Financial Development and Growth When it Takes Time-to-Build

Johannes A. Barg[a], Wolfgang Drobetz[b], Erwin Hansen[c], Rodrigo Wagner[d]

This draft: January 2020

Abstract

We revisit the classic debate on financial development and growth (Rajan and Zingales, 1998) under the lens of investment cycle's heterogeneity between industries in the economy. This feature, known as time-to-build, recognizes that projects take more time to be completed in some industries than in others. Our first contribution is computing a new, updated measure of time-to-build for a broad set of industries based on the behavior of U.S. corporations. Our second contribution is studying the mediating effect of time-to-build on the relationship between financial development and growth. On theoretical grounds, it is ambiguous whether this slow investment profile amplifies or moderates the relationship. Empirically, we find that among industries that require more external funding, those with longer time-to-build tend to be less sensitive to the financial development of the country. This finding is consistent with theories in which slow or long-run projects tend to be disproportionally funded with retained earnings rather than by external sources of funding.

Keywords: Financial development, External financial dependence, Industry growth, Time-to-Build, Capital expenditure (CapEx)

JEL Classification: G32, G31, G38, O41.

[a] Hamburg Business School, University of Hamburg, Germany
[b] Hamburg Business School, University of Hamburg, Germany
[c] Facultad de Economía y Negocios, Universidad de Chile
[d] UAI Business School, Chile. Corresponding email: rodrigo_wagner@post.havard.edu

1 Introduction

Dating back to at least Schumpeter (1911), researchers have tried to understand the relationship between financial development and economic growth. Theoretically, well-developed financial systems should support economic growth by reallocating capital to investment projects that generate the highest value and by effectively reducing risk arising from moral hazard, adverse selection and financing costs (Aghion et al., 2018). Although there has been research suggesting a positive relationship between financial development and economic growth (King and Levine, 1993; Levine and Zervos, 1998), Rajan and Zingales (1998) were the first who analyzed the underlying dynamics and characteristics of this relationship. Introducing a new approach that compares within-country, between-industry differences, the authors show that financial development facilitates economic growth by reducing the cost of external financing to financially dependent industries. Particularly, an industry with a relatively higher dependence on external financing develops faster in a country which financial system is higher developed than in a country with undeveloped financial markets. This result is in line with Beck (2003), Love (2003) and Beck et al. (2005) who find that financial development supports economic growth by reducing (external) financing constraints.

In this study, we revisit the relationship between growth and financial dependence but explicitly considering the length of the investment cycle in different industries and recognizing its heterogeneities. We address this issue by studying *time-to-build*[1], the time that is required to complete an investment project in a given industry (Tsyplakov, 2008). This feature of common investment projects has already been picked up in various research areas like business cycles (Kydland and Prescott, 1982), investment behavior (Majd and Pindyck, 1987; Bar-Ilan and Strange, 1996) or capital structure (Tsyplakov, 2008) and helped to explain their existence and structure. A central characteristic of time-to-build is that it not only raises the problem that one have to evaluate future market conditions, but also increases the probability that the project will be abandoned before its completion (Majd and Pindyck, 1987; Alvarez and Keppo, 2002). These factors significantly raise the uncertainty for investors and impede the chances to get external financing for the project. Thus, the resulting lack of investment projects hampers economic growth.

[1] Alternative terms include, among others, *construction lag*, *gestation lag* or *investment lag*.

As growth is one of the elementary parts of the relationship posed by Schumpeter (1911), the abovementioned theoretical considerations on time-to-build raise the research question of whether time-to-build also affects the relationship between financial development and economic growth. Dealing with this question, this paper incorporates time-to-build as an additional interaction variable into the original regression setup of Rajan and Zingales (1998). The results suggest that high levels of time-to-build mitigate the positive growth effect that well-developed financial systems have on industries, which are relatively more in need of external financing. This finding is in line with theories that suggest that slow and lumpy investment projects are primarily funded by internal funds and are thus less dependent on the development of the national financial market.

To the best of our knowledge, we are the first who introduces time-to-build to the interplay between financial development and economic growth. Therefore, our paper contributes mainly to two lines of literature. First, it enlarges the body of literature that aims to provide further understanding on the fundamental relationship between financial development and economic growth by introducing alternative variables that channel this relationship. Second, it adds a new strand of literature to the research area that deals with the analysis of time-to-build as a moderating variable of economic phenomena.

The remainder of this paper is structured as follows: Section 2 provides a theoretical background on the relationship between financial development and economic growth as well as on time-to-build. Building on this, Section 3 and Section 4 describe our methodology and data. Empirical results are presented in Section 5. Finally, Section 6 summarizes the main points of this paper.

2 Literature Review

This study fits in two strands of literature: the relationship between financial development and economic growth and time-to-build.

2.1 Financial Development and Economic Growth

One of the first who raises the idea of a positive relationship between financial development and economic growth was Schumpeter (1911). Within his theory of economic development, banks have the task to provide credit to entrepreneurs who use this credit, in turn, to alter the traditional flow of the economy through innovations. Those innovations ensure a more effective allocation of resources and are thus the drivers of economic growth. Accordingly, in the framework of Schumpeter (1911), financial development benefits economic growth through the ability of providing credit and thereby growth potential to entrepreneurs.

Criticism to this finding is posed by, among others, Robinson (1952) or Lucas (1988). They cast doubt on the validity of the positive influence of financial development on economic growth and state that financial development rather follows than leads economic growth. Nevertheless, motivated by Schumpeter's (1911) and Goldsmith's (1969) observation of a parallelism between financial development and economic growth, a growing body of literature has developed that aims to empirically prove the positive relationship between financial development and economic growth. King and Levine (1993), for example, show that there is a strongly positive relationship not only between high levels of financial development and current fast rates of growth, but also between high levels of financial development and future fast rates of growth. Showing that current well-developed financial systems may lead to outstandingly fast growth rates and improvements in the efficiency of capital allocation over the next 10 to 30 years, King and Levine's (1993) results support the original notion of Schumpeter (1911). A similar positive impact of financial intermediaries on growth is provided by Beck et al. (2000).

While the aforementioned studies characterize financial development mainly by the development of the banking sector, the following studies broaden the view on the financial sector by additionally including capital markets. First theoretical ideas thereon date back to Levine (1991). He states that well-developed capital markets, especially liquid stock markets, have two important features: First, investors may diversify their investments by investing in a large number of firms rather than in only one firm and, second, investors may sell stakes of a firm at any time when liquidity is needed without disrupting the firm's operations. Therefore, well-developed capital markets encourage firm investments and consequently growth by reducing productivity risk and liquidity risk. This growth benefiting effect of developed financial markets is further supported by, among others, Bencivenga et al. (1995).

While financial development has been divided into the development of the banking sector and the development of the financial markets so far, Demirgüç-Kunt and Maksimovic (1996), Levine and Zervos (1998) and Beck and Levine (2004) develop models that integrate both measures of financial development. They also show that in the case of a simultaneous consideration, higher levels of development have a significantly positive correlation with current and future rates of growth.

Building on the mentioned suggestions of a positive relationship between financial development and economic growth, Rajan and Zingales (1998) develop an influential model that analyses the channel through which financial development enhances growth. Overcoming the criticism of omitted variables in previous studies, the authors show by analyzing within-country, between-industry differences that financial development disproportionally helps those industries to grow that are relatively higher dependent on external financing. This reasoning along with the used method and variables is subsequently used in multiple other studies (Cetorelli and Gambera, 2001; Beck and Levine, 2002; Laeven et al., 2002; Claessens and Laeven, 2003; Fisman and Love, 2003; Beck et al., 2004 and Fisman and Love, 2007).

2.2 Time-to-Build

Before introducing time-to-build in the aforementioned research area of financial development and economic growth, this subchapter provides an overview on how time-to-build is considered so far within economic literature. Ever since Aftalion (1927) described "the long period required for the production of fixed capital" as crucial for the description of business cycles, time-to-build became an important feature in the analysis of economic phenomena. Reviewing previous literature, we identify three areas of research that constitute the main literature on time-to-build thus far: business cycles, investment behavior and capital structure. The large body of literature presented in this subsection suggests that one cannot neglect time-to-build in the analysis of the relationship between financial development and economic growth.

With the intention to explain the existence and structure of business cycles, Kydland and Prescott (1982) fit a general equilibrium model to U.S. quarterly data from the period following World War II. After reviewing commonly used technologies to describe business cycles, the authors conclude that the neoclassical model as well as the adjustment cost model are not adequate. To solve this problem, they integrate time-to-build into their model. Assuming a time-to-build of four quarters, Kydland and Prescott (1982) achieve a better fit to the data on hand compared to the traditional models. Thus, they conclude, that their model is superior in explaining key elements of the business cycles like "the cyclical variances of economic time series, the covariances between real output and other series, and the autocovariance of output" (Kydland and Prescott, 1982).

Although Rouwenhorst (1991) or Stadler (1994) cast doubt on the full validity of the influence of time-to-build in Kydland and Prescott's (1982) model, the model is picked up and adapted in several other studies. Christiano and Todd (1996), for example, extend this model by implementing a so-called time-to-plan before the actual time-to-build. This model maintains the original results and additionally shows that productivity leads hours worked and that business investments lag output over the business cycle. Altug (1989) further refined the model of Kydland and Prescott (1982) by assuming that investments in structures and investments in equipment have different lengths of time-to-build. Taking up Altug's (1989) model, Del Boca et al. (2008) state that there are differences in the evidence of the time-to-build effect. While this evidence is given for structure investments with time-to-build lengths in the range of two to three years, it is only given up to a time-to-build of one year in the case of equipment investments. Wen (1998) identified an additional demand-side effect of time-to-build and added it to the model of Kydland and Prescott (1982).

The second main research area where time-to-build is often included is the area of investment behavior. Majd and Pindyck (1987) contribute to this area by analyzing investment projects, for which investment decisions and cash outlays occur irreversibly and sequentially over time, a constant maximum rate exists at which investments and construction can proceed, and no cash flow is generated before completion. In this environment, time-to-build is the amount of time that results from dividing the project's total cash outlay by the maximum rate of investment per year. To give an illustration, if there is an investment project that requires a total cash outlay of $6 million and the maximum rate of investment per year is $2 million, the minimum time for completion, i.e. the time-to-build, is three years. Majd and Pindyck (1987) argue that traditional investment decision rules, like the discounted cash flow rule, might undervalue investment projects when they ignore that in front of each sequential payment, the firm can decide whether to exercise the payment or cut off the project and continue at a later stage. Thus, they introduce a compound option approach, which characterizes each sequential payment as a new option. Based on their model, the authors find that time-to-build hampers the continuation of investment projects and reduces the overall value. This effect is further strengthened if there is uncertainty in the form of high standard deviation of stock market returns. Additionally, Alvarez and Keppo (2002) find that the existence of time-to-build decreases the incentives to execute an investment.

Contrary, Bar-Ilan and Strange (1996) show that time-to-build may offset uncertainty and reduce inertia. They argue that due to the existence of a lag between the start and the completion of an investment project, the opportunity costs of delaying an investment project do not base on the output prices today but rather on the future output prices when the project will be completed and cash flows be generated. According to them, a long time-to-build increases the likelihood of extremely high output prices while the downside potential is reduced by the opportunity to abandon the project. In this context, as investment projects cannot be completed immediately, the postponement of an investment project with time-to-build increases the opportunity costs as the threat arises to miss out future high cash flows. Consequently, investors hurry to start their investment projects, as they do not want to miss high cash flows simply because the project is not yet completed. Therefore, in contrast to Majd and Pindyck (1987), Bar-Ilan and Strange (1996) show that time-to-build rather hastens than hampers investments. This is further supported by Bar-Ilan et al. (2002), Pacheco-de-Almeida and Zemsky (2003) and Sarkar and Zhang (2013).

The third and youngest strand of literature incorporating time-to-build deals with capital structure and leverage dynamics. As in the case of investment behavior, there is still disagreement in the literature on how time-to-build projects are financed. Sarkar and Zhang (2015), for example, postulate that for lumpy investments a firm's leverage ratio is an increasing function of time-to-build. They ground this finding on the fact that higher debt levels increase the firm's tax shield, which may offset the lower project value due to the longer delay of cash inflows. This finding is not only consistent with Agliardi and Koussis (2013), but also with Marchica and Mura (2010) and DeAngelo et al. (2011), who describe debt financing of unexpected investment shocks as an opportunity to remain financially flexible, while saving the costs of issuing equity and maintaining the current cash balances.

Opposing to this, Tsyplakov (2008) shows, after including time-to-build and investment lumpiness into a dynamic capital structure model, that leverage ratios are time-varying over the course of an investment project. As investment projects with time-to-build do not immediately generate cash flows, there are no immediate income streams that can service debt or need to be protected by a tax shield. Therefore, according to Tsyplakov (2008), investment projects with longer time-to-build are financed with a significantly larger fraction of equity. Once the investment project is completed and generates cash, firms can readjust their capital structure to a higher fraction of debt to reduce their taxable income via the tax shield. Besides the tax shield's irrelevance during the project's construction lag, Dudley (2012) argues that using cash and equity for financing time-to-build projects prevents the firm from debt induced bankruptcy costs.

Despite this argumentation towards financing of long time-to-build projects with equity, it is unclear, whether firms use internal or external equity. To analyze this issue, one can interpret time-to-build projects as projects that postpone demand shifts to the future. Assuming investors to be shortsighted and managers to be better informed, the stock prices should be undervalued at the time of the project start and managers should exploit this situation by repurchasing equity (or at least not issuing additional equity). In fact, DellaVigna and Pollet (2013) can observe this rational behavior of managers only in the case of short time-to-build projects. For long time-to-build projects, the usage of internal funds for the reduction of external equity is not observable. This suggest that in the absence of additional debt and equity issuing, the internal funds must be used to finance the long time-to-build project. Also Frank and Goyal (2009)support for this intuition by referring to Tsyplakov (2008) and assuming that firms stock pile retained earnings until they spend their money on capital expenditures.

3 Empirical Model

To explore our research question whether and how time-to-build affects the relationship of financial development and economic growth, we base our analysis on the widely used regression model of Rajan and Zingales (1998). Thus, we first replicate their exact regression model in order to check its applicability to our more recent dataset:

$$\begin{aligned} Growth_{j,k} = {} & \beta_1 \cdot Industry\ Share_{j,k} \\ & + \beta_2 \cdot \left(External\ Dependence_j \times Financial\ Development_k\right) \\ & + \iota_j + \kappa_k + \varepsilon_{j,k}\ , \end{aligned} \tag{1}$$

where $Growth_{j,k}$ describes the average annual growth rate of output of industry j in country k, $Industry\ Share_{j,k}$ refers to industry j's average share in country k's total output in manufacturing in 2001, $External\ Dependence_j$ represents industry j's dependence on external finance and $Financial\ Development_k$ quantifies country k's financial market development. ι_j and κ_k represent industry and country fixed effects, respectively, and $\varepsilon_{j,k}$ is the error term.

Next, similar to Fisman and Love (2007), we add another interaction term to the basic regression model in Equation (1). In particular, we add the product of time-to-build and financial development:

$$
\begin{aligned}
Growth_{j,k} = {} & \beta_1\, Industry\ Share_{j,k} \\
& + \beta_2 \left(External\ Dependence_j \times Financial\ Development_k\right) \\
& + \beta_3 \left(Time\text{-}to\text{-}Build_j \times Financial\ Development_k\right) + \iota_j + \kappa_k + \varepsilon_{j,k}\,,
\end{aligned} \tag{2}
$$

where $Time\text{-}to\text{-}Build_j$ stands for the average time-to-build of industry j. Note that we do not include the "missing" interaction between $Time\text{-}to\text{-}Build_j$ and $External\ Dependence_j$ in Equation (2) as such an interaction would only vary by industry j, and thus be wiped out by our industry fixed effect ι_j.

Finally, as we want to analyze the influence of time-to-build on Rajan and Zingales' (1998) original interaction term of external dependence and financial development, we further adjust our model by implementing a triple interaction term covering time-to-build, external dependence and financial development. We estimate the following model:

$$
\begin{aligned}
Growth_{j,k} = {} & \beta_1 \cdot Industry\ Share_{j,k} \\
& + \beta_2 \cdot \left(External\ Dependence_j \times Financial\ Development_k\right) + \beta_3 \\
& \cdot \left(TTB_j \times Financial\ Development_k\right) + \beta_4 \\
& \cdot \left(TTB_j \times External\ Dependence_j \times Financial\ Development_k\right) + \iota_j \\
& + \kappa_k + \varepsilon_{j,k}\,.
\end{aligned} \tag{3}
$$

Using the model in Equation (3), the coefficient β_4 indicates whether time-to-build amplifies (+) or moderates (-) Rajan and Zingales' (1998) original interaction coefficient between external dependence and financial development.

4 Data, Descriptive Statistics and Time-to-Build Measurement

We build a dataset by merging information from three main sources: COMPUSTAT Fundamentals North America (2018) of Standard & Poor's, INDSTAT 4 (2018) of the United Nations Industrial Development Organization (UNIDO) and World Bank Open Data (2018). Due to differences in the structure of the data sources and therefrom-arising data constraints, our sample contains data for the manufacturing sector[2] from 2001 to 2012.

4.1 Growth and Industry Share

As indicated by the description of our regression equations, the dependent variable in each regression is the average annual growth rate of output[3]. This rate is calculated for each industry in every country by taking the geometric mean over the years between the earliest and latest available value of output[4]. Country averages of annual growth rates of output are reported in column 4 of Table 1. For industry averages see column 9 of Table 2.

Data on this country-specific as well as industry-specific variable is obtained from the UNIDO industrial statistics database INDSTAT 4 and classified by the International Standard Industrial Classification of All Economic Activities (ISIC). During our observation window between 2001 and 2012, there has been a successive change in the ISIC classification standard from ISIC Revision 3 to ISIC Revision 4. In the course of this change, several industries of the manufacturing sector have been reclassified. To remain consistent and have a longer time series of continuous data, we translate ISIC Revision 4 codes back to ISIC Revision 3 codes. While the matching of ISIC Revision 3 and ISIC Revision 4 is not possible on the 3-digit (industry groups) and 4-digit (industry class) level due to a great amount of substantial reclassifications, we execute the matching on the 2-digit (industry division) level based on the concordance tables provided by the UNIDO. Subsequently, we correct for inflation using the Consumer Price Index for All Urban Consumers of the Federal Reserve Bank of St. Louis (CPIAUCSL, 2018). Consistent with Rajan and Zingales (1998), we drop data that is separated by at least five years to prevent biases arising from poorly maintained data.

To calculate our control variable, the share of industry *i* in country *j* in the first year of the sample, i.e. 2001, we use the same UNIDO dataset and follow the description of Rajan and

[2] Among others, the same industry restriction can be found in Koeva (2000) and Del Boca et al. (2008). Apart from the common usage, this industry restriction is evident for our analysis approach as firms in the manufacturing sector usually have distinct and clearly identifiable investment projects (i.e. construction of a factory), which is crucial for our measure of time-to-build.

[3] While Rajan and Zingales (1998) use value added data for the determination of industry growth, they raise the concern that they actually want to measure growth in output but do not have the data for that. As we can access output data across industries and countries via the INDSTAT 4 database, we address Rajan and Zingales' (1998) concern by using the more appropriate output data. Nonetheless, not tabulated calculations using value added instead of output yield similar results.

[4] An alternative calculation (not reported) of the average annual growth rates can be done by using differences in logarithms of value added. This, however, yields similar results.

Zingales (1998). For every country, this variable is obtained by dividing the output of each industry in 2001 by the total output in that country in 2001.

4.2 Financial Development

The aim of the financial development variable is to reflect how easy borrowers and savers can interact (through financial intermediaries) and how confident they are in the national financial system. A well-developed financial system should thus be associated with improved communication, monitoring, risk management and valuation as well as a stable legal and regulatory framework (Rajan and Zingales, 1998; Levine 2005).

Within the previous literature, a variety of measures for financial development has been used. Those measures include, among others, accounting standards, liquidity ratios or balance-based indicators (Levine, 2005). For the sake of comparison of our results and due to data availability reasons, we use the market capitalization ratio proposed by Rajan and Zingales (1998) as our measure of financial development. This measure has also been used in a number of related studies like those of Beck and Levine (2002) and Fisman and Love (2007). Following this line of literature, the quantification of financial development in this paper is calculated as the ratio of domestic credit to private sector plus stock market capitalization over gross domestic product (GDP). Using data from World Bank Open Data, Table 1 shows the calculated capitalization ratios for 104 countries in column 3. Its components are presented in the first two columns.

[Insert Table 1 here]

4.3 External Dependence

Having specified economic growth and financial development, we now define those variables, for which we want to analyze to what extend the interaction with financial development benefits or impedes economic growth.

Unfortunately, we do not have explicit data on the actual use of external financing. Even if there were such data, it would probably reflect the equilibrium between supply and demand for external funds and would therefore not be usable for our analysis, as we are only interested in the pure value of the latter. As an alternative, we follow the measuring approach of Rajan and Zingales (1998) and use annual fundamentals data from Compustat for U.S. firms between 2001 and 2012.

By using data, which only consists of publicly traded firms from the U.S., the question may arise whether this data set is appropriate to run a regression analysis across industries and across countries. Rajan and Zingales (1998) promote the usage of this data by highlighting three main arguments. First, they argue that technological shocks primarily occur worldwide and increase investment opportunities above the internal available funds. Consequently, the demand for and the dependence on external finance raises in the specific industry in all countries. For example, it is very likely that the invention of smartphones increased the demand for external funds not only in the U.S. (e.g. Apple), but also for firms in other parts of the world (e.g. Samsung in South Korea, Huawei in China, HTC in Taiwan). Second, as the U.S. capital markets are among the most developed markets in the world and as large, publicly listed firms face the least frictions for raising capital, Compustat provides data form a nearly perfect capital market. This allows us to assume that the amount of external finance used by the reported firms is a comparatively pure measure of their actual demand. Third, the high disclosure requirements for publicly traded firms in the U.S. result in a highly comprehensive data set.

Having chosen the dataset, we now calculate the actual external dependence. Like Rajan and Zingales (1998), we define the use of external finance as capital expenditures minus cash flow from operations. While Compustat provides us with an already defined variable for capital expenditures, we further define cash flow from operations, in accordance with Rajan and Zingales (1998), as the sum of the following Compustat items: income before ordinary taxes, depreciations and amortizations; deferred taxes; equity in net loss earnings; sale of property, plant and equipment and investments gain; funds from other operations; decreases in inventories; decreases in receivables; increases in payables. To make this measure comparable over countries and industries, we calculate for each firm the ratio of capital expenditures that is not financed with cash flow from operations by summing up the use of external finance, as described above, over the whole sample period and dividing it by the sum of capital expenditures over the whole sample period. Finally, the industry's external dependence is obtained by taking the industry median. This measuring approach allows us to correct for temporal fluctuations, to reduce outliers and to account for natural differences between larger and smaller firms. Sorted by industry division, Table 2 summarizes the calculated figures of external dependence in column 8.

4.4 Time-to-Build

While the preceding variables were mainly defined in accordance with Rajan and Zingales (1998) to ensure comparability, we now address the variable that has not been considered in the analysis of financial development and economic growth so far: time-to-build. To define this variable, we use quarterly fundamentals data from the Compustat universe and adopt the above-mentioned notion that the U.S. markets are nearly frictionless. Thus, in accordance with the argumentation on external dependence in Subsection 4.3, we use U.S. data to create a world-wide proxy of time-to-build. To calculate our time-to-build variable, Compustat provides us with detailed accounting information on 1,919 U.S. companies.

We compute time-to-build figures by replicating the measuring approach of Tysplakov (2008).[5] As publicly listed U.S. firms must report their fundamentals quarterly, this accounting-based approach frees us from the reliance on the willingness of firms to participate in surveys. Furthermore, it provides us with an efficient way to deal with a large data set and allows us to analyze multiple investment projects per firm.[6] Thus, after correcting the data for inflation using the CPIAUCSL and securing currency equality (in USD), we calculate for each firm and each quarter the investment ratio and depreciation ratio by dividing the quarterly capital expenditures and depreciations, respectively, by fixed assets (quarterly value of property, plant and equipment, PPE). Then, we indicate "big ticket" investment ratios as investment ratios which are one standard deviation above the mean investment ratio of a certain company. Having found such a "big ticket", we determine the biggest depreciation ratio in the following five years (20 quarters) and calculate the time-to-build as the difference between the "big ticket" and the following biggest depreciation.[7] It is important to note, that Tsyplakov's (2008) suggestion of using a five years window is associated with two further restrictions on the data set: First, we can only

[5] Within the economic literature, some alternative, source-dependent measuring approaches have been developed. In some cases, data is provided in such an explicit way that both the start date and the (expected) completion date of an investment project are available. In those cases, one can simply determine the time-to-build by calculating the difference between both dates (Mayer and Sonenblum, 1955; Kalouptsidi, 2014). In other cases, however, other systematical measuring approaches need to be developed. Those approaches range from surveys (Mayer, 1960), over value weighted mean construction periods (Montgomery, 1995) to manual reviews of company news (Koeva, 2000).

[6] In comparison to Koeva (2000), for example, we examine more than 50 times as many investment projects as her.

[7] Essential for the chosen measuring approach is on the one hand, that the Generally Accepted Accounting Principles (GAAP) regulate that firms are only allowed to deduct depreciations after the building of the new assets is finalized and on the other hand that the U.S. tax law allows for accelerated depreciations (Tsyplakov, 2008).

consider those investments which are followed by at least 20 quarters with consecutive information on depreciation ratios and, second, the fixed size of the observation window does not allow analyzing industries that have significantly longer lead times.

As many of the investment projects have not only one lump investment at the beginning of the project, but rather a stream of investments throughout the beginning of its construction phase, we investigate different definitions of a project. First, we assume that consecutive quarters of big investment ratios belong together to one big investment project until there is one quarter of no "big ticket" between them ("TTB1" measure). Second, consecutive quarters of big investment ratios are assumed to be one big investment project until there are two quarters of no "big ticket" in-between ("TTB2" measure). And, third, consecutive quarters of big investment ratios are still one big investment project until there are three consecutive quarters of no "big ticket" between them ("TTB3" measure, see Figure 1 for illustration).

[Insert Figure 1 here]

To avoid an interference of overlapping investment projects, we adjust Tsyplakov's (2008) approach in such a way that we can investigate multiple projects per company. This is done by assigning high depreciations ratios only to one investment project. This means, in case there is a depreciation ratio which is the maximum within the 20-quarter-window of two different investment projects, this specific depreciation ratio is assigned to the first investment project and the second investment project is matched with the second highest depreciation ratio in its 20-quarter-window (see Figure 2 for illustration). The latter approach is applicable for overlapping investment projects, as we solely work with mean figures of time-to-build.

[Insert Figure 2 here]

Following Tsyplakov's (2008) adjusted measuring approach as described above, column 2, 4 and 6 of Table 2 show our time-to-build measures.

[Insert Table 2 here]

We find an average time-to-build of 11.7 quarters for all three specifications of time-to-build.[8] In the light of the large variation in time-to-build estimates,[9] we provide new empirical evidence to the question of how long time-to-build lasts.

5 Empirical Results

Having clarified the regression setup and defined all relevant variables, this section presents the results obtained from the regression equations that were defined in Section 3. Following the structure of that section, we first present the results of the replication of Rajan and Zingales (1998), then deal with the introduction of the double-interaction term between time-to-build and financial development, and finally concentrate on the interaction of time-to-build with the original interaction term of external dependence and financial development. For each regression, we apply all three measures of time-to-build. In the second part of this section, we demonstrate the robustness of our results by running our regressions again with alternative measures of financial development. All regressions include country and industry fixed effects. The standard errors are clustered at the country and industry level.

5.1 Main Test

Table 3 reports the results of our replication of Rajan and Zingales' (1998) original regression setup. The coefficient of industry share is significantly negative at the 1% level and the one of the interaction between external dependence and financial development is significantly positive at the 5% level. This indicates that growth is negatively influenced by the industry share and positively by the interaction between external dependence and financial development. Especially the latter finding shows that Rajan and Zingales' (1998) original conclusion also holds true for our up-to-date dataset: industries that are relatively more in need of external financing

[8] Opposing to our adjusted measuring approach, Tsyplakov's (2008) original measuring approach does not require that each "big ticket" investment has to be followed by at least 20 quarters with consecutive information on depreciation ratios in order to be considered. Ignoring this requirement, we find average time-to-build of 2.21 compared to 2.14 years proposed by Tsyplakov.

[9] Just to name a few examples in order to illustrate the large variety of time-to-build figures: Mayer (1960) reveals a time-to-build of 21 months by running a survey with 110 U.S. companies and asking them about plant buildings or plant additions. Ghemawat (1984) mentions that in the U.S. titanium dioxide industry, the construction of a typical plant takes four years. Lieberman (1987) states about two years for the construction of a new plant in the chemical industry. Majd and Pindyck (1986) report that the production of a new line of aircraft takes eight to ten years and that the construction of a new underground mine or the development of a large petrochemical plant requires at least five years. Koeva's (2000) review of company news reveals an average time-to-build of approximately two years, with a peak of 86 months in the utilities industry. Del Boca et al. (2008) work with a time-to-build of 12 quarters for structures and four quarters for equipment. Salomon and Martin (2008) obtain an average time-to-build of 28 months in the semiconductor industry, with a minimum of nine and a maximum of 55 months.

develop disproportionally faster in countries with higher-developed financial systems. This successful replication of Rajan and Zingales' (1998) results allows us to conclude that the proposed methodology is still applicable to more up-to-date data, and that we can reliably build our further analysis on their basic model.

[Insert Table 3 here]

We now concentrate on the results of the regression that includes an interaction between time-to-build and financial development in addition to the interaction term between external dependence and financial development. Table 4 shows in column 1-3 that for all three measures of time-to-build, the interaction coefficient of external dependence and financial development remains significantly positive at the 1% or 5% level. This result is consistent with the regression results in Table 3 and those of Rajan and Zingales (1998). The newly introduced interaction coefficient between time-to-build and financial development, however, shows no significance. Accordingly, the simultaneous implementation of the interaction term of financial development with external dependence and the interaction term of financial development with time-to-build indicates that it is still the former that generates influence on economic growth.

[Insert Table 4 here]

Table 5 summarizes the results of the regression analysis that bases on the aforementioned regression and additionally includes a triple-interaction term between time-to-build, external dependence and financial development. Columns 1-3 show, as before, that the coefficient estimate for industry share is significantly negative at the 1% level. The coefficient estimates of the interaction variable of external dependence and financial development are still significantly positive at the 1% or 5% level. Surprisingly, the interaction coefficient of financial development with our first measure of time-to-build (column 1) is significantly negative at the 10% level while the interaction coefficients of financial development with the other two measures of time-to-build remain insignificant (columns 2-3) like in Table 4. Fitting this exceptional result in the context of our results so far, one has to minimize the relevance of the reported significance at the 10% level. It has to be taken into consideration that a significance level of 10% only gives a likelihood of 90% that the coefficient is different from zero. Thus, there is a high probability that the significance for the TTB1 × FD coefficient is stated by chance.

Independent of this, the interaction coefficients of time-to-build with external dependence and financial development are significantly negative for all three measures of time-to-build. The significance levels are 5% percent for the interaction with TTB1 and TTB3 and 1% for the interaction with TTB2. The coefficient estimates indicate that given a high interaction coefficient between external dependence and financial development, a high time-to-build mitigates the positive influence on growth.

[Insert Table 5 here]

5.2 Robustness Test

So far results of our main test show that the growth benefiting effect well-developed financial systems have on industries that are relatively more in need of external financing is mitigated by high levels of time-to-build. Although we already consider different measures of time-to-build in order to ensure robustness, one may argue that our results so far depend on the way financial development is defined. To alleviate this concern, we introduce alternative measures of financial development in the following subsection. On the one hand, this procedure raises the robustness of our results and, on the other hand, it allows a broader insight in the relationship between financial development and economic growth. To avoid redundant repetitions of similar regressions, we focus on our preferred measure of time-to-build, namely TTB2.

In preparation of the robustness test, we generate alternative measures of financial development by decomposing the financial development measure proposed by Rajan and Zingales (1998) into its components. This leaves us with two new measures of financial development: domestic credit to private sector over GDP (“Domestic Credit”), and market capitalization over GDP (“Market Capitalization”). Descriptive statistics for both are summarized in Table 1, columns 1 and 2.

Table 6 shows that the replication of Rajan and Zingales’ (1998) original analysis still holds true when using domestic credit or market capitalization as measures of financial development. All coefficient estimates are significant, and the signs are in line with our previous replication analysis. With the exception of the ED × Market Capitalization coefficient, which is significant at the 5% level, all coefficients are highly significant at the 1% level. Thus, as in the previous subsection, we can conclude that the methodology proposed in Rajan and Zingales’ (1998) original paper is still applicable and that we can reliably build our further robustness tests on this basic model.

[Insert Table 6 here]

For the analysis of the double-interaction of time-to-build, Table 7 shows the results of the robustness test. Again, the results show high significance levels and are in line with our main test in the previous subsection. Accordingly, as for the robustness test before, the results from our main test are still robust and not fundamentally altered when incorporating alternative measures of financial development.

[Insert Table 7 here]

Our third robustness test, the application of the alternative measure of financial development in the triple-interaction term between time-to-build, external dependence and financial development, supports the findings of our main test. For both financial development proxies, Table 8 shows that all coefficients remain highly significant at the 1% level and do not deviate much from the regression results of our main test.

[Insert Table 8 here]

For all cases, the test of alternative measures of financial development supports the results of our main test. Therefore, our results are not only robust to different measures of time-to-build as already indicated in Subsection 5.1, but also to different measures of financial development. This further strengthens the confidence in the validity of the results and the relevance of this paper' contribution to the understanding of the relationship between financial development and economic growth. We do not only provide robust evidence that, in the presence of time-to-build, the growth of industries that are comparably more dependent on external financing is less sensitive to the development of the national financial market, but we also show, as indicated in Table 8, that this holds true for both the debt and the equity market. These results suggest that firms tend to finance most of their investments that take time-to-build with internal funds.

6 Conclusion

In this paper, we introduce time-to-build as a new moderating variable into the well-known relationship between financial development and economic growth. Building on Rajan and Zingales' (1998) influential study, we corroborate their central argument that industries with relatively higher need of external financing grow disproportionally faster in countries with well-developed financial systems with up-to-date data from 2001 to 2012. Most importantly, the introduction of time-to-build in this context reveals that high levels of time-to-build mitigate the growth benefiting effect highly developed financial systems have on industries that are relatively higher dependent on external financing. Theoretically, this result shows that industries with long investment cycles relies heavily in internal sources of financing rather than external ones (Frank and Goyal, 2009).

An additional contribution of this study is that we provide new empirical data on the distribution of time-to-build across industries. Although the further development of Tsyplakov's (2008) measuring approach allows us to make use of an extensive dataset, this procedure restricts our analysis in two ways. First, we can only consider very big investment projects ("big tickets") and, second, the accuracy of our measurement is limited to quarters. Further research could possibly help overcome this limitation. Particularly, the application of text mining in connection with formerly manual measuring approaches seems to be promising in achieving this goal.

References

Aftalion, A., 1927, The theory of economic cycles based on the capitalistic technique of production, *Review of Economics and Statistics*, 9(4), 165-170.

Aghion, P., P. Howitt and R. Levine, 2018, Financial development and innovation-led growth, 2018, in T. Beck and R. Levine, Eds.: *Handbook of finance and development*, Edward Elgar Publishing, Cheltenham, UK.

Agliardi, E. and N. Koussis, 2013, Optimal capital structure and the impact of time-to-build, *Finance Research Letters*, 10, 124-130.

Altug, S., 1989, Time-to-build and aggregate fluctuations: Some new evidence, *International Economic Review*, 30(4), 889-920.

Alvarez, L.H.R. and J. Keppo, 2002, The impact of delivery lags on irreversible investment under uncertainty, *European Journal of Operational Research*, 136, 173-180.

Bar-Ilan, A. and W.C. Strange, 1996, Investment lags, *American Economic Review*, 86(3), 610-622.

Bar-Ilan, A., A. Sulem and A. Zanello, 2002, Time-to-build and capacity choice, *Journal of Economic Dynamics & Control*, 26, 69-98.

Beck, T., 2003, Financial dependence and international trade, *Review of International Economics*, 11(2), 296-316.

Beck, T., A. Demirgüç-Kunt and V. Maksimovic, 2005, Financial and legal constraints to growth: Does firm size matter?, *Journal of Finance*, 60(1), 137-177.

Beck, T. and R. Levine, 2002, Industry growth and capital allocation: does having a market- or bank-based system matter?, *Journal of Financial Economics*, 64, 147-180.

Beck, T. and R. Levine, 2004, Stock markets, banks and growth: Panel evidence, *Journal of Banking & Finance*, 28, 423-442.

Beck, T. and R. Levine and N. Loayza, 2000, Finance and the sources of growth, *Journal of Financial Economics*, 58, 261-300.

Bencivenga, V.R., B.D. Smith and R.M. Starr, 1995, Transaction costs, technological choice, and endogenous growth, *Journal of Economic Theory*, 67, 153-177.

Cetorelli, N. and M. Gambera, 2001, Banking Market Structure, Financial Dependence and Growth: International Evidence from Industry Data, *Journal of Finance*, 56(2), 617-648.

Christiano, L.J. and R.M. Todd, 1996, Time to plan and aggregate fluctuations, *Quarterly Review*, 20(1), 14-27.

Claessens, S. and L. Laeven, 2003, Financial development, property rights, and growth, *Journal of Finance*, 58(6), 2401-2436.

DeAngelo, H., L. DeAngelo and T.M. Whited, 2011, Capital structure dynamics and transitory debt, *Journal of Financial Economics*, 99, 235-261.

Del Boca, A., M. Galeotti, C.P. Himmelberg and P. Rota, 2008, Investment and time to plan and build: A comparison of structures vs. equipment in a panel of Italian firms, *Journal of the European Economic Association*, 6(4), 864-889.

DellaVigna, S. and J.M. Pollet, 2013, Capital budgeting versus market timing: An evaluation using demographics, *Journal of Finance*, 68(1), 237-270.

Demirgüç-Kunt, A. and V. Maksimovic, 1998, Law, finance, and firm growth, *Journal of Finance*, 53(6), 2107-2137.

Dudley, E., 2012, Capital structure and large investment projects, *Journal of Corporate Finance*, 18, 1168-1192.

Fisman, R. and I. Love, 2003, Trade credit, financial intermediary development, and industry growth, *Journal of Finance*, 58(1), 353-374.

Fisman, R. and I. Love, 2007, Financial dependence and growth revisited, *Journal of the European Economic Association*, 5(2-3), 470-479.

Frank, M.Z. and V.K. Goyal, 2009, Capital structure decisions: Which factors are reliably important?, *Financial Management*, 38(1),1-37.

Ghemawat, P., 1984, Capacity expansion in the titanium dioxide industry, *Journal of Industrial Economics*, 33(2), 145-163.

Goldsmith, R.W., 1969, *Financial structure and development*, Yale University Press, New Haven, NY.

Kaplouptsidi, M., 2014, Time to build and fluctuations in bulk shipping, *American Economic Review*, 104(2), 564-608.

King, R.G. and R. Levine, 1993, Finance and growth: Schumpeter might be right, *Quarterly Journal of Economics*, 108(3), 717-737.

Koeva, P., 2000, The facts about time-to-build, *IMF Working Paper*, International Monetary Fund.

Kydland, F.E. and E.C. Prescott, 1982, Time to build and aggregate fluctuations, *Econometrica*, 50(6), 1345-1370.

Laeven, L., D. Klingebiel and R. Kroszner, 2002, Financial crises, financial dependence, and industry growth, *Policy Research Working Paper No. 2855*, The World Bank.

Levine, R., 1991, Stock markets, growth, and tax policy, *Journal of Finance*, 46(4), 1445-1465.

Levine, R., 2005, Finance and growth: Theory and evidence, 2005, in P. Aghion and S.N. Durlauf, Eds.: *Handbook of Economic Growth, Volume 1A*, Elsevier, Amsterdam.

Levine, R. and S. Zervos, 1998, Stock markets, banks, and economic growth, *American Economic Review*, 88(3), 537-558.

Lieberman, M.B., 1987, Excess capacity as a barrier to entry: An empirical appraisal, *Journal of Industrial Economics*, 35(4), 607-627.

Love, I., 2003, Financial development and financing constraints: International evidence form the structural investment model, *Review of Financial Studies*¸ 16(3), 765-791.

Lucas, R.E., Jr., 1988, On the mechanics of economic development, *Journal of Monetary Economics*, 22, 3-42.

Majd, S. and R.S. Pindyck, 1987, Time to build, option value, and investment decisions, *Journal of Financial Economics*, 18, 7-27.

Marchica, M.-T. and R. Murat, 2010, Financial flexibility, investment ability, and firm value: Evidence from firms with spare debt capacity, *Financial Management*, 39(4), 1339-1365.

Mayer, T., 1960, Plan and equipment lead times, *Journal of Business*, 33(2), 127-132.

Mayer, T. and S. Sonenblum, 1955, Lead times for fixed investment, *Review of Economics and Statistics*, 37(3), 300-304.

Montogomery, M.R., 1995, 'Time-to-build' completion patterns for nonresidential structures, 1961-1991, *Economics Letters*, 48, 155-163.

Pacheco-de-Almeida, G. and P. Zemsky, 2003, The effect of time-to-build on strategic investment under uncertainty, *RAND Journal of Economics*, 34(1), 166-182.

Rajan, R.G. and L. Zingales, 1998, Financial dependence and growth, *American Economic Review*, 88(3), 559-586.

Robinson, J., 1952, The generalization of the general theory, 1952, in J. Robinson, Ed.: *The rate of interest and other essays*, Macmillan, London.

Rouwenhorst, K.G., 1991, Time to build and aggregate fluctuations: A reconsideration, *Journal of Monetary Economics*, 27, 241-254.

Salomon, R. and X. Martin, 2008, Learning, knowledge transfer, and technology implementation performance: A study of time-to-build in the global semiconductor industry, *Management Science*, 57(7), 1266-1280.

Sarkar, S. and C. Zhang, 2013, Implementation lag and the investment decision, *Economic Letters*, 119, 136-140.

Sarkar, S. and C. Zhang, 2015, Investment policy with time-to-build, *Journal of Banking & Finance*, 55, 142-156.

Schumpeter, J.A., 1911, *Theorie der wirtschaftlichen Entwicklung*, Duncker & Humblot, Leipzig.

Stadler, G.W., 1994, Real business cycles, *Journal of Economic Literature*, 32(4), 1750-1783.

Tsyplakov, S., 2008, Investment friction and leverage dynamics, *Journal of Financial Economics*, 89, 423-443.

Wen, Y., 1998, Investment cycles, *Journal of Economic Dynamics and Control*, 22, 1139-1165.

Figure 1: Illustration of Time-to-Build Measures

Figure 1 illustrates by means of a stylized data cutout how "big tickets" are aggregated to distinct investment projects. "Big ticket" is equal to 1 if the corresponding investment ratio is one standard deviation above the mean investment ratio. For the latter three columns, 1 indicates the start of an investment project and the hatched area outlines which "big ticket" investments belong to the same investment project. A TTB1 project is separated from a following investment project if there is at least one quarter of no "big ticket". TTB2 projects are separated by at least two quarters of no "big ticket" and TTB3 projects have at least three quarters of no "big ticket" in-between.

Company (gvkey)	Quarter	Investment ratio	Depreciation ratio	Big ticket	TTB1 project	TTB2 project	TTB3 project
1078	1988q2	0.071	0.041	1	1	1	1
1078	1988q3	0.065	0.040				
1078	1988q4	0.089	0.028	1	1		
1078	1989q1	0.069	0.038				
1078	1989q2	0.062	0.037				
1078	1989q3	0.090	0.041	1	1	1	
1078	1989q4	0.062	0.036				
1078	1990q1	0.072	0.041	1	1		
1078	1990q2	0.071	0.039	1			
1078	1990q3	0.063	0.038				
1078	1990q4	0.078	0.040	1	1		
1078	1991q1	0.064	0.040				
1078	1991q2	0.067	0.039				
1078	1991q3	0.050	0.037				
1078	1991q4	0.102	0.035	1	1	1	1
1078	1992q1	0.079	0.041	1			
1078	1992q2	0.084	0.038	1			
1078	1992q3	0.084	0.037	1			
1078	1992q4	0.099	0.031	1			
1078	1993q1	0.067	0.038				
1078	1993q2	0.073	0.040	1	1		
1078	1993q3	0.072	0.037	1			
1078	1993q4	0.073	0.031	1			

Figure 2: Illustration of Single Depreciation Usage

By means of a stylized data cutout, Figure 2 illustrates how one depreciation is only used for one investment project. For both investment projects, one starting in 1989q2 and one starting in 1989q4, the 1993q3 depreciation ratio (red) is the maximum depreciation ratio in their respective 20 quarter observation windows. According to our adjustment of Tsyplakov's (2008) measuring approach, however, this depreciation is only used for the first investment project starting in 1989q2. For the second investment project starting in 1989q4, the second highest depreciation ratio (green) of its 20 quarter window is used for the determination of the project's end date.

Company (gvkey)	Quarter	Investment Ratio	Depreciation ratio	Big ticket	TTB1 project
1010	1989q2	0.051	0.015	1	**1**
1010	1989q3	0.040	0.015		
1010	1989q4	0.056	0.016	1	**1**
1010	1990q1	0.043	0.015	1	
1010	1990q2	0.051	0.015		
1010	1990q3	0.025	0.015		
1010	1990q4	0.030	0.015		
1010	1991q1	0.016	0.015		
1010	1991q2	0.011	0.015		
1010	1991q3	0.014	0.015		
1010	1991q4	0.006	0.015		
1010	1992q1	0.015	0.016		
1010	1992q2	0.010	0.016		
1010	1992q3	0.013	0.016		
1010	1992q4	0.018	0.015		
1010	1993q1	0.010	0.017		
1010	1993q2	0.013	**0.021**		
1010	1993q3	0.026	**0.022**		
1010	1993q4	0.022	0.018		
1010	1994q1	0.018	0.018		
1010	1994q2	0.013	0.019		
1010	1994q3	0.026	0.019		

Table 1: Descriptive Statistics, by Country

This table presents summary statistics for all 104 countries for which we have data from World Bank Open Source and UNIDO INDSTAT 4. Financial development (FD) in column 3 is defined like in Rajan and Zingales (1998) as the market capitalization ratio which is obtained by dividing the sum of domestic credit to private sector (column 1) and market capitalization (column 2) through GDP. The average annual growth rates of output in column 4 are obtained by taking the geometric mean over the years between the earliest and latest available value.

Country	(1) Domestic Credit	(2) Market Capitalization	(3) FD	(4) Growth in Output
Afghanistan	4.78			0.42
Albania	5.99			0.15
Algeria	8.01			0.03
Armenia	7.57			0.14
Australia	88.69	99.18	187.87	0.14
Austria	89.71	12.77	102.49	0.08
Azerbaijan	9.36			0.24
Bahrain	41.82	73.52	115.34	0.15
Bangladesh	24.18	1.81	25.99	0.21
Belgium	65.94	69.73	135.66	0.08
Bermuda		69.50		0.12
Bolivia (Plurinational State of)	53.56			0.14
Botswana	16.59			0.11
Brazil	29.00	33.29	62.30	0.15
Bulgaria	14.45	0.58	15.03	0.16
Burundi	16.30			-0.01
Canada	173.23	83.55	256.78	0.01
Chile	73.63	79.33	152.97	0.05
China	110.04	30.90	156.57	0.29
China, Hong Kong Special Administrative Region	148.98	298.74	447.72	0.03
China, Macao Special Administrative Region	63.86			0.01
Colombia	24.25	34.46	63.72	0.14
Congo	4.90			0.27
Cyprus	142.10	79.19	239.49	0.01
Czechia	37.27	12.07	49.34	0.14
Denmark	138.83	51.67	190.50	0.01
Ecuador	23.97			0.11
Egypt	54.93	86.99	136.28	0.15
Eritrea	29.03			0.04
Estonia	40.60			0.14
Ethiopia	21.28			0.20
Fiji	35.66			0.08
Finland	52.72	147.35	200.07	0.06
France	76.98	85.34	162.32	0.03
Georgia	7.52			0.24
Germany	112.04	54.94	166.98	0.07
Greece	50.08	62.23	112.31	0.02
Hungary	32.60	19.18	53.48	0.09
Iceland	97.46			0.15
India	29.01	46.55	78.60	0.18
Indonesia	20.29	14.33	34.62	0.18
Iran (Islamic Republic of)	30.08	5.82	35.90	0.06
Iraq	1.27			0.34
Ireland	71.85	69.00	140.85	0.05
Israel	76.76	44.11	120.87	0.06
Italy	60.59	45.38	105.97	0.04
Japan	183.18	52.62	235.80	0.05
Jordan	75.71			0.19

Kazakhstan	15.98	5.52	21.50	0.26
Kenya	25.22	8.05	33.27	0.17
Kuwait	56.63	64.87	121.49	0.14
Kyrgyzstan	3.83			0.13
Latvia				0.10
Lithuania				0.13
Luxembourg	78.81	106.76	185.57	0.09
Madagascar	8.38			-0.05
Malawi	5.21			0.16
Malaysia	129.10	128.23	257.34	0.12
Malta	97.72	31.32	161.41	-0.09
Mauritius	57.82	21.56	79.38	0.05
Mexico	12.88	16.69	29.56	0.11
Mongolia	9.14			0.38
Morocco	42.60			0.13
Namibia	41.31	4.24	45.55	0.07
Nepal	29.42			0.05
Netherlands	111.67	117.92	229.59	0.06
New Zealand	106.70	33.08	139.78	0.08
Norway	96.29	39.92	136.21	0.05
Oman	40.13	20.89	61.02	0.20
Panama	102.53	20.81	123.35	0.10
Paraguay	26.80			0.31
Peru	23.80	18.82	42.62	0.14
Philippines	37.53	27.86	65.39	0.12
Poland	23.61	13.66	37.26	0.14
Portugal	114.96	38.12	153.08	0.06
Qatar	34.89			0.30
Republic of Korea	106.06	43.88	149.94	0.10
Republic of Moldova	14.76			0.23
Romania	8.58	2.71	11.29	0.14
Russian Federation	16.84			0.22
Saudi Arabia	27.09			-0.10
Senegal	14.98			0.19
Serbia	31.39	6.73	24.51	0.11
Singapore	115.68	129.57	245.25	0.10
Slovakia	33.81	1.77	42.07	0.21
Slovenia	0.19	16.58	28.26	0.06
South Africa	138.79	121.28	260.07	0.13
Spain	95.13	74.80	169.93	0.05
Sri Lanka	30.73	8.45	39.19	-0.02
State of Palestine	21.48	12.80	34.28	0.10
Sweden	90.51	98.58	189.09	0.07
Switzerland	140.56	189.27	329.83	0.08
Tajikistan	22.91			0.37
Thailand	93.08	29.88	122.96	0.11
The former Yugoslav Republic of Macedonia	16.30			0.09
Trinidad and Tobago	41.91	44.07	85.98	0.12
Tunisia	61.51	10.11	71.62	0.10
Turkey	15.03	24.16	39.19	0.19
Ukraine	13.03			0.18
United Kingdom of Great Britain and Northern Ireland	121.89	132.56	254.45	0.02
United Republic of Tanzania	5.38	3.83	9.22	0.18
Uruguay	53.85			0.13
Viet Nam	39.29			0.26
Yemen	5.73			0.20
Mean	52.34	52.82	122.13	0.12
Median	37.27	38.12	118.10	0.12
Standard deviation	43.88	52.55	88.82	0.09

Table 2: Descriptive Statistics, by Industry

This table presents summary statistics for all 20 manufacturing industry divisions, I extracted from the UNIDO INDSTAT 4 data set based on ISIC Revision 3 codes. The number of investment projects in columns 1, 3 and 5 represent the number of investment projects that are used in each industry division for the calculation of the corresponding time-to-build measures in columns 2, 4 and 6. In accordance with Tsylakov (2008), time-to-build is calculated as the difference between a "big ticket" investment (investment ratio that is one standard deviation above the average) and the highest depreciation in the following 5 years. Thereby, a TTB1 project is separated from a following investment project if there is at least one quarter of no "big ticket". TTB2 projects are separated by at least two quarters of no "big ticket" and TTB3 projects have at least three quarters of no "big ticket" in-between. Time-to-build is measured in quarters. Number of firms (column 7) indicates the number of firms within each industry division that is used for the calculation of external dependence (ED, column 8). ED is defined, as stated in Rajan and Zingales (1998), as the fraction of capital expenditures that is not funded from cash flows from operations. Thereby, cash flows from operations are defined as sum of the following Compustat items: income before ordinary taxes, depreciations and amortizations; deferred taxes; equity in net loss earnings; sale of property, plant and equipment and investments gain; funds from other operations; decreases in inventories; decreases in receivables; increases in payables. The average annual growth rates of output in column 9 are obtained by taking the geometric mean over the years between the earliest and latest available value.

Industry Division	(1) Number of Investment Projects 1	(2) TTB1	(3) Number of Investment Projects 2	(4) TTB2	(5) Number of Investment Projects 3	(6) TTB3	(7) Number of Firms	(8) ED	(9) Growth in Output
Food and beverages	302	12.39	263	12.28	246	12.28	219	0.24	0.13
Tobacco	16	10.19	13	11.85	13	11.85	7	0.63	0.07
Textiles	25	10.36	24	10.13	23	9.78	27	-0.37	0.06
Wearing apparel	105	11.49	88	11.43	82	11.57	84	0.00	0.08
Leather	54	12.43	45	12.47	41	12.85	30	-2.93	0.07
Wood and straw	43	10.49	39	10.56	34	10.74	39	0.13	0.12
Paper	68	12.87	59	12.97	55	13.05	65	-0.08	0.12
Printing and media	43	13.12	39	13.33	36	12.94	39	-0.25	0.06
Coke and refined petroleum	66	12.09	53	12.17	50	12.30	73	0.17	0.20
Chemicals and pharmaceuticals	1282	11.84	1114	11.60	1006	11.51	1262	8.49	0.15
Rubber and plastics	116	11.71	99	11.86	90	12.01	100	0.10	0.15
Other non-metallic mineral products	55	12.71	46	12.02	40	12.33	50	0.42	0.14
Basic metals	97	10.96	75	10.52	66	10.30	98	0.32	0.14
Fabricated metal products	176	10.74	139	10.63	129	10.62	121	-0.91	0.14
Computer, electronic and optical products	1627	11.67	1364	11.47	1234	11.50	1207	0.83	0.09
Electrical equipment	181	12.03	157	11.85	145	11.68	159	0.85	0.15
Machinery and equipment	371	11.98	316	11.71	277	11.47	266	0.19	0.17
Motor vehicles	166	11.92	143	11.41	128	11.78	139	0.58	0.15
Transport equipment	154	12.18	141	12.12	121	11.88	83	0.03	0.12
Furniture and other manufacturing	409	11.03	338	10.86	298	10.86	360	0.83	0.14
Mean	267.80	11.71	227.75	11.66	205.70	11.67	221.40	0.46	0.12
Median	110.50	11.88	93.50	11.78	86.00	11.73	91.00	0.18	0.14
Standard deviation	424.32	0.84	360.49	0.83	325.61	0.87	357.40	2.06	0.04

Table 3: Replication of Rajan and Zingales (1998)

This table presents the results of the replication of Rajan and Zingales' (1998) original regression. The dependent variable is growth in output. This growth rate is calculated by taking the average annual growth rate for each industry and each country between 2001 and 2012. Industry share represents the share of industry *i*'s output in country *j*'s total output in 2001. External dependence (ED) is defined like in Rajan and Zingales (1998) as the fraction of capital expenditures that is not funded from cash flows from operations. Our main measure of financial development (FD) is defined as the market capitalization ratio measure of Rajan and Zingales (1998). It is the sum of domestic credit to private sector and market capitalization divided by GDP. ED and FD are standardized after calculation and merging.

Average Growth Rate of Output

VARIABLES	(1) Growth
Industry Share	-0.257 ***
	(0.0680)
ED × FD	0.00334 **
	(0.00118)
Observations	941
Adjusted R-squared	0.478
Country FE	YES
Industry FE	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Interaction of Time-to-Build with Financial Development

This table presents the results of the regression that adds an additional interaction term between time-to-build and financial development to the original regression of Rajan and Zingales (1998). The dependent variable is growth in output. This growth rate is calculated by taking the average annual growth rate for each industry and each country between 2001 and 2012. Industry share represents the share of industry *i*'s output in country *j*'s total output in 2001. External dependence (ED) is defined like in Rajan and Zingales (1998) as the fraction of capital expenditures that is not funded from cash flows from operations. Our main measure of financial development (FD) is defined as the market capitalization ratio measure of Rajan and Zingales (1998). It is the sum of domestic credit to private sector and market capitalization divided by GDP. ED and FD are standardized after calculation and merging. Time-to-Build (TTB) is calculated following Tsyplakov (2008) by the difference between a "big ticket" investment (investment ratio that is one standard deviation above the average) and the highest depreciation in the following five years. Thereby, TTB1 (TTB2, TTB3) assumes investment projects to be individual if they are separated by at least one (two, three) quarters without a "big ticket" investment.

Average Growth Rate of Output

	(1)	(2)	(3)
VARIABLES	Growth	Growth	Growth
Industry Share	-0.256 ***	-0.257 ***	-0.256 ***
	(0.0674)	(0.0678)	(0.0677)
ED × FD	0.00332 **	0.00333 ***	0.00327 ***
	(0.00127)	(0.00113)	(0.00110)
TTB1 × FD	-0.00201		
	(0.00189)		
TTB2 × FD		-0.000130	
		(0.00212)	
TTB3 × FD			-0.000807
			(0.00169)
Observations	941	941	941
Adjusted R-squared	0.478	0.478	0.478
Country FE	YES	YES	YES
Industry FE	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Interaction of Time-to-Build with External Dependence and Financial Development

This table presents the results of the regression that adds an interaction term between time-to-build and financial development as well as a triple-interaction term between time-to-build, external dependence and financial development to the original regression of Rajan and Zingales (1998). The dependent variable is growth in output. This growth rate is calculated by taking the average annual growth rate for each industry and each country between 2001 and 2012. Industry share represents the share of industry *i*'s output in country *j*'s total output in 2001. External dependence (ED) is defined like in Rajan and Zingales (1998) as the fraction of capital expenditures that is not funded from cash flows from operations. Our main measure of financial development (FD) is defined as the market capitalization ratio measure of Rajan and Zingales (1998). It is the sum of domestic credit to private sector and market capitalization divided by GDP. ED and FD are standardized after calculation and merging. Time-to-Build (TTB) is calculated following Tsyplakov (2008) by the difference between a "big ticket" investment (investment ratio that is one standard deviation above the average) and the highest depreciation in the following five years. Thereby, TTB1 (TTB2, TTB3) assumes investment projects to be individual if they are separated by at least one (two, three) quarters without a "big ticket" investment.

Average Growth Rate of Output

	(1)	(2)	(3)
VARIABLES	Growth	Growth	Growth
Industry Share	-0.257 ***	-0.257 ***	-0.256 ***
	(0.0670)	(0.0674)	(0.0671)
ED × FD	0.139 **	0.0762 ***	0.0826 **
	(0.0540)	(0.0253)	(0.0317)
TTB1 × FD	-0.00508 *		
	(0.00246)		
TTB2 × FD		-0.00227	
		(0.00274)	
TTB3 × FD			-0.00353
			(0.00247)
TTB1 × ED × FD	-0.0114 **		
	(0.00454)		
TTB2 × ED × FD		-0.00625 ***	
		(0.00212)	
TTB3 × ED × FD			-0.00682 **
			(0.00268)
Observations	941	941	941
Adjusted R-squared	0.478	0.477	0.478
Country FE	YES	YES	YES
Industry FE	YES	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Robustness Test – Replication of Rajan and Zingales (1998)

This table presents the results of an alternative replication of Rajan and Zingales' (1998) original regression. Different to the main test, this robustness test uses domestic credit to private sector over GDP (Domestic Credit) and market capitalization over GDP (Market Capitalization) as measures of financial development. The dependent variable is growth in output. This growth rate is calculated by taking the average annual growth rate for each industry and each country between 2001 and 2012. Industry share represents the share of industry *i*'s output in country *j*'s total output in 2001. External dependence (ED) is defined like in Rajan and Zingales (1998) as the fraction of capital expenditures that is not funded from cash flows from operations. ED, Domestic Credit and Market Capitalization are standardized after calculation and merging.

Average Growth Rate of Output

	(1)	(2)
VARIABLES	Growth	Growth
Industry Share	-0.295 ***	-0.258 ***
	(0.0747)	(0.0684)
ED × Domestic Credit	0.00390 ***	
	(0.00101)	
ED × Market Capitalization		0.00334 **
		(0.00147)
Observations	1,438	941
Adjusted R-squared	0.428	0.478
Country FE	YES	YES
Industry FE	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Robustness Test – Interaction of Time-to-Build with Financial Development

This table presents the results of the alternative regression that adds an additional interaction term between time-to-build and financial development to the original regression of Rajan and Zingales (1998). Different to the main test, this robustness test uses domestic credit to private sector over GDP (Domestic Credit) and market capitalization over GDP (Market Capitalization) as measures of financial development. The dependent variable is growth in output. This growth rate is calculated by taking the average annual growth rate for each industry and each country between 2001 and 2012. Industry share represents the share of industry *i*'s output in country *j*'s total output in 2001. External dependence (ED) is defined like in Rajan and Zingales (1998) as the fraction of capital expenditures that is not funded from cash flows from operations. ED, Domestic Credit and Market Capitalization are standardized after calculation and merging. Time-to-Build (TTB) is calculated following Tsyplakov (2008) by the difference between a "big ticket" investment (investment ratio that is one standard deviation above the average) and the highest depreciation in the following five years. Thereby, TTB2, assumes investment projects to be individual if they are separated by at least two quarters without a "big ticket" investment.

	Average Growth Rate of Output	
	(1)	(2)
VARIABLES	Growth	Growth
Industry Share	-0.295 ***	-0.258 ***
	(0.0747)	(0.0692)
ED × Domestic Credit	0.00388 ***	
	(0.000990)	
ED × Market Capitalization		0.00348 **
		(0.00128)
TTB2 × Domestic Credit	-0.000243	
	(0.00145)	
TTB2 × Market Capitalization		0.00256
		(0.00187)
Observations	1,438	941
Adjusted R-squared	0.428	0.478
Country FE	YES	YES
Industry FE	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Robustness Test – Interaction of Time-to-Build with External Dependence and Financial Development

This table presents the results of the regression that adds an interaction term between time-to-build and financial development as well as a triple-interaction term between time-to-build, external dependence and financial development to the original regression of Rajan and Zingales (1998). Different to the main test, this robustness test uses domestic credit to private sector over GDP (Domestic Credit) and market capitalization over GDP (Market Capitalization) as measures of financial development. The dependent variable is growth in output. This growth rate is calculated by taking the average annual growth rate for each industry and each country between 2001 and 2012. Industry share represents the share of industry *i*'s output in country *j*'s total output in 2001. External dependence (ED) is defined like in Rajan and Zingales (1998) as the fraction of capital expenditures that is not funded from cash flows from operations. ED, Domestic Credit and Market Capitalization are standardized after calculation and merging. Time-to-Build (TTB) is calculated following Tsyplakov (2008) by the difference between a "big ticket" investment (investment ratio that is one standard deviation above the average) and the highest depreciation in the following five years. Thereby, TTB2, assumes investment projects to be individual if they are separated by at least two quarters without a "big ticket" investment.

	Average Growth Rate of Output	
	(1)	(2)
VARIABLES	Growth	Growth
Industry Share	-0.296 ***	-0.259 ***
	(0.0740)	(0.0685)
ED × Domestic Credit	0.0684 ***	
	(0.0179)	
ED × Market Capitalization		0.110 ***
		(0.0308)
TTB2 × Domestic Credit	-0.00215	
	(0.00174)	
TTB2 × Market Capitalization		-0.000539
		(0.00333)
TTB2 × ED × Domestic Credit	-0.00552 ***	
	(0.00152)	
TTB2 × ED × Market Capitalization		-0.00912 ***
		(0.00257)
Observations	1,438	941
Adjusted R-squared	0.428	0.478
Country FE	YES	YES
Industry FE	YES	YES

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1