifically: (a) If $\left(\mathbf{E}\{R_{J_1}\} - \mathbf{E}\{R_{J_2}\}\right)_{\text{below cutoff}} > \left(\mathbf{E}\{R_{J_1}\} - \mathbf{E}\{R_{J_2}\}\right)_{\text{above cutoff}}$ then the price of risk is negative. Otherwise, it is positive. (b) If $\left(\mathbf{E}\{R_{J_1}\} - \mathbf{E}\{R_{J_2}\}\right)_{\text{below cutoff, high-foreign share}} > \left(\mathbf{E}\{R_{J_1}\} - \mathbf{E}\{R_{J_2}\}\right)_{\text{below cutoff, low- foreign share}}$, then the price of risk is negative. Otherwise, it is positive.

Proof. Let the price of risk for the productivity shock be λ_{A^*}, then, given that firms do not make dynamic decisions, any difference in expected returns is due to cash-flow risk, since

$$\left(\mathbf{E}\{R_{J_1}(\varphi)\} - \mathbf{E}\{R_{J_2}(\varphi)\}\right) = \lambda_{A^*}\left(\mathcal{E}^*\left(\Pi_{LJ_1}(\varphi) + \Pi_{NJ_1}(\varphi)\right) - \mathcal{E}^*\left(\Pi_{LJ_1}(\varphi) + \Pi_{NJ_1}(\varphi)\right)\right)$$

Thus if the price of risk is positive $\left(\lambda_{A^*} < 0\right)$, I have

$$\left(\mathbf{E}\{R_{J_1}\} - \mathbf{E}\{R_{J_2}\}\right)_{\text{below cutoff}} < \left(\mathbf{E}\{R_{J_1}\} - \mathbf{E}\{R_{J_2}\}\right)_{\text{above cutoff}}$$

would be a contradiction with the results in Proposition 1.

C Computational Approach

C.1 Summary of the Model for Simulations

Variable	X	Equation
Aggregate Consumption	C_t	$C_{Dt}^{a_0} C_{0t}^{1-a_0}$
Differentiated Consumption	C_{Dt}	$\left[\sum_j C_{Jt}^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}$
Industry Expenditures	$P_{Jt}C_{Jt}$	$(P_{Jt}/P_{Dt})^{1-\theta}\, a_0 PC$
Entry Cutoff	$\underline{\varphi}_{NJ}$	$\left(\mathrm{B}_J^* f_J\right)^{1/(\sigma_J-1)} K$
IT Cutoff	$\underline{\varphi}_{ITJ}$	$\Gamma_J \underline{\varphi}_{NJ}$
Mass of MNEs	ζ_{NJ}	$1 - G(\underline{\varphi}_{NJ})$
Mass of IT adopters	ζ_{ITJ}	$\zeta_{ITJ} = \Gamma_J^{-\gamma_J} \zeta_{NJ}$
Wages	w	Normalized to 1
Local goods	$p_J(\varphi)$	$\sigma_J w A^{-1} \varphi^{-1}/(\sigma_J - 1)$
Non local goods	$p_{NJ}^*(\varphi)$	$\begin{cases} K^* \frac{w}{w^*}(\frac{A^*}{A})^{\zeta} p_J^*(\varphi) & \text{if } \underline{\varphi}_{NJ} < \varphi \leq \underline{\varphi}_{ITJ} \\ \frac{w}{w^*}(\frac{A^*}{A})^{\zeta} p_J^*(\varphi) & \text{if } \varphi > \underline{\varphi}_{ITJ} \end{cases}$
Industry price index	P_J	$\left(N_J \cdot p_J\left(\bar{\varphi}_J\right)^{1-\sigma_J} + \zeta_{NJ}^* N_J^* K^* \frac{w}{w^*}(\frac{A^*}{A})^{\zeta} p_J^*\left(\bar{\varphi}_{NJ}^*\right)^{1-\sigma_J} H_J^*\right)^{\frac{1}{1-\sigma_J}}$
Aggregate price index	P_D	$\left[\sum_J P_J^{1-\theta}\right]^{\frac{1}{1-\theta}}$
Local Profits	$\pi_J(\varphi)$	$\left(\frac{p_J(\varphi)}{P_J}\right)^{1-\sigma_J} \left(\frac{P_J}{P_D}\right)^{1-\theta} a_0 PC/\sigma_J$
Non-local Profits	$\pi_{NJ}(\varphi)$	$\left(\frac{p_{NJ}(\varphi)}{P_J^*}\right)^{1-\sigma_J} P_J^* C_J^*/\sigma_J - f_J/A - f_{ITJ}/A\mathbb{I}(\varphi \geq \underline{\varphi}_{ITJ})$
Valuations	$v_{J,t}(\varphi)$	$\beta \mathbf{E}_t S_{t,t+1}\left(v_{J,t+1}(\varphi) + \pi_{J,t+1}(\varphi) + \pi_{NJ,t+1}(\varphi)\right)$
Useful Constants:	B_J^*	$\frac{\sigma_J\left(\frac{\sigma_J}{\sigma_J-1}\frac{w^*}{w}(\frac{A}{A^*})^{\zeta}\right)^{\sigma_J-1}}{C_J^* A^{\sigma_J}\left(P_J^*\right)^{\sigma_J}}$
	Γ_J	$\left(\frac{1}{K^{\sigma_J-1}-1}\right)(f_{ITJ}/f_J)^{1/(\sigma_J-1)}$

The model summarized above is solved using third-order approximations of the policy function around the deterministic steady-state of the model. The model is simulated 12000 periods, where the first 2000 are dropped, assuming that after that the variables follow their ergodic distribution. The moments, then, are calculated based on the data generated for the remaining periods of simulated data. The impulse response functions are calculated as the response of a model quantity with respect to a one standard deviation of the aggregate shocks A or A^*.

D Measurement and Data Construction

This Appendix contains additional information on the sample and data construction. In this section, I describe in detail the construction of the final dataset, starting from the firm- level dataset of stock returns, balance sheet data and multinational firms' employment and sales. Then, I describe the measurement of IT intensity at the occupation level and the aggregation of the index at the industry level. I conclude providing summary statistics for all of those data.

D.1 Firm level Data

I use monthly stock returns from the Center for Research in Security Prices (CRSP) and annual accounting information from the CRSP/COMPUSAT Merged Annual Files. The sample excludes FIRE (Finance, Insurance and Real Estate) industries and regulated firms (4-digit SIC codes between 4000 and 4999, as well as between 6000 and 6999). It includes only firms with ordinary shares (CRSP share codes 10 and 11) that are traded on either NYSE, AMEX, or NASDAQ for the period between January 1991 and December 2019. Firm-level accounting variables are winsorized at the 1% level in every sample year to reduce the influence of possible outliers. Moreover, I rely on historical segment data of firms reporting foreign income from COMPUSTAT to classify firms in multinationals and non multinational firms as in Fillat and Garetto (2015a) and the industrial classification of those segment to define firms as conglomerates. In addition, I use analysts' split-adjusted annual earnings forecasts from the Institutional Brokers Estimates System (I/B/E/S) database. I define and construct the following variables for every firm:

- *Cost of goods sold* involves all direct costs involved with producing a good. This includes the cost of materials and other intermediate inputs, as well as the labor directly used to produce a good. It is observed on the income statement. The Compustat variable is COGS.

- *Selling, general and administrative expenses* are all direct and indirect selling, general and administrative expenses. They include overhead costs and costs such as advertisement or packaging and distribution. It is observed on the income statement. The Compustat variable is XSGA.

- *Operating expenses* are the sum of cost of goods sold and selling, general, and administrative expenses. The Compustat variable is XOPR.

- *Assets* is the logarithm of a firm's total book assets (AT).

- *PP&E* is net property, plant and investment (PPENT) scaled by total book assets (AT).

- *Size, Book-Market and Profitability* are calculated following Fama and French.
- *Market Leverage* is the firm's financial leverage and defined as the proportion of total debt of the market value of the firm. The market value of the firm is the market value of common equity defined as in Fama and French. Total debt is the book value of short-term (DLC) and long-term interest bearing debt (DLTT).
- *Revenue* is total sales. The Compustat Fundamentals variable is SALE.
- Foreign *Revenue* is total sales in specific geographic segment. The Compustat Segments variable is SALE.

D.2 Data on Foreign Multinational Firms in the United States based on BEA Surveys

I combine several sources to create consistent measures of the number of foreign multinational companies, their market share and employment across industries (consistent SIC4 Codes) in the United States. In particular, I combine the following data sources: 1. the BEA International Surveys on Foreign Direct Investment in the United States(FDIUS), 2. BLS Multi Factor productivity Industry data

The Bureau of Economic Analysis (BEA) every year generates, using survey data, statistics on foreign multinationals related operations in the United States. In the survey on foreign direct investment in the United States, multinational firms are considered those with activities in the U.S. who are affiliated with foreign companies (own at least 50% of the company in the United States). These data contain a wide variety of indicators of their financial structure and operations. To construct the measures of foreign firms' sales and employment I use the data provided summarizing operations across industries (Table A2 of the second part of tables: Majority-Owned U.S. Affiliates). In particular, I use the data on the number of firms, sales and employment across industries. The industry classification used is based on SIC3 codes before 1997 and based on SIC4 codes after. I standardize the data across years in a consistent way using SIC4 classifications. Details on the process used follow. This BLS MFP Database provide similar data on sales and employment, along with price indices, and cost data across industries, in a consistent way during the sample period. The data of multinational firms share in the United States at the SIC-4 levels have a high (80% on average) correlation with measures of multinational firms shares in the United States based on the segments data of publicly listed firms and as a result, even with the imputations described in section 3, the value of Sales obtained from Compustat and Worldscope can be to provide a comprehensive measure of foreign firms' operations in the United States across industries.

D.3 Measuring IT intensity

At first I describe the task based measure of IT intensity at the occupation level.

D.3.1 Occupation-level IT intensity

To understand the IT intensity of tasks at the occupation level, indices from the O*NET skill, task and knowledge measures are used, that incorporate information on the knowledge, activities related to Information Technology and computers. The list below summarizes the description of the tasks, skills and knowledge, that lead to an occupation to be considered more or less IT intensive.

Variables and detailed questions/descriptions: The questions and descriptions used to define the intensity with which occupations use Information Technology follows closely Gallipoli and Makridis. I now describe the questions/answers related to *Knowledge* used in each occupation that are used to rank occupations. Then the questions about *Skills* and at the end those related to the *Work Environment.*

The structure will be as follows. First, the general description of the question is given and then I present the specific question used and possible answers that responders will choose and their corresponding ranking.[46]

In terms of *Knowledge,* I rank occupations based on knowledge of:

- **Computers and Electronics**: Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software

  Question: What level of COMPUTERS AND ELECTRONICS is needed to perform your current job?

  L(ow ranking): Operate a VCR to watch a pre-recorded training tape H(igh ranking): Create a program to scan computer disks for viruses

- **Engineering and technology**: Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.

  Question: What level of knowledge of ENGINEERING AND TECHNOLOGY is needed to perform your current job?

  L: Install a door lock H: Plan for the impact of weather in designing a bridge

In terms of *Skills,* I rank occupations based on knowledge of:

- **Programming**: Writing computer programs for various purposes

  Question: What level of PROGRAMMING is needed to perform your current job?

  L: Write a program in BASIC to sort objects in a database H: Write expert system programs to analyze ground radar geological data for probable existence of mineral deposits

[46] I report the lowest and highest level in terms of ranking. In total there are 6 different levels.

- **System Evaluation:** Identifying measures or indicators of system performance and the actions needed to improve or correct performance, relative to the goals of the system

  Question: What level of SYSTEMS EVALUATION is needed to perform your current job?

  L: Determine why a coworker has been overly optimistic about how long it would take to complete a task H: Evaluate the long-term performance problem of a new computer system

- **Quality control analysis:** Conducting tests and inspections of products, services, or processes to evaluate quality or performance

  Question: What level of QUALITY CONTROL ANALYSIS is needed to perform your current job?

  L: Inspect a draft memorandum for clerical errors H: Develop procedures to test a prototype of a new computer system

- **Operations analysis:** Analyzing needs and product requirements to create a design

  Question: What level of OPERATIONS ANALYSIS is needed to perform your current job?

  L: Select a photocopy machine for an office H: Identify the control system needed for a new process production plant

- **Technology design:** Generating or adapting equipment and technology to serve user needs

  Question: What level of TECHNOLOGY DESIGN is needed to perform your current job?

  L: Adjust exercise equipment for use by a customer H: Create new technology for producing industrial diamonds

- **Management of Material Resources:** Obtaining and seeing to the appropriate use of equipment, facilities, and materials needed to do certain work.

  Question: What level of MANAGEMENT OF MATERIAL RESOURCES is needed to perform your current job?

  L: Rent a meeting room for a management meeting H: Determine and monitor the computer system needs of a large corporation

In terms of *Work Environment,* I rank occupations based on the every day use and update of:

- **Computers**: Using computers and computer systems (including hardware and software) to program, write software, set up functions, enter data, or process information.

Question: What level of WORKING WITH COMPUTERS is needed to perform your current job?

L: Enter employee information into a computer database H: Set up a new computer system for a large multinational company

- **Email**:

  Question: How frequently does your current job require electronic mail?

- **Relevant knowledge**: Keeping up-to-date technically and applying new knowledge to your job

  Question: What level of UPDATING AND USING RELEVANT KNOWLEDGE is needed to perform your current job?

  L: Keep up with price changes in a small retail store H: Learn information related to a complex and rapidly changing technology

- **Data or Information**: Identifying the underlying principles, reasons, or facts of information by breaking down information or data into separate parts.

  Question: What level of ANALYZING DATA OR INFORMATION is needed to perform your current job?

  L: Determine the location of a lost order H: Analyze the cost of medical care services for **all** hospitals(in the country)

- **Processing Information:** Compiling, coding, categorizing, calculating, tabulating, auditing, or verifying information or data.

  Question: What level of PROCESSING INFORMATION is needed to perform your current job?

  L: Tabulate the costs of parcel deliveries H: Compile data for a complex scientific report

For each of these questions, sub-indices are constructed related to the intensity (average ranking of choices by respondents) of IT across occupations between 2004 and 2016. Then, they are aggregated at the occupation level, to construct an average occupation intensity score, constant across years. Lastly it is standardized (I create z scores of the IT intensity across occupations).

Then, CPS occupation classifications are harmonized between 1990 to 2015 to the five-digit SOC-level. Given the availability of the data and the time invariant score of the IT intensity of an occupation, the scores of occupational IT intensity can be linked to data dated back to 1990.

The primary data for employment and wages come from the the annual Current Population Survey (CPS) between 1991 and 2019 accessed through the Integrated Public Use Microdata (IPUMS) data portal. To mitigate concerns about partial attachment to the labor market , the sample of workers from the CPS is restricted to full-time workers between age 20 and 65, with over \$5,000 in annual labor income, at least 20 weeks worked per year, and over \$2 real hourly wages. Nominal variables are deflated using the 1990 price index.

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