SSE Riga Student Research Papers
2019 : 2 (212)

THE EFFECTS OF PASSIVE INVESTING ON CAPITAL ALLOCATION EFFICIENCY

Authors: Diana-Vlada Dragancea
Eugeniu Papuha

ISSN 1691-4643
ISBN 978-9984-822-

November 2019
Riga

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Diana-Vlada Dragancea

and

Eugeniu Papuha

Supervisor: Tālis J. Putniņš

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Abstract

This paper analyzes the relationship between passive investing and capital allocation efficiency across a set of 33 countries over the period 2003-2015. In the context of a global trend of increasing ETF holdings, it is important to assess whether passive investing poses a threat to efficiency and evaluate whether there is any need for a change in future policy initiatives towards regulations that are supportive of active investing. With the help of a variety of both causal and non-causal frameworks we show that (1) markets rarely reach harmful levels of passive investing due to a natural equilibrium mechanism, (2) passive investing, at moderate levels, is not harmful to capital allocation efficiency and (3) at high levels, passive investing has a negative impact on capital allocation efficiency. We find that a mere 1.40% of the country-year observations in our dataset reach levels of passive investing that could be detrimental to capital allocation efficiency and provide a theoretical background to explain the existence of a natural equilibrium framework that keeps passive investing at harmless levels. We conclude that under normal market conditions passive investing poses no threat to allocative efficiency.

Acknowledgements

We thank our supervisor, Dr. Tālis J. Putniņš, for endless support, invaluable feedback and involvement throughout the thesis writing process.

1. Introduction

One of the main roles of the economy is to efficiently direct capital to where it is most needed. Moving capital from stagnating industries to growing ones is necessary to maximize economic growth and increase the value to society. The financial system facilitates the flow of funds from hands which have surplus funds, to hands which are facing a shortage in funds. Be it by direct financing - selling equity on the primary market, or indirect financing- raising capital from the banking system, the financial system is the platform that enables the flow. Profit-maximizing investors try to understand ex-ante what the fair value price of assets are and allocate resources so as to reflect their beliefs. Through their forward-looking investment decisions, active investors make the price discovery mechanism reach an equilibrium faster than would otherwise be possible.

Recently, Exchange-Traded Funds (ETFs) have been pronouncedly gaining popularity. ETFs are baskets of securities of virtually any asset classes, traded on an exchange. Traditionally, ETFs were designed to track specific indices, markets or sectors of the economy; however, today there are different types of ETFs, alternative investment ETFs and style ETFs allowing investors to gain exposure to different investment strategies (Fidelity, n.d.). According to Morningstar (2018), ETFs have been growing at an average rate of 16.5% over the last 10 years in the US, much faster than the 2% growth rate of active mutual funds. This is not a North American trend only, as data show that in Asia the share of passive investments in equity funds has almost tripled from 16% in 2007, and in Europe it increased from 13% to 34% (Institutional Investor, 2018). A recent survey-based study performed by EY (2017) predicts that "ETF assets have the potential to reach $7.6tn by 2020 […] equivalent to a CAGR of approximately 18%" (p. 5). What is more, the same study asserts that "regulation is having an increasingly positive effect on ETF distribution" (p. 22). Jim Norris, head at Vanguard, is "confident that the growth rates we've seen will continue and perhaps even accelerate in the years ahead, especially outside of the US. The take-up of ETFs is just beginning to gain momentum in Europe and it is still very early days in Asia and LatAm" (as cited in FT, 2018).

Although perceived as a good alternative to investors who are not concerned with price discovery, passive investing[1]- a type of investing strategy consisting of tracking an index or a market-weighted portfolio - is criticized for free-riding on the information acquisition efforts of active traders (Coles, Heath, & Ringgenberg, 2018). Among the effects of passive investing on the informational efficiency of markets, two concerns stand out as highly debated (Easley, Michayluk, O'Hara, & Putnins, 2018). Firstly, increasing passive investing has been linked with increasing co-movement of stock returns due to the trading of baskets of stocks at a time instead of differentiating trade direction and order size across stocks. The second concern is that passive investors do not seek to correct mispricings and so contribute to a deterioration in the amount of stock-specific information in markets. The debate on whether passive investing harms or improves market efficiency has led to a proliferation of studies with conflicting views. Bolla, Kohler and Wittig (2016) link passive investing with an increase in the co-movement of securities. In turn, Wurgler (2000) shows that the relation between an increase in synchronicity and capital allocation efficiency is a negative one. Linking the two findings, AllianceBernstein L.P., a global asset management firm, published a controversial note on the threat posed by the increase in the share of passively-managed funds on the efficiency of capital allocation, going as far as claiming that a market that is predominantly passive is worse than Marxism (2016).

It is particularly important now, as the share of passively held assets appears to be at an all-time high, to understand whether there is any real threat of market failure in the financial system or the observable trend is a harmless change in the investment vehicle. If a natural mean-reverting mechanism is the only defense in front of potential negative effects from this phenomenon, it might be in the interest of policymakers to assess how successful the natural equilibrium mechanism has been at protecting markets from allocative efficiency harm. Resting on this evaluation is the direction of future policy initiatives relating to the investment universe.

To better understand the implications of the growth in passive investing, we aim to study the impact of passive investing on capital allocation efficiency. Consequently, we state the following research question:

[1] Throughout the thesis, we use the terms “passive investing”, “passiveness” and “passive” interchangeably.

How does the increasing popularity of passive investing impact capital allocation efficiency?

We try to answer this question by analyzing a sample of 33 countries across the world and their stock markets over the period 2003-2015. We show that the typical moderate level of passive investing is not harmful to capital allocation efficiency; however, if passive investing were to increase past a high threshold, allocative efficiency might be harmed. Our results are consistent with the existence of a natural equilibrium mechanism that prevents passive investing from reaching levels where efficiency is substantially impacted. Namely, as passive investing increases and inefficiencies begin to emerge, opportunities for arbitrage appear and active investing becomes more attractive, constraining the further growth of passive investing within harmless levels. Consistent with such a mechanism, conjectured by theory, in the entire sample of 33 countries and 13 years, a mere 1.40% of the country-year observations reach levels of passive investing that could be detrimental to capital allocation efficiency.

Our paper contributes to a growing body of literature on the implications that increasing passive investing might have on various aspects of financial markets and the real economy. The previously mentioned statistics on the growth of ETFs and loud supporters of active investing, such as AllianceBernstein L.P., are trying to make a case for a change in the direction of future policy initiatives towards regulations that are more supportive of active management, rather than passive. As previously mentioned, we find no significant results to indicate that the current level of passive investing is in any way harmful to the economy.

The thesis is structured as follows. Section 2 provides a review of the literature that is relevant to our research. Section 3 describes the data, and section 4 describes the measures that we employ in our empirical analysis. In section 5 we introduce the theoretical framework and discuss the empirical findings. Section 6 shows various robustness tests. Section 7 acknowledges the limitations of our approach and section 8 concludes.

2. Literature review

In this section we provide a synthesis of the information available in academic papers on the topic of our study and the motivation behind the research question and chosen hypotheses.

2.1. The role of the financial system

The conviction that financial markets have an important role for the real economy has been a long standing one. Although economists have come up with conflicting explanations of the mechanism through which financial markets improve the real economy, and, thus, the importance of the financial system for economic growth, the predominant view is that there is a positive relation between the two.

When financial markets are not efficient, there is a reduction in real economic activity. Levine and Zervos (1998) investigate the link between stock markets and long-run growth and find "a strong, positive link between financial development and economic growth" and their results suggest that "financial factors are an integral part of the growth process" (p. 554).

The channel through which the primary markets affect the real economy is relatively straightforward, since money flows to firms straight from investors. The financial system enables the identification of investment opportunities, reduces investment in unproductive assets, mobilizes savings, boosts technological innovations and improves risk taking (Rajan & Zingales, 1998). Another important channel used in the literature to explain this relationship is trading. Most of the trading occurs on the secondary market. Since in this case capital just changes hands among investors, there is no obvious effect on the real economy. However, Bond, Edmans and Goldstein (2012) argue that prices in secondary markets affect the real economy through the actions of decision makers. The explanation they propose for this link are all derived from the informational role of prices.

2.2. Capital Allocation Efficiency

"A fundamental job of the economy is to allocate capital efficiently" (Wurgler, 2000, p. 188). In other words, resources should be directed to growing industries, with good prospects when it comes to expected returns. In turn, capital should be withdrawn from industries with poor prospects.

There is a body of literature that looks at how the financial system contributes to the efficient allocation of capital. In his book, "*Lombard Street: A Description of the Money Market*" (1873), Bagehot argues that the ability of capital markets to efficiently allocate capital was one of the primary drivers of England's superior economic growth in the second half of the nineteenth century. The book started a conversation on the link between capital allocation efficiency and economic growth. In his book "*The theory of economic development*" (1934), Schumpeter highlights the crucial role of financial intermediaries on economic growth in that they direct savings to firms, and thus decide on the allocation of capital across firms. Beck, Levine and Loayza (2000) find a positive link between better functioning financial intermediaries and capital allocation efficiency, "with positive repercussions for long-run economic growth" (p. 296).

Particularly important to mention are studies by Wurgler (2000) and Bolla et al. (2016). Wurgler identifies a mechanism by which the financial system improves the allocation of capital. The author's analysis shows that variables which can be used to analyze financial markets explain the difference that can be observed in the efficiency of capital allocation across countries. An important finding relevant to our study is the "synchronicity" channel. Wurgler finds that synchronicity, as calculated by Morck, Yeung and Yu (2000), strongly negatively correlates with the author's measure of capital allocation efficiency. "Synchronicity" of stock prices is defined as "the extent to which stock returns on individual firms move together" (p. 198). The negative effect of co-movement in stock prices remains statistically significant after introducing other controls for capital allocation efficiency.

Wurgler's measure has become a standard in the literature on capital allocation efficiency. Researchers who have continued on the strand of literature on finance do not fail to mention Wurgler's paper as one of the main studies on the efficiency of investment allocation (La Porta, Lopez-de-Silanes, Schleifer, and Vishny (2002), Beck and Levine (2002), Sun (2014)). Few other attempts have been made at deriving a measure that quantifies the efficiency with which capital is allocated across industries. Cavallo, Galindo, Izquierdo and Leon (2013) compute the elasticity of investments to total factor productivity, taking into account how this relationship differs according to changes in price volatility. Although innovative and attractive through its ease of computation, this measure has an important drawback – it forces the authors to make several crucial assumptions: the coefficients in the Cobb-Douglas function are assumed to be the same across industries; the rate of return for physical capital is assumed to be constant across industries in the US and across time; and the capital share is assumed to be the same across countries and across time.

2.3. Active and passive investing

In general, there are two main investment strategies: active and passive. Passive investors buy index funds that track one market index or another. Their goal is to earn the market return. Active investors pick different stocks that they think will perform well and hope to earn a higher return than the market.

Although there are advantages and disadvantages to both these strategies, passive investing is becoming more and more popular and is capturing new capital. The main value propositions of index funds are risk diversification and low costs (Vanguard, 2017). Due to the fact that index funds only track an index, trading costs are minimized - index funds that track the S&P 500 for example only need to change the portfolio composition when companies are replaced in the index itself. Not only is the cost of passive investing lower than that of active, but literature also shows that the cost has been decreasing (Garleanu & Pedersen, 2018) and, the wedge between the costs of the two strategies increases over time with increasing turnover of passive investing (French, 2008).

Other advantages of passive funds include good transparency and tax efficiency (Wharton, n.d.). Market participants are always aware what an index entails, and the buy-and-hold style of passive avoids capital gain taxes. In turn, Easley et al. (2018) explain the hedging and short-selling benefits provided by ETFs – another driver of passive investing popularity. Exchange-traded funds relax the constraints of active investors when it comes to taking speculative positions - ETFs that specialize in following specific factors or characteristics allow for complex hedging strategies. Also, due to the innovative complex strategies of ETFs, investors can get access to illiquid or difficult to trade stocks and enter short positions that would otherwise be more expensive or not possible.

Although research has shown that active managers cannot consistently outperform the market (Malkiel, Returns from Investing in Equity Mutual Funds 1971 to 1991, 1995), there are still advantages offered by active investing. It is more flexible, since managers are not bounded by a specific portfolio composition. Hedging, risk and tax management are also among the benefits offered by active investing (Wharton, n.d.). These benefits are possible through the use of short-selling and put options, through the ability to not invest in some industries that might be too risky. The choice between active and passive strategies ultimately comes down to “whether you believe in trying to beat the market or whether you believe in [minimizing] costs” (Wharton, n.d.).

As the choice of investors appears to be shifting towards a more passive strategy and the trend has been predicted to continue in the foreseeable future, it is worth exploring previous studies that have tried to quantify this trend. To measure passive investing, one can first take a look at active investing, since active management can be defined “as any deviations from passive” (Cremers & Petajisto, 2009, p. 3334). One measure of active management can be chosen over another depending on the type and aspect of active management intended to be captured.

Tracking error volatility is one of the standard ways to measure how actively a fund is managed. It is defined as the time-series standard deviation of the difference between the return of a fund and that of its benchmark index (Cremers & Petajisto, 2009). The measure was first explained by Grinold and Kahn (1999) two decades ago. Using Tracking Error on its own would be a good proxy for bets on systematic risk; however, it would not capture the part of active management attributable to diversified stock picks. That is why Cremers and Petajisto (2009) derive Active Share, another measure of active management that quantifies the overlap in the holdings of a mutual fund with those of its benchmark index by measuring the portfolio weight differences. Together, the two measures allow to distinguish between stock selection and bets on systematic risk, providing a comprehensive picture of active management. Computing both measures requires data on portfolio composition of mutual funds as well as the composition of their benchmark indices.

An interesting finding using Active Share and Tracking Error was provided recently by Easley et al. (2018). The authors use the two measures to study the level of activeness of ETFs. Focusing on US stocks from 2000 to 2017, they find that, scaled by

AUM, 58% of ETFs have an Active Share larger than 50% and that 86% of the dollar volume traded by ETFs is traded by ETFs with an Active Share larger than 75%. In other words, active ETFs make up the majority of the ETF universe, both according to size and trading. What is more, the activeness level of ETFs has been increasing through time, indicating that ETFs have been evolving as a more active investment vehicle rather than linearly increasing the ratio of passively-to-actively held assets. The most important takeaway from the study is that the increase in ETFs appears to not have translated in a decrease in the overall activeness of investors. This is why, using ETFs-related measures for the size of the passive industry, such as the number of ETFs or holdings of ETFs, could lead to severely overstating the size of the industry relative to active investing. The rise in ETFs holdings represents a change in the investment vehicle preferred by investors; investors' overall appetite for betting against the market appears to still be there.

Another take on measuring the size of active management is provided by Bhattacharya and Galpin (2011). Their metric attempts to indicate the popularity of passive investing and is backed by a very intuitive idea: if all investors can choose only between a value-weighted portfolio and a risk-free asset, then dollar turnover, defined as "dollar volume of shares traded divided by the dollar market capitalization of the stock" (p. 741), should be the same for all stocks. In this hypothetical world, there would be no deviations from constant turnover, otherwise some stock-picking exists. Bhattacharya and Galpin exploit this characteristic and measure the value-weighted cross-sectional variance at a point in time. In a market where all investors value-weight, this measure would be 0; if at least some investors pick stocks, there would be deviations from constant turnover and this measure becomes higher than 0. Computing the value-weighted cross-sectional variance of log-turnover requires three basic stock-level variables: number of shares outstanding, volume traded and share price.

2.4. Implications of increasing passive investing

The topic of the total effect of passive investing on social welfare continues to be a debate among academics, with no clear answer available in the literature (Coles et al., 2018).

Two important concerns have previously been linked to a rise in passive investing: increasing stock price correlation and decreasing stock-specific information in prices (Easley et al., 2018). Bolla et al. (2016) perform a study where they find that correlation of stock returns increases when the share of passively-managed assets is higher. Similarly, Coles et al. (2018) find strong evidence that an increase in passive investing is linked to changes in prices that are significantly different from a random path. The effect of passive investing on volatility is explored by Ben-David, Franzoni and Moussawi (2018). The authors conclude that volatility increases with ETF ownership. A similar result related to both concerns is reached by Israeli, M. C. Lee and Sridharan (2017), who also show that an increase in ETFs trading leads to a deterioration in informational efficiency. Coles et al. (2018) have closely-related findings, bringing forward evidence that a change in ownership composition towards a more passive one leads to a deterioration in weak-form price efficiency.

On the other side of the debate, Easley et al. (2018) show that although passive investing is said to have been increasing during the last decade, co-movement of stocks has been steadily following a downward trend. These results might be reconciled with specialized ETFs - niche ETFs that follow specific industries, products or factors - offsetting the effect of broad index-based ETFs on moving prices at the same time. The second concern is also refuted. Firm-specific information in prices is not following the same trend as ETF holdings and, while the variation of specific information as a share of return variation is higher in 2017 than in 2000, ETF holdings showcase the opposite trend. The authors conclude that the said increase in passive investing is exaggerated by the belief that ETFs are passive investment vehicles and that the concerns related to the believed rise in passive investing to the detriment of active investing do not hold to empirical scrutiny.

It is difficult to reconcile the various findings available in the literature due to the different aspects of passive investing studied and we leave the study of the total effect of passive investing on social welfare for future research. The results that are discussed in this section are brought forward in order to illustrate the debate that is taking off in the academic universe in the context of increasing popularity of passive investing. We contribute to the available literature by studying the impact of passive investing on capital allocation efficiency alone.

Of particular interest on the topic of passive investing and allocative efficiency is a research note published by AllianceBernstein L.P. (Fraser-Jenkins, Gait, Harmsworth, Diver, & McCarthy, 2016). The authors go as far as asserting that the degree of market failure in predominantly passive capital markets is higher than that under Marxism. The reasoning the authors provide for their remark is that central planning, if rational and forward-looking, is still superior to no planning and backward-looking resource allocation decisions that characterize passive strategies. Undoubtedly, the authors also try to prove that a predominantly active regime is preferred to both Marxism and a passive one.

The authors believe that it is possible to define a “fair value” towards which stock prices mean-revert over time and which emerges naturally eventually. If this belief holds, the note explains, it should be possible to try to profit from deviations from the equilibrium price. At the same time, by directing capital accordingly - investing funds in stocks which are believed to be undervalued and withdrawing funds from the ones which are overvalued – investors can precipitate the emergence of the equilibrium price. This strategy can be defined as an active one, in that it is forward-looking and tries to follow the “fair value” of an asset by studying the dynamics of the real economy. Therefore, capital markets in which assets are predominantly actively managed should be expected to converge to a “fair price” quicker than possible in other regimes. The authors estimate that price volatility is introduced in the short and medium terms in markets which are predominantly passive and equilibrium is reached slower. Active investors act as to create a self-correcting price-mechanism and allow the quick discovery of information about the dynamics of the real economy. In turn, passive investors direct funds to where past performance was the highest, irrespective of whether that performance was in the direction of the “fair value”, thus diluting the information observable in the dynamics of the economy.

Finally, the research note raises the same question as the one we try to address in our study. If an increase in passive investing can be associated with an increase in stock price synchronicity, which has also been shown to negatively impact the efficiency in capital allocation, the current high growth in passive investing might pose threats to how efficiently resources are allocated in a country. AllianceBernstein L.P. do not provide an empirical analysis of the issue at hand, and this is what we try to add to the current body of literature.

Although missing an empirical analysis to support the assertions they make, the report from Bernstein stirred up reactions from big firms and academic researchers. Andrew W. Alford, Managing Director at Goldman Sachs Asset Management has a different view on how the industry of active versus passive investing is changing: “the threat posed by indexers is overstated” (Alford, 2017, p. 2). Alford highlights the changes in the construction of trading strategies due to innovation, and the blurring of the line that divides active and passive. According to the note, deviations in prices will always occur and should not be attributed to the growth in passive investing and active managers simply need to embrace the latest trends in order to keep being successful.

Another record of disagreement with the dystopic picture painted by the note from Bernstein came from economist and writer Burton Malkiel. Malkiel is of the opinion that the marginal active investor is the one that matters in making prices informative. The author states that having even 5-10% of all investors following an active strategy would be enough to correct mispricing (Malkiel, 2016). Although the proportion mentioned appears to be an arbitrary one, the view that the marginal investor is the one that matters in driving prices back to equilibrium is interesting in the discussion about the implications of rising passive investing popularity. On a similar note, Coles et al. (2018) touch upon the question of “how many active managers are enough to ensure that prices correctly reflect fundamental value” (p. 2). The authors use earning response coefficients and Stambaugh, Yu and Yuan’s (2015) measure of anomaly mispricing to show that, although passive investing might have a negative impact on the price discovery process, it does not alter investors’ ability to participate in arbitrage or to impound information into prices by trading. In other words, at current observable levels of passive investing, the size of the active investing industry does not appear to have shrunk to the point where there is not enough capital to move prices to equilibrium.

2.5. Allocative equilibrium in the investment universe

The idea of a natural mean-reverting equilibrium mechanism in the investment universe is a recent one. An important contribution was made by Pastor and Stambaugh (2012). The authors start their research from the puzzling fact that active funds, although exhibiting an underperforming track record relative to passive benchmarks, have remained relatively significant in size. Some light is shed on this puzzle by making a case for decreasing returns to scale in the active management industry: “any fund manager's ability to outperform a passive benchmark declines as the industry's size increases" (p. 741). The authors derive a model of returns to scale in which they allow active managers to learn from the track record of the industry. Although investors are uncertain about future excess returns, they learn from observing realized returns. After a period of underperformance, investors understand that the industry is oversaturated and there are little excess returns to be made. This helps explain the slight downward trend in the size of the active management industry relative to passive investing. However, the decrease appears to be modest in comparison to the longer-standing track record of underperformance of active funds. If we account for the fact that investors are aware of the decreasing returns to scale character of the active management industry, they also know that if they allocate less to active management now, their future excess returns will be higher. As a result of their desire to capture the increasing returns made possible by the relative size of active investing decreasing, investors will still leave a portion of their capital in active portfolios. Decreasing returns to scale in this case provide cushioning for the decrease in the size of active management – "investors disinvest less than they would if returns to scale were constant" (p. 741). Therefore, after some time of underperformance, we can expect the equilibrium share of active-to-passive management to be lower, but still significant, which explains the trends that we observe in the market today. The authors expect that the decreasing returns to scale characteristic will keep the size of active management at large levels for years to come.

The second important contribution the 2012 paper makes is showing that investors are slow at learning about the decreasing returns of active management because their learning is hindered by endogeneity: when they learn something, they change the way they allocate funds; after changing how much they allocate to active management, they learn from the realized excess returns. Consequently, the observable equilibrium allocation is slow to change, investors remaining uncertain and their initial beliefs about returns to scale persisting.

An important driver of the size of the active industry is competition among investors. Magkotsios (2018) shows that competition among active funds slowly drains the overall profitable opportunities available in the market. Eventually, the overall surplus gets to zero and on average active managers underperform the benchmark. On a similar note, Pastor and Stambaugh (2012) explain that competition drives investors to increase the share of capital they allocate to active management, resulting in an equilibrium share of active management that is higher than that under profit-maximization and no competition. More competition across investors, via driving the size of active management, allows more stock-specific information to get impounded into prices. In turn, investors can make more informed decisions after observing prices on the market and the efficiency with which capital is allocated across firms increases.

To connect the above to allocative efficiency we first need to understand what creates profitable opportunities in financial markets. The Efficient Market Hypothesis states that assets are fairly priced and markets reflect all available information. Consequently, investors cannot outperform the market because prices only react to new information (Fama, 1970). As an implication, if profitable opportunities exist in the market and there are some excess returns to be exploited by active investors, then markets are not fully efficient. This means that when efficiency is low, investors will try to profit from the existing mispricing and will increase the money allocated to active funds. This will happen up until the point when the previously discussed decreasing returns to scale kick in and there are no more inefficiencies to profit from. Conversely, when passive grows, noise is introduced into prices and mispricings arise (Coles et al., 2018).

From the above, we theorize that the relationship between active, and therefore passive, investing and allocative efficiency is one of a constantly self-adjusting equilibrium. When passive grows in popularity past the beneficial levels discussed before (shorting and hedging benefits), efficiency deteriorates to the point where mispricings arise and give birth to potential excess returns. Investors then, chasing for those returns, move their money into active portfolios to try to profit from market inefficiency, and the share of passive decreases, until the point when all mispricing is driven out of the market and no excess returns are possible anymore. Active managers start underperforming, and the money they manage starts flowing into passive again, creating space for new potential mispricings to be exploited.

Because of the equilibrium mechanism, investors are expected to correct the inefficiencies before they get too large, or before passive gets to very high levels. This is in line with the previously discussed paper of Coles et al. (2018), which does not find a relationship between increases in passive investing and the ability of arbitrageurs to impound information into prices. This leads us to formulate hypothesis number 1:

H1: Markets rarely reach harmful levels of passive investing due to a natural equilibrium mechanism.

However, it might be plausible that most capital in a market needs to be in passive portfolios for an increase in passiveness to deteriorate efficiency. It is because we think that the relationship between the two is non-linear. When there is relatively little money in passive funds, increases in the level of passiveness do not affect efficiency very much, as there is a lot of active capital that impounds most of the information into prices. At the beginning passive investing might even improve efficiency, due to the lifting of some short-selling constraints in the market and to the improved hedging opportunities. However, when most money is passive, and there is very little money managed by stock-pickers, there is not enough trading going on to move prices in the correct direction and eliminate inefficiencies. Further increases in passive deteriorate efficiency much faster. In the extreme case when all the capital is passively managed, efficiency drops to 0, as there is no price discovery going on. This is in line with the notion that efficient prices do not require all investors to pay attention to fundamentals, only the *marginal* investor (Malkiel 2016). Following this logic, we expect the relationship to look similar to the following:

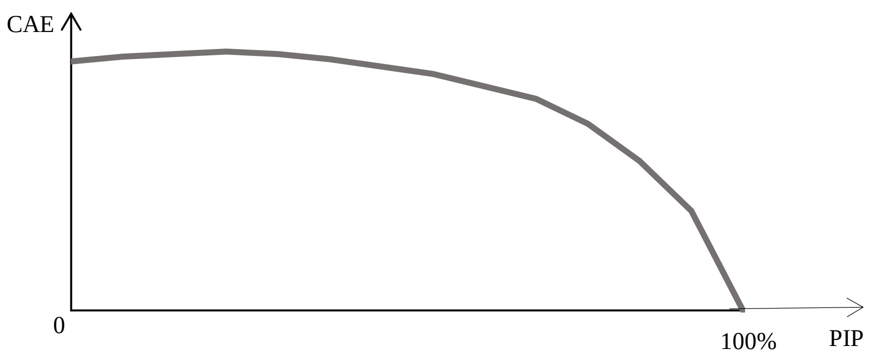

Figure 1. A possible nonlinear relationship between passive investing popularity and capital allocation efficiency. Created by the authors.
This figure illustrates the theoretical non-linear relationship between passive investing popularity and capital allocation efficiency, as derived by the authors. CAE represents Capital Allocation Efficiency; PIP stands for Passive Investing Popularity. At low-to-moderate levels, passive investing is not harmful to efficiency and might even contribute to improving it, due to relaxation of short selling constraints and hedging benefits. At high levels, the slope of the CAE function turns steep, and PIP starts harming efficiency. When all capital is invested passively no price discovery takes place and CAE drops to zero.

This leads us to formulate the following two hypotheses:

H2: Passive investing, at moderate levels, is not harmful to capital allocation efficiency.

H3: At high levels, passive investing has a negative impact on capital allocation efficiency.

Ideally, we would test our hypotheses according to an equilibrium model; however, deriving a formal equilibrium model is outside the scope of our thesis and is left for future research. We will employ various frameworks which will still allow us to capture the relationship we are interested in without having to assume a structural form.

2.6 Implications on policymaking

The note by AllianceBernstein L.P. is aimed as a call to policy makers and raises a number of interesting questions related to the impact of an increase in passive investing on how capital is allocated across firms. To stress the lack of focus of current policies on the phenomenon of the high-growth rate of passive investing the authors bring forward the example of the capital markets union (CMU), a plan launched by the European Commission in 2014 (EC, n.d.). The primary role of the CMU is to "maximize the benefits of capital markets and non-bank financial institutions for the real economy" (Maijoor, 2014). In September 2015 the European Commission adopted the "Action Plan on Building a Capital Markets Union" (EUR-Lex, 2015). The document lacked a discussion on the differences between passive and active investment strategies and the implications of each. One year after the note was published, the Action Plan had its mid-term review. The revised working staff document does contain a short section on "Passive long-term investments and ETFs" (EC, 2017, p. 83); however, the section, highlights only the benefits of passive investing compared to active strategies, concluding that "passive wait and hold strategies are thus the logical answer to maximize returns". Therefore, Bernstein's concern that the European Commission's policy initiatives does not address the implications of the increase in the popularity of passive investing on the real economy is still relevant. We will try to shed some light on whether there is need for future policies to change directions in the regulations initiatives they bring forward and take into account the changes that have been happening in the investment universe.

To sum up, until this point we have tried to show that (i) the financial system contributes to the efficient allocation of capital, and thus to economic growth, (ii) ETFs have been gaining popularity, (iii) passive investing is associated with an increase in stock price synchronicity, (iv) co-movement in stock prices has a negative impact on the efficiency of capital allocation and (v) going forward, the natural allocative equilibrium mechanism is expected to keep passive investing below harmful levels. We identified that there have been little attempts made to quantify the effects of passive investing on capital allocation efficiency, which has been raised as a potential issue taking into account the context of high recent growth of ETFs that is expected to continue in the future.

3. Data

For the empirical part of our analysis we use four data sources. Firstly, to approximate the capital allocation efficiency by country we use the UNIDO Industrial Statistics Database at the 2-digit level of SIC (UNIDO, 2018). The database contains data for value added, output and gross fixed capital formation for 22 industries of the manufacturing sector, at the 2-digit level of the International Standard Industrial Classification of All Economic Activities (ISIC) Revision 3. INDSTAT2 is the largest database on industrial statistics. The classification provides the information in a consistent and standardized manner for all available years, making the dataset appropriate for long-term analysis (UNIDO, n.d.). The dataset is available to students for research purposes free of charge. The dataset includes data for over 40 years - from 1963 to 2016 - and, after removing the countries for which the information is severely incomplete or data appear to be flawed[2], it comprises time series data for 33 countries. The year 2016 is dropped from our analysis as the data for it appear to be flawed[3].

Output is “the value of production” or “the sum of the value of all goods or services that are actually produced within an establishment and become available for use outside that establishment plus any goods and services produced for own final use” (United Nations Statistical Office, 2008, p. 108). Gross Fixed Capital Formation represents “the total value of a producer’s acquisitions, less disposals, of fixed assets during the accounting period plus certain specified expenditure on services that adds to the value of non-produced assets” (p. 111). Lastly, value added is “the value of shipments of goods (output) minus the cost of intermediate goods and required services (but not including labor), with appropriate adjustments made for inventories of finished goods, work-in-progress, and raw materials” (Wurgler, 2000, p. 191). Value added is adjusted “for inventories of finished goods, work-in-progress, and raw materials” (p. 191).

[2] Some countries we exclude on the basis that they were not included in Wurgler’s research even though the dataset he uses has a rather global coverage. In some cases, we exclude a country if the existing literature shows that results for price efficiency-related measures, such as stock price volatility, take unusual values for the respective country. We exclude these countries so as to avoid biases in our results due to outliers.

[3] When running yearly OLS regressions to approximate Wurgler’s (2000) measure we oserved that CAE for 2016 was taking extremely high values for most countries in our sample, which could be explained in no other way than the values for investments and value added for the year 2016 being flawed.

To avoid outliers, we follow Wurgler's (2000) method of trimming economic statistics – observations which show a growth rate of over 172% or a decrease of 63%, that is, the absolute value of log growth exceeds 1, are excluded. Taking into account the fact that excluding economically small industries does not alter results, we proceed to excluding observations that contribute less than 0.1% of the total value added for the manufacturing sector. Altogether, we keep 93.3% of the initially available data.

The second data source we use is Datastream (2018). To calculate a proxy for the popularity of passive investing, we need the following data at daily frequency: stock prices, stock market capitalization and share traded volume. The data are retrieved so as to match the country sample of the data in INDSTAT2 and the time frame for which we perform our analysis is 2003-2015.

The sample that we use is made up of the stocks listed on the biggest stock exchange of each country. We make three exceptions from this criterion: Japan, Germany and the United States, since these three countries each have two very large stock exchanges and excluding one might flaw our sample. From Japan we include stocks from the Tokyo and Osaka stock exchanges, from Germany – Deutsche Boerse AG and XETRA, and from the United States – NYSE and NASDAQ. We focus on common equity and stocks that trade in their home country and local currency. Since we use USD as the currency in which we perform our analysis, stocks are required to have information for the variables that we need in USD. We include both active and dead stocks in order to mitigate survivorship bias. Following the trimming method of Ang, Hodrik, Xing and Zhang (2009), we exclude the 5% smallest stocks by market capitalization in non-US countries.

The third data source we turn to is World Economic Outlook Database from IMF (2018). We extract Gross Domestic Product per year in USD for the period 2003-2015 for the countries in our dataset. We use GDP in calculating measures of financial development, which we employ as control variables in our frameworks.

The last set of data that we employ is compiled from the OECD Pensions Indicators database (n.d.), OECD Pensions at a Glance reports (OECD, n.d.) and an appendix in the "*Indexing and active fund management: International evidence*" (2016) paper by Cremers, Ferreira, Matos and Starks. The OECD Pensions Indicators database

(OECD, n.d.) covers pension plans statistics for both OECD and non-OECD countries on a yearly basis. From there we retrieve values for pension funds as percent of total assets in the pension system by country on a yearly basis. OECD publishes a biennial report on the pension systems in both OECD and G20 countries - Pensions at a Glance (OECD, n.d.). There we find a year for every country in which a reform or change took place in the pension system, which moved the system towards DC pension planning. According to OECD classification, DC pension plans are "occupational pension plans under which the plan sponsor pays fixed contributions" (OECD, 2005, p. 14). As opposed to Defined Benefit pension plans, DC pension systems facilitate market competition by having pension funds be managed by entities other than the government. A need for safe and well-diversified investments appears and passive funds are often included in the offering, making it more likely that more capital will be invested passively (Cremers et al., 2016). We follow the compilation approach of Cremers et al. (2016). The reason why we are not able to simply use the data as compiled by the authors is that some of the countries in our dataset are either lacking data there or have reforms in years outside our 2003-2015 sample period. That is why, we are able to use the years Cremers et al. provide only for some countries; the rest we gather ourselves from OECD reports. See Appendix A for the list of countries for which information is available, the year of their reform and the data source we use to retrieve the respective year.

4. Measures

In this section we present the measures that we employ for our empirical analysis: capital allocation efficiency, passive investing popularity and financial development.

4.1. Capital allocation efficiency

First, we employ Wurgler's (2000) measure of capital allocation efficiency. The author's measure defines the efficiency with which capital is allocated across firms as the elasticity with which investments respond to changes in value added. Simple in its specification and computation, Wurgler's measure is the one most frequently used in the literature for computing capital allocation efficiency and does not require heavy or too many assumptions. The main assumption the author makes is that optimal allocation of capital can be defined as increasing investments in growing industries and withdrawing capital from declining ones. Wurgler uses value added as a natural measure of industry growth - summed up across all firms in an economy and analysed on a year-on-year basis, value added shows the rate of GDP growth, i.e. economic growth. The variable that should respond to changes in value added in the model is investments. Since data for depreciation is not available, the model uses growth in gross fixed capital formation as a measure of growth of investments. The following regression will allow us to estimate the elasticity of investment to value added in country c in a given period, which is our proxy for the efficiency of capital allocation in said country. A country that increases investment in its growing industries and withdraws funds from the ones that are declining will be characterized by high capital allocation efficiency. The specification we use, as derived by Wurgler, is the following:

$$(1)\quad \ln(I_{ict}/I_{ict-1}) = \alpha_{ct} + CAE_{ct} \times \ln(VA_{ict}/VA_{ict-1}) + \varepsilon_{ict}$$

I: gross fixed capital formation

VA: value added

i: subscript for every ISIC-2 industry

c: subscript for every country

t: index for the time period

α_{ct}: constant term

CAE: capital allocation efficiency

ε_{ict}: error term

Wurgler addresses the concern of reverse causality in his specification. The author mentions previous studies ((Mayer, 1960); (Hall, 1977)) which show that on average, fixed capital becomes productive two years after an investment has been made. This means that investment cannot cause a change in value added, since CAPEX does not become productive immediately.

Appendix B reports the elasticity of investment to value added for each country for the 2003-2015 period. The estimates for almost all countries are positive, as would be expected, the exceptions being Philippines and Colombia. A negative coefficient would signal a totally inefficient use of capital, as it would mean that money flows into shrinking industries and is taken out from growing ones. However, the coefficients for the Philippines and Colombia, even if negative, are not statistically significant. The estimates range from 0 to 1 and the average for all 33 countries is 0.531. The highest elasticity is Portugal's at 0.985, and the lowest statistically significant coefficient is Mexico's at 0.358. Republic of Korea comes second with 0.973, Norway is third with a coefficient of 0.932. The top is rounded up by Brazil, France and Australia. The United Kingdom is 14th highest, Japan is 17th, Germany is 18th and the United States are 19th. Poland and Brazil have the highest R^2 with 0.329 and 0.323 respectively, and there is a strong positive relationship between the estimated elasticity and the R^2, the correlation coefficient being 0.804.

The capital allocation efficiency coefficients are essentially elasticities and have an economic meaning. To illustrate their meaning, we interpret and compare the elasticities of two countries: if the value added of the average industry in the UK grew by 10%, investment in that industry would increase by 6.38%, while if the same growth happened in the average industry in Ireland, the investment would grow by only 3.46%, keeping everything else constant.

To be able to perform variations of the OLS framework, we also compute average elasticities for the following periods of time: 2003-2009 and 2010-2015 (7 and 6 years) and 2003-2007, 2008-2011 and 2012-2015 (5, 4 and 4 years). We do not report these computations as they lack illustrative purpose.

To check how closely we are able to follow Wurgler's methodology we replicate the estimation of capital allocation efficiency for the same country sample (to the extent that our data allows us to) and time period as the one in his paper. The only difference lies in the databases we use. While Wurgler employs INDSTAT3, at the 3-digit level of SIC, we use INDSTAT2. The author also adds information from other sources to the database. While both databases are compiled and made available by UNIDO, the main distinction between them is the level of granularity at which data are presented – INDSTAT2 has less granular industry decomposition. Unfortunately, INDSTAT3 was discontinued so we are not able to go as far as using the same database, but we still perform this step so as to solidify our beliefs that the analysis is headed in the right direction. To compare our estimates with the ones obtained by Wurgler, we calculate the correlation between the two. The correlation we obtained is 0.896 and we proceed with our analysis.

4.2. Popularity of passive investing

Second, we employ the theory-based metric derived by Bhattacharya and Galpin (2011). The intuition behind this measure is described in section 2.3. The proxy that the authors come up with for popularity of active investing is the "value-weighted cross-sectional variance of log turnover" - the greater the popularity of active investing, the higher the value of the metric. The authors also define this metric as unpopularity of passive investing. Following Bhattacharya and Galpin's approach, we begin by approximating *Passive Investing Unpopularity (PIU)* at monthly frequencies for each country and then compute the yearly average for that country. The initial estimation of the value-weighted cross-sectional variance of log turnover is presented below:

$$(2)\quad PIU_t = \sum_i w_{it} \times (\ln(turnover)_{it} - \sum_i w_{it} \times \ln(turnover)_{it})^2$$

$w_{it} = \frac{Market\ Cap\ of\ stock\ i\ at\ time\ t}{Market\ Cap\ of\ market\ at\ time\ t}$,

$(turnover)_{it} = \frac{Share\ Volume\ of\ stock\ i\ at\ time\ t}{Shares\ Outstanding\ of\ stock\ i\ at\ time\ t}.$

PIU: Passive Investing Unpopularity or value-weighted cross-sectional variance of log turnover

i: subscript for every stock

t: index for the time period

Since we study the effect of passive investing on capital allocation efficiency, for ease of interpretations we employ a variation of this metric provided by Bhattacharya and Galpin in the same study. The variation is, conversely, a proxy for passive investing popularity: it takes the value of 1 when there is no deviation from constant dollar turnover, meaning that the investment universe is completely passive; as the value-weighted cross-sectional variance of log turnover increases, the transformed measure comes closer to zero, meaning that the market is predominantly active. This transformation also helps in case there are large outliers in the initially estimated measure, because when *PIU* is very large, a change in it will not result in as big of a change in the transformed measure, as it is already very close to 0. Since the range of the new measure is bounded by 0 and 1, we can interpret it in terms of percentages, making for easier reading of results later in the analysis. The estimation of this transformed measure is the following:

$$(3) \quad PIP_{ct} = e^{-PIU_{ct}}$$

PIP: Passive Investing Popularity

To compute yearly PIU we first calculate the measure on a monthly basis and then take the average as our yearly proxy. As previously mentioned, we further transform the measure so as to be able to interpret it as popularity of passive investing. To further aggregate the measure as the analysis calls we compute averages. As with capital allocation efficiency, we do not report the aggregated computations as they lack illustrative purpose.

Figure 1 reports the exponential of the value-weighted cross sectional variance of turnover for the whole 2003-2015 period for each country. As can be seen from the figure, passive investing is the most popular in the UK, the USA, Republic of Korea and Switzerland. It is least popular in Brazil, Germany and Indonesia. The numbers behind the illustration above can be found in Appendix C.

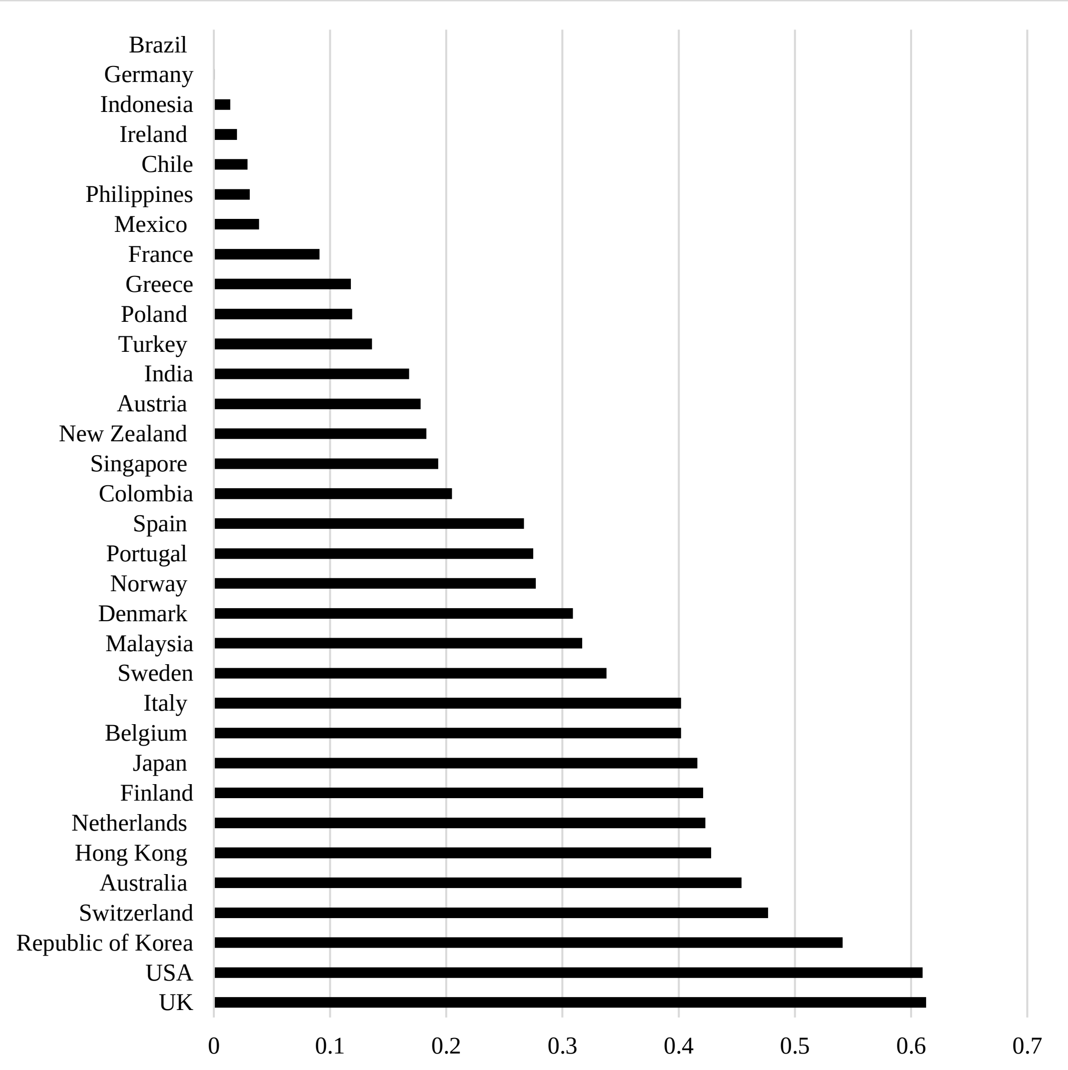

Figure 2. Popularity of passive investing across the world (2003-2015). Created by the authors using data from Datastream (2018)

Passive investing popularity is calculated for the period 2003-2015 following Bhattacharya and Galpin's *(2011)* approach and is equal to the negative exponential of cross-sectional variance of log turnover. Before calculating the exponential, monthly values for countries are aggregated for the 13 year-period by calculating arithmetic averages.

As can be seen from Appendix C, the countries where passive investing is the most popular tend to be developed markets. Out of the top 17 countries in our ranking, 15 are developed markets. Out of the bottom 16 countries, 10 are emerging markets. Our results are consistent with Bhattacharya and Galpin's findings that passive investing tends to be more popular in developed markets. One result that is counterintuitive is the case of Germany, which ranks second according to the unpopularity of passive investing. This is most likely because our measure is simply a proxy for actual investor preferences, and also German investors directing more funds to actively held assets during the time frame that we study. We also check the time trend of passive investing in the world:

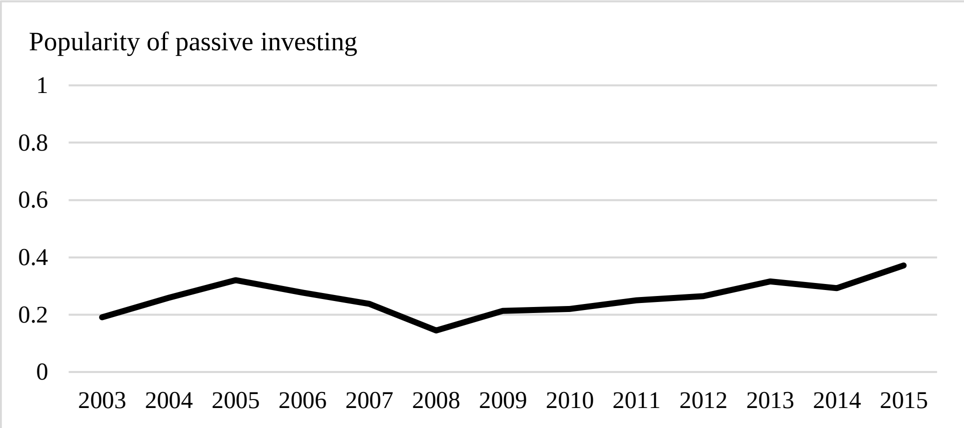

Figure 3. Aggregate world popularity of passive investing (2003-2015). Created by the authors using data from Datastream (2018)

Passive investing popularity is calculated for the period 2003-2015 following Bhattacharya and Galpin's *(2011)* approach and is equal to the negative exponential of cross-sectional variance of log turnover. Before calculating the exponential, monthly values for countries are aggregated for the 13 years-period by calculating arithmetic averages and the world trend is found by weighting the obtained measure by the stock market capitalization of each country.

Figure 3 shows that the average trend in the popularity of passive investing is an upward one. Passive investing has been gaining popularity over the last two decades. This result is consistent with the trend noted in the 2011 paper by Bhattacharya and Galpin. However, it is important to note here that the increase appears to be modest compared to the statistics on ETF holdings. This comes to show once again that ETF growth does not linearly translate into passive investing growth and the concerns related to the negative impact of these changes on allocative efficiency might turn out to be somewhat overstated.

4.3. Controls

To isolate the effect of popularity of passiveness our model controls for the level of financial development in a country. This approach follows Wurgler's (2000) finding that the level of financial development is a mechanism through which financial markets improve the real economy. Later, Beck and Levine (2002) also document that overall financial development boosts efficient capital allocation.

We use several measures of financial development. The first one, total stock market capitalization to GDP (STK/GDP), measures the size of a country's financial market relative to the size of the economy. It is calculated by summing the market capitalization of all stocks in a country in a given year, and dividing it by the country's GDP in that year. However, this measure by itself might not capture the entire desired effect that financial development might have on capital allocation efficiency. Fundamentally, efficiency is not necessarily about size, but more about efficiently trading on the information available. To capture this effect, we use volume traded to GDP (VO/GDP). This measure, calculated by summing the volume traded of all stocks in a country in a given year and dividing this sum by its GDP in that year, can capture how much trading is actually going on in a country relative to the size of the economy. Lastly, our third measure, volume traded to market cap (VO/STK), which tries to capture the effect of both size and volume, is derived by dividing the second measure by the first. The measures are not perfectly correlated, as can be seen in Table 1; therefore, it is good to consider including more than one in our models, as they can measure a different component of what we call "financial development".

	STK/GDP	**VO/GDP**	**VO/STK**
STK/GDP	1		
VO/GDP	0.697	1	
VO/STK	-0.064	0.5759	1

Table 1. Correlations between different measures of financial development. Created by the authors using data from Datastream (2018) and IMF (2018).

The table shows the correlations between three measures of financial development. STK/GDP is the ratio of stock market capitalization-to-GDP. VO/GDP is equal to dollar-volume traded during a year divided by GDP. VO/STK is an aggregate measure of the two previous components and represents the ratio of dollar-volume traded divided by market capitalization. Stock market capitalization and volume turnover values are retrieved from Datastream *(2018)*; GDP data are obtained from IMF *(2018)*.

We also control for country and time-fixed effects. Not controlling for time-invariant factors that are correlated to both how efficiently capital is allocated in the country and how popular passive investing is, such as financial sophistication, will introduce an omitted variable bias in our models. As for time-fixed effects, they allow us to control for factors such as world investing trends, that might influence both of our measures of interest. We test for the joint significance of time and country-fixed effects, and the tests are positive in most cases. For illustrative purposes, in all specifications we present the results we obtain both when controlling and not controlling for fixed effects. We motivate our use of fixed effects over random effects by performing the Hausman test, which shows us that some correlation exists between our independent variables and entity effects.

5. Methodology and the empirical relation between CAE and PIP

Below we present the several approaches we take to empirically study how the level of passive investing affects allocative efficiency. We use the measures and control variables described in the previous section to estimate the relationship between the popularity of passive investing strategies and the efficiency with which capital is allocated in the economy.

5.1. Base model

To approximate the impact of the popularity of passiveness on capital allocation efficiency we propose the following simple specification which links the two measures in an OLS regression:

$$(4)\quad \widehat{CAE}_{ct} = \gamma + \beta(PIP)_{ct} + \{controls\} + \epsilon_{ct}$$

$\widehat{CAE}$: estimated capital allocation efficiency

γ: constant term

β: elasticity of capital allocation efficiency to passive investing popularity

PIP: passive investing popularity

$\{controls\}$: additional variables used to isolate the effect of passive investing popularity on the efficiency of capital allocation

ϵ_c: error term

Ideally, we would estimate efficiency at a yearly frequency for every country, calculate PIP per year for every country, and then perform our regression. However, since CAE is estimated beforehand using OLS, we need to have enough observations in the initial regression to have trustworthy estimates. Because our dataset has only 22 industries, there are not enough observations to consistently estimate CAE for each year for each country. That is why we are forced to pool years together, and estimate CAE for longer periods. However, for illustrative purposes we also present the results we obtain when using yearly CAE in the section on robustness tests (section 6). There we present two other specifications, with CAE approximated over periods of 7 and 6 years, and 5, 4 and 4 years.

In the main specification, which we present here, we pool all our years together, and estimate efficiency for each country for the whole period of 13 years. We then calculate PIP for each country for the same time frame, by computing arithmetic averages, and then perform the cross-country OLS regressions. The results are reported in Appendix D. There are 8 different regressions reported, the difference being the use of different control variables for financial development. Generally, we cannot attest a strong linear relationship between CAE and PIP. Only in one specification, the one which uses the ratio of total stock market capitalization to GDP as the proxy for financial development, we find a significant relationship between our two variables of interest. The coefficient is positive, and tells us that an increase in passive investing popularity by 1 percentage point results in an increase in allocative efficiency of 0.004. In terms of interpreting the magnitude of the effect, a one standard deviation increase in passive leads to an increase in efficiency of 0.327 standard deviations.

Due to the fact that when a regression includes VO/STK the other two proxies for financial development lose explanatory power, from now on all further reported regressions include only one measure for financial development: either STK/GDP, or VO/STK. In unreported regressions, we vary the measures used for proxying financial development, and the results mainly remain unchanged.

Using this base model, we were unable to document a strong relationship between allocative efficiency and the level of passiveness, let alone find evidence of passive investing harming efficiency. This result is in line with Hypothesis 1. Since the relation between capital allocation efficiency and passive investing popularity runs both ways, the natural equilibrium is at work ensuring that any inefficiencies that are introduced because of passive investing are wiped out by active investors. As expected, at this point we do not observe a significant harmful effect of PIP on CAE. However, the base model has one potential concern that might have influenced our results. CAE is not an observed measure; it is one that is estimated using OLS regressions. This is not in best econometric practice, as we use previously fitted values in regressions. To avoid this, we further proceed by using interaction variables to estimate the relationship of interest.

Although we cannot infer causality from the base model due to potential endogeneity concerns, it is still informative to take a look at, because it helps us test Hypotheses 1 and 2. Here we are not trying to determine causality, but the general equilibrium relationship between efficiency and passive investing. The causal relationship between passive investing and efficiency will be further explored using instrumental variables.

5.2. Interaction framework

To further explore the efficiency-passive relationship we employ a second framework that allows us to concurrently estimate capital allocation efficiency and how it responds to changes in passive investing, with the help of interaction terms. The framework is as follows:

$$
\begin{aligned}
(5)\quad \ln\left(\frac{I_{ict}}{I_{ict-1}}\right)
&= \alpha + \beta \ln(VA_{ict}/VA_{ict-1}) + \gamma\,(PIP)_{ct} \\
&+ \delta(PIP)_{ct} \times \ln(VA_{ict}/VA_{ict-1}) + \vartheta\{controls\}_{ct} \\
&+ \theta\{controls\}_{ct} \times \ln(VA_{ict}/VA_{ict-1}) + \{fixed\ effects\} + \varepsilon_{ict}
\end{aligned}
$$

i: subscript for every ISIC-2 industry

c: subscript for every country

t: index for the time period (year)

α_c: constant term

$\beta_c, \delta_c, \theta_c$: estimated regression coefficients

$\{controls\}$: a set of control variables

$\{fixed\ effects\}$: country and time-fixed effects

ε_{ict}: error term

This approach allows us to concurrently estimate both the relationship between investments and value added and the impact of popularity of passive investing on the efficiency with which capital is allocated across firms.

Let us assume we have the framework above but without any control variables. In this case, β would be the capital allocation efficiency when there is no passive investing. If there is some passiveness, and PIP becomes higher than 0, then capital allocation efficiency becomes β+ $\delta * PIP$. Therefore, our coefficient of interest becomes δ, which denotes how capital allocation efficiency changes when passiveness changes. In Appendix E we report 9 variations where we try to approximate this effect, which is denoted in the table as $ln\left(\frac{VA_{ict}}{VA_{ict-1}}\right)$xPIP. For an example of interpretation, let us look at regression (1) in Appendix E. An increase in passive investing popularity of 1 percentage point will result in CAE increasing by 0.0004, or 0.093% of the average CAE of 0.4. In other words, an increase of PIP from 15% to 16% will result in an increase of CAE from 0.53755 to 0.53792. However, of course this coefficient is not statistically significant at any level, so we cannot actually say any effect exists. No matter what measure for financial development we use, or whether we add time and/or country fixed effects, we are not able to find significance. From this we conclude that we cannot say that passive investing negatively affects allocation efficiency, at least not at normal levels, which is in line with Hypothesis 1.

5.3. Nonlinearity framework

Consistent with our second and third hypotheses, we expect the relationship between capital allocation efficiency and passive investing to be non-linear. To explore this empirically, we look at the decile of observations that are most passive in our dataset. We sort our industry-country-year observations from most passive to least passive, and keep only the top 10%, leaving us with 897 observations. We are left with industry-country-years with levels of passiveness between 56% and 73%. We then perform the previous OLS regressions that use interaction terms on this limited sample. The results are reported in Appendix F. We are interested in the coefficient on $ln\left(\frac{VA_{ict}}{VA_{ict-1}}\right)$xPIP. This specification moves PIP to values situated on the right of the expected curve in Figure 1, where the slope of the CAE function in terms of PIP is steeper than the usual observable levels of passive. In this region of the curve, we expect to find that passive investing popularity is harmful to allocative efficiency.

In the iterations without any fixed effects, the coefficient is significant only when using VO/STK as a control. But when we add fixed effects, the coefficients become significant. This could be because of the elimination of some previously omitted time and country specific variables that biased our approximations that do not include fixed effects. These results can also be economically interpreted. For example, the coefficient in formulation (9) is -4.730 and it is significant at the 5% level. It means that if PIP increases by 1 percentage point, CAE will decrease by 0.0473 (or 11.82% of the average CAE of 0.4), keeping VO/STK constant. Another interpretation could be that in a country with VO/STK at the level of the sample average of 1.17, increasing PIP from 60% to 61% and keeping VO/STK constant, CAE will decrease from 0.57989 to 0.53259. These findings are in line with Hypothesis 3.

We continue our analysis by implementing another model that allows us to study the impact of passive investing on capital allocation efficiency, and also allows us to very roughly get a feel for the shape of the non-linear function that connects them. We will use a model that makes use of several dummy variables that divide our original sample into 8 parts, depending on the level of passive investing. This specification allows us to explore the nonlinearity of the relation between CAE and PIP, without having to derive a formal structural equilibrium equation or assume a particular functional form. We are able to easily isolate the impact of passive investing on efficiency at different levels of passive investing. The model is the following:

$$\text{(6)}\quad \ln\left(\frac{I_{ict}}{I_{ict-1}}\right) = \alpha + \beta \ln\left(\frac{VA_{ict}}{VA_{ict-1}}\right) + \delta_1 D^{>65\%} + \gamma_1 \ln\left(\frac{VA_{ict}}{VA_{ict-1}}\right) \text{ x } D^{>65\%} +$$

$$\delta_2 D^{60-65\%} + \gamma_2 \ln\left(\frac{VA_{ict}}{VA_{ict-1}}\right) \text{ x } D^{60-65\%} + \delta_3 D^{50-60\%} +$$

$$\gamma_3 \ln\left(\frac{VA_{ict}}{VA_{ict-1}}\right) \text{ x } D^{50-60\%} + \delta_4 D^{40-50\%} + \gamma_4 \ln\left(\frac{VA_{ict}}{VA_{ict-1}}\right) \text{ x } D^{40-50\%} +$$

$$\delta_5 D^{30-40\%} + \gamma_5 \ln\left(\frac{VA_{ict}}{VA_{ict-1}}\right) \text{ x } D^{30-40\%} + \delta_6 D^{20-30\%} +$$

$$\gamma_6 \ln\left(\frac{VA_{ict}}{VA_{ict-1}}\right) \text{ x } D^{20-30\%} + \delta_7 D^{10-20\%} + \gamma_7 \ln\left(\frac{VA_{ict}}{VA_{ict-1}}\right) \text{ x } D^{10-20\%} + \delta_8 D^{0-10\%} +$$

$$\gamma_8 \ln\left(\frac{VA_{ict}}{VA_{ict-1}}\right) \text{ x } D^{0-10\%} + \{controls\}_{ct} + \theta \times \{controls\}_{ct} \times \ln\left(\frac{VA_{ict}}{VA_{ict-1}}\right) + \varepsilon_{ict}$$

A dummy is equal to one if PIP for the respective observation is in the range that the respective dummy is responsible for. In this case, we are mainly interested in γ_1, which is the coefficient that tells us how being in the most passive group influences efficiency. In Appendix G, this coefficient can be found as $\ln(VA_{ict}/VA_{ict-1})\text{x}D^{>65\%}$. To be able to estimate this model, we need to exclude one dummy to avoid perfect multicollinearity. We choose to exclude $D^{0-10\%}$, which are the observations with the lowest levels of passive. The coefficients on all other interacted terms that use dummies will be interpreted relative to the coefficient for this category, which is β.

In all variations of the model above, the coefficient of interest is significant, which further supports our hypothesis that at high levels of passive, passiveness negatively affects efficiency. The only other interaction term that is sometimes significant is the one that interacts the log change in value added with the dummy for the group 60-65%. It is always positive, which means that at moderate to high levels of passiveness, passiveness can actually be beneficial, but not at the extreme. This is in line with some of the literature that suggests that passiveness can actually increase efficiency and with our Hypotheses 2 and 3.

An advantage of this model is that we can sketch a rough line that shows us the relationship between efficiency and passive. We use the coefficients estimated in an unmentioned regression, that has both time and country fixed effects, but does not control for financial development. This is done to make it easier to plot the coefficients, because including a financial development measure would mean having to assume a certain level for this measure for each category. The coefficients, as well as 95% confidence intervals, are plotted below:

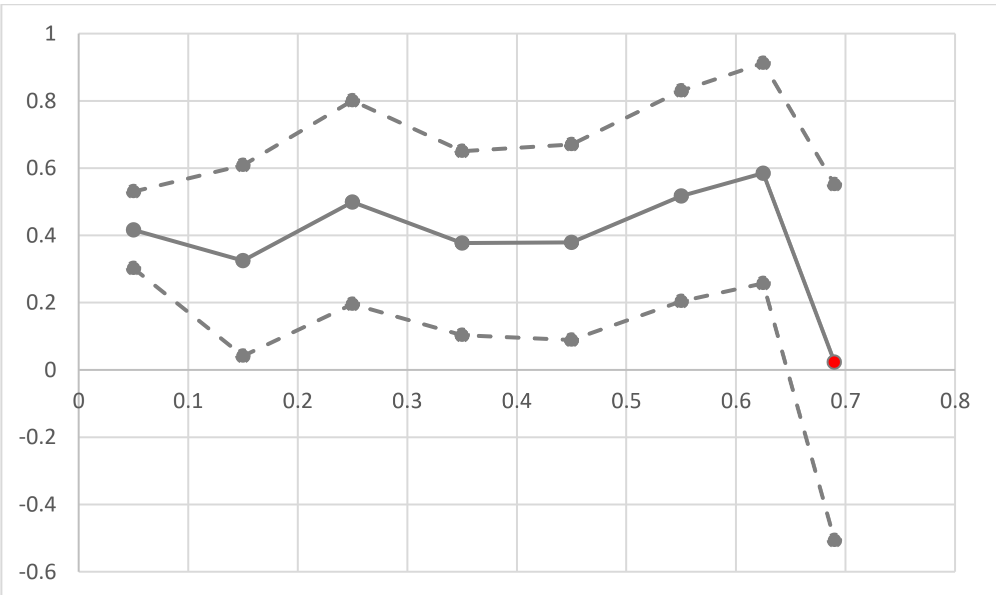

Figure 2. An empirical relationship between capital allocation efficiency and passive investing (2003-2015). Created by the authors using data from Datastream (2018) and INDSTAT2 (2018).
The figure presents the empirical non-linear relation between Capital Allocation Efficiency, as derived by Wurgler *(2000)*, and Passive Investing Popularity, as derived by Bhattacharya and Galpin *(2011)*. The points on the graph are estimated using a dummy interaction framework in which observations are grouped according to how passive they are. The dotted lines represent the 95% confidence intervals. At low-to-moderate levels of passive investing (<65%), there is no significant effect of passive investing on efficiency. At high levels (the red dot), passive investing has a significant negative effect on allocative efficiency.

The graph is plotted using the coefficient β as the value for the first group, with levels of passive between 0-10%. Then the coefficients for each next category are added to this β to find the level of efficiency for the respective category. The only significant coefficient we find in this iteration is the one for the most passive category (point shown in red on the graph). There is a general trend of efficiency increasing very little with passive, however when passive gets to very high levels, efficiency suddenly drops. The group that sees harmful effects on CAE from passiveness is small however, as only 1.40% of the country-year observations belong in it. The general shape of the function estimated empirically has a slight resemblance to the one we would expect to see, derived from economic reasoning.

One concern arising at this stage is that, as discussed in Section 4.2., the world's greatest economies are the ones showing the highest levels of passive. If the UK, Japan or the US go over the arbitrary level of 65% PIP, this would immediately imply that a large proportion of the world's equity market is exceeding a dangerous threshold and, thus, a large share of the world capital is allocative in an inefficient manner. However, this reasoning is far from perfect. Since developed markets are usually large economies, these countries can afford having a larger share of their stock markets being held passively simply because the remaining share of funds in the hands of investors is still large enough to move prices when converted into a nominal amount. Going back to the idea that the marginal investor is the one who matters when it comes to exploiting mispricings, it follows that larger markets might need proportionally fewer investors to move prices, since the funds managed by these investors are nominally larger than the the funds managed by the same share of investors in a smaller economy.

5.4. Instrumental variables framework

Instrumenting for passive investing in our first framework would help gauge the pure effect that passive investing has on capital allocation efficiency, rather than having the effect intertwine with changes in the popularity of passive investing occurring due to changes in efficiency. As previously discussed, we suspect that there is a self-adjusting equilibrium between allocative efficiency and the level of passive investing. That means that there is a potential endogeneity problem, caused by reverse causality. It is possible that the level of efficiency in a country affects the level of passive investing. As we already mentioned, if there are mispricings caused by low efficiency, passive investing will decrease until those mispricings disappear. If the markets are highly efficient, active managers cannot outperform the market, and some investors will transfer money into passive funds. Thus, there is a concern that our results could be unreliable, as there is a reverse link, that goes from efficiency to passive.

To mitigate these concerns, we employ an instrumental variables model. Following the work of Cremers, Ferreira, Matos and Starks (2016), we identify a potential instrumental variable: the year when there was a reform or a change in the pension system in the country, facilitating a shift from defined benefit (DB) towards defined contribution (DC) pension planning. The idea behind this instrument, as explained by the authors, is that DC plans offer larger exposure to passively-held assets. The instrument is a dummy variable that takes the value 1 starting with the year when the reform/change took place. Appendix A shows the year of the reform in the countries for which we were able to gather this information. With this binary variable, we try to capture the effect that getting a passive fund has on a country by isolating the exogenous variation in our PIP variable. Since our instrument is a dummy variable with yearly frequency, we use yearly CAE on the left-hand side as well. As before, we present specifications with different measures of financial development as controls, as well as accounting for no entity-specific effects, country and/or year-fixed. Appendix H presents our results.

The reform year instrument, although attractive due to its exogeneity, is not a strong enough instrument on its own. The F-statistic when instrumenting with this dummy variable alone is only 2.12. Following the same logic, we employ a second instrument – amount of funds in the pension system as percent of GDP on a yearly basis. There are several reasons behind this choice of instrument. Firstly, we believe that the variation in the amount of funds in the pension system of a country is a good proxy for the variation in passive investing. Similarly to the case of the reform year, changes in the pensions system have an impact on the allocation of funds between passive and active investing industries, since pension funds are usually invested in safe and well-diversified portfolios. We normalize this measure by GDP, to have comparable data. For all of the countries covered by the OECD Pensions at a Glance reports, 28 out of the 33 countries in our dataset, we are able to find reforms/changes related to DB and DC pension plans. Secondly, we assume that this instrument is not related to capital allocation efficiency, other than through changes in the level of passive investing. We perform overidentification and endogeneity tests and find that, indeed, both instruments are exogenous. Thirdly, the data for pension funds is relatively rich and readily available. Although the previous two reasons would've applied to variables that represent some part of a breakdown of pension funds by pension plan, such as DC pensions for example, the information in that case is severely lacking. The F-statistic when including both instruments in 50.72 and we conclude that the two are relevant and continue with our analysis.

We report the instrumental variables framework results in Appendix H. In most iterations, except regression (8), the funds in the pension system over GDP measure is significant in explaining the level of passive investing. One potential reason for the lack of significance in regression (8) is the high correlation (0.636) between the instrument (Pensions) and the control variable (STK/GDP). This might introduce multicollinearity in the specification and bias the results. After instrumenting for passive investing, we observe that the impact of PIP on CAE is still insignificant, which lets us conclude that at the usual levels observable in markets, passive investing does not harm efficiency, and helps us accept Hypothesis 2.

6. Robustness tests

In this section we present some of the empirical work we did in order to test our conclusions. Firstly, we extend our base model to two time periods instead of one. We divide our sample into two periods, of 7 and 6 years. We then perform the same steps as before: estimating efficiency per country per period; estimating the popularity of passive; linking the two in regressions. The results are reported in Appendix I. As before, the coefficients are mostly insignificant. We only find significance in specifications that use STK/GDP as a control variable: one that includes no fixed effects, and another one that has time fixed effects. The coefficients that are significant are still positive, which further support our previous suspicion that at low-to-moderate levels passive does not harm efficiency.

We then perform a third variation meant to increase the number of observations in the second regression stage. However, we do that at the cost of our proxy for CAE becoming noisier, since there are less observations in the initial regressions that estimate these coefficients. In this last specification, whose results are reported in Appendix J, we see largely the same story as before. No relationship between efficiency and passiveness is found.

Lastly we employ a model where we try to first estimate efficiency for each year for each country, and then link it to passiveness. This increases the number of observations in the regressions that link efficiency to passiveness at the cost of having less observations in the initial estimation of efficiency. As a result, our efficiency estimates are very noisy and very few of them are actually significant, as we only have 22 observations in each initial regressions that estimate the CAE coefficients. The results of the last specification are reported in Appendix K. In the specifications that do not include country fixed effects, there is a significantly positive relationship between passiveness and efficiency. When we control for country fixed effects however, the significance disappears, which could be because there is some omitted variable, like the financial sophistication of a country, which might make indexing more popular as well as make markets more efficient. As mentioned in section 4.3., we are interested in the specifications with both time and country fixed effects, and in this case these specifications find no significant relationship, so our main conclusions remain unchanged.

7. Limitations

In this section we acknowledge the drawbacks of our approach. Firstly, following Wurgler's approach, our computation of capital allocation efficiency only takes into account manufacturing industries. The manufacturing sector might not be the major one for developed economies and, thus, the capital allocation efficiency measure might not be representative for the particular country. Accounting for the major sector for every country would be a good improvement to our model. There are several reasons as to why we still account only for manufacturing industries. To begin with, we exclude other industries from the analysis so as to avoid noise being introduced in our results due to structural differences across industries. Using only manufacturing industries allows us to make comparisons through value added and gross fixed capital formation, and, thus, capital allocation efficiency. In order to be able to compute this measure, comparable data on value added and gross fixed capital formation is needed, which would be difficult to compile taking into account every country's main industries.

Secondly, while the efficiency of capital allocation is estimated for manufacturing industries only, the proxy for the popularity of passiveness of the equity market is estimated for the entire market, which is likely to include sectors other than manufacturing. It is important to remember that the measure for passiveness that we employ is simply a proxy for the preference of investors when it comes to their investing strategy. More importantly, the capital allocation efficiency across industries in the manufacturing sector is likely to correlate with the efficiency in allocating capital across other industries and across stocks within industries.

8. Conclusion

The recent increasing popularity of Exchange-Traded Funds has raised questions regarding the impact of passive investing on the efficiency of financial markets; some even went as far as calling a predominantly passive regime worse than Marxism. The debate on the effect of passive investing on various aspects of efficiency is still ongoing in the literature and, to our knowledge, no existing studies try to quantify the impact of passive investing on the primary role of financial markets – allocating capital. Our thesis tries to fill this gap in the literature by studying how the increasing popularity of passive investing impacts capital allocation efficiency. With this goal in mind we employ both causal and non-causal empirical frameworks, which allow us to test and accept three hypotheses.

Our analysis is based on a theoretical concept – there is a self-adjusting equilibrium between passive investing and capital allocation efficiency. We provide both a theoretical background and empirically use the endogenous relation between passiveness and efficiency to support the existence of an equilibrium mechanism; thus, we accept our first hypothesis . The other two hypotheses look at the effect of passive investing on allocative efficiency at different levels of passive, requiring us to employ the exogenous variation in passive investing. Interaction and instrumental frameworks allow us to draw causal conclusions and accept the following hypotheses: at low-to-moderate levels, passiveness is not harmful to efficiency, whereas the effect turns significantly negative at high levels of passive investing. Tying this conclusion to our first finding, passiveness is constrained from reaching harmful levels by a natural self-adjusting equilibrium mechanism, since only 1.40% of country-year observations reach these levels.

With this in mind, we conclude that, under normal market conditions, passive investing is harmless to capital allocation efficiency. Besides filling a gap in the existing literature, our findings have implications on future policymaking initiatives. The worries that some practitioners and academics have formulated appear to be overstated. At this point, existing financial markets mechanisms such as competition, transparency and liquidity are enough to ensure well-functioning markets.

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10. Appendices

Appendix A. Pension reform year

This table reports the year of reforms or changes that took place in the pension system of several countries for which such information was present, where the change brought a shift towards DC pension planning. The data was compiled from OECD Pensions at a Glance reports (OECD, n.d.) and an appendix in the "Indexing and active fund management: International evidence" paper by Cremers, Ferreira, Matos and Starks (2016). We present the respective year and source of the data.

Country	Reform year	Source
Australia	2014	OECD Pensions at a Glance 2015
Austria	2012	OECD Pensions at a Glance 2013
Belgium	2010	OECD Pensions at a Glance 2013
Chile	2008	OECD Pensions at a Glance 2013
Denmark	2006	Cremers et al (2016) Appendix
Finland	2007	Cremers et al (2016) Appendix
France	2010	OECD Pensions at a Glance 2013
Germany	2004	Cremers et al (2016) Appendix
Greece	2011	OECD Pensions at a Glance 2013
India	2009	OECD Pensions at a Glance 2013
Indonesia	2015	OECD Pensions at a Glance 2015
Ireland	2014	OECD Pensions at a Glance 2013
Italy	2011	OECD Pensions at a Glance 2013
Japan	2012	OECD Pensions at a Glance 2013
Republic of Korea	2010	OECD Pensions at a Glance 2013
Mexico	2012	OECD Pensions at a Glance 2013
Netherlands	2006	Cremers et al (2016) Appendix
New Zealand	2007	OECD Pensions at a Glance 2015
Norway	2006	Cremers et al (2016) Appendix
Poland	2004	Cremers et al (2016) Appendix
Portugal	2007	Cremers et al (2016) Appendix
Singapore	2013	OECD Pensions at a Glance 2009 Special Edition Asia/Pacific
Spain	2011	OECD Pensions at a Glance 2013
Sweden	2007	OECD Pensions at a Glance 2011
Switzerland	2012	OECD Pensions at a Glance 2013
Turkey	2012	OECD Pensions at a Glance 2013
United Kingdom	2004	Cremers et al (2016) Appendix
United States of America	2015	OECD Pensions at a Glance 2015

Appendix B. Capital allocation efficiency

The table reports estimates of capital allocation efficiency as the elasticity of value added to changes in gross fixed capital formation, following Wurgler's (2000) approach. The estimates are provided for 33 countries and arranged in a descending order from the most efficient. The estimates are obtained according to the following regression:

$$\ln(I_{ict}/I_{ict-1}) = \alpha_{ct} + CAE_{ct} \times \ln(VA_{ict}/VA_{ict-1}) + \varepsilon_{ict}$$

where I is gross fixed capital formation, VA is value added, i is a subscript for every ISIC-2 industry, c is a subscript for every country in the sample, t is an index for the time period, α_{ct} is the constant term of the model, CAE stands for capital allocation efficiency and ε_{ict} is the error term. Data on value added and gross fixed capital formation and industry classification are obtained from the INDSTAT2 database of the United Nations (2018). CAE stands for Capital Allocation Efficiency. SE, N, R2 and P represent the standard error, number of observations, R-squared and P-value of the regression.

Rank	Country	CAE	SE	N	R2	P
1	**Portugal**	0,985	0,198	209	18,02%	0
2	**Republic of Korea**	0,973	0,214	196	20,46%	0
3	**Norway**	0,932	0,13	163	28,82%	0
4	**Brazil**	0,908	0,16	130	32,29%	0
5	**France**	0,811	0,094	190	24,35%	0
6	**Australia**	0,783	0,165	165	15,86%	0
7	**Poland**	0,781	0,121	200	32,94%	0
8	**New Zealand**	0,752	0,239	113	14,36%	0,002
9	**Denmark**	0,702	0,188	201	14,99%	0
10	**Spain**	0,683	0,125	250	17,69%	0
11	**Belgium**	0,652	0,145	229	10,43%	0
12	**Switzerland**	0,639	0,258	97	6,95%	0,015
13	**Hong Kong**	0,639	0,466	65	4,42%	0,176
14	**United Kingdom**	0,638	0,113	236	20,59%	0
15	**Greece**	0,58	0,124	202	10,24%	0
16	**Turkey**	0,544	0,161	222	8,46%	0,001
17	**Japan**	0,504	0,154	187	9,90%	0,001
18	**Germany**	0,492	0,135	253	13,28%	0
19	**United States of America**	0,489	0,133	167	9,02%	0
20	**Sweden**	0,481	0,088	177	14,58%	0
21	**Singapore**	0,473	0,159	203	4,34%	0,003
22	**Netherlands**	0,452	0,205	198	6,42%	0,029
23	**Austria**	0,449	0,124	225	9,95%	0
24	**Finland**	0,447	0,138	205	7,31%	0,001
25	**Italy**	0,404	0,081	240	8,93%	0
26	**India**	0,377	0,119	223	4,70%	0,002
27	**Mexico**	0,358	0,143	217	3,48%	0,013
28	**Ireland**	0,346	0,182	168	2,60%	0,059
29	**Malaysia**	0,253	0,201	145	1,24%	0,21
30	**Indonesia**	0,186	0,199	90	1,01%	0,352
31	**Chile**	0,144	0,223	61	0,84%	0,522
32	**Philippines**	-0,133	0,217	80	0,50%	0,544
33	**Colombia**	-0,192	1,302	15	0,19%	0,885

Appendix C. Popularity of passive investing across the world (2003-2015)

This table presents "Passive", the exponential of the value-weighted cross sectional variance of turnover as calculated by Bhattacharya and Galpin (2011). This measure can be interpreted as the level of popularity of passive investing in a country, on a scale from zero to one. The value-weighted cross-sectional variance is firstly calculated on a monthly basis and then aggregated yearly. An average is then calculated for every country. The sample consists of 33 countries, 21 of which are classified as developed and the rest – as developing. The third and seventh columns contain dummies according to this classification. The countries are ordered according to their measure of passive investing. Data are retrieved from Datastream (2018).

Rank	Country	Developed=1 Emerging=0	Passive	Rank	Country	Developed=1 Emerging=0	Passive
1	UK	1	0,613	18	Colombia	0	0,205
2	USA	1	0,61	19	Singapore	1	0,193
3	Republic of Korea	0	0,541	20	New Zealand	1	0,183
4	Switzerland	1	0,477	21	Austria	1	0,178
5	Australia	1	0,454	22	India	0	0,168
6	Hong Kong	1	0,428	23	Turkey	0	0,136
7	Netherlands	1	0,423	24	Poland	0	0,119
8	Finland	1	0,421	25	Greece	0	0,118
9	Japan	1	0,416	26	France	1	0,091
10	Belgium	1	0,402	27	Mexico	0	0,039
11	Italy	1	0,402	28	Philippines	0	0,031
12	Sweden	1	0,338	29	Chile	0	0,029
13	Malaysia	0	0,317	30	Ireland	1	0,02
14	Denmark	1	0,309	31	Indonesia	0	0,014
15	Norway	1	0,277	32	Germany	1	0,001
16	Portugal	1	0,275	33	Brazil	0	0
17	Spain	1	0,267	**-**	**Average**	**-**	**0,257**

Appendix D. The effect of passive investing on capital allocation efficiency, pooled OLS

This table reports regression estimates in which the dependent variable is the pooled estimated country allocative efficiency for the period 2003-2015, calculated following Wurgler's (2000) approach. The key independent variable, PIP, is a proxy for the popularity of passive investing, as derived by Bhattacharya and Galpin (2011). The numeration (1) – (8) corresponds to the number of the model. The models differ by the set of variables included, particularly the measure(s) for financial development. STK/GDP is the ratio of stock market capitalization-to-GDP. VO/GDP is equal to dollar-volume traded during a year divided by GDP. VO/STK is an aggregate measure of two previous components and represents the ratio of dollar-volume traded divided by market capitalization. T-statistics are reported in parentheses, and *, **, *** show the level of statistical significance (* p<0.10; ** p<0.05; *** p<0.01). R^2 is the R-squared of the model. Data are retrieved from three sources: INDSTAT2 (2018), Datastream (2018) and World Economic Outlook (2018). The sample is comprised of 33 countries and includes common stocks only.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.432	0.448	0.431	0.314	0.457	0.325	0.310	0.245
	(4.90)***	(5.03)***	(4.90)***	(3.19)***	(5.88)***	(3.11)***	(3.18)***	(1.54)
PIP	0.364	0.444	0.332	0.152	0.164	0.195	0.241	0.307
	(1.59)	(1.83)*	(1.03)	(0.89)	(0.62)	(1.01)	(1.15)	(1.14)
STK/GDP		-0.040			-0.134	-0.017		0,082
		(-2.10)**			(-1.87)*	(-0.86)		(0.61)
VO/GDP			0.016		0.230		-0.052	-0.211
			(0.19)		(1.39)		(-0.96)	(-0.71)
VO/STK				0.222		0.213	0.240	0.337
				(2.90)***		(2.57)**	(3.08)***	(1.67)
R^2	0.07	0.10	0.07	0.25	0.18	0.23	0.26	0.27
Estimation method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Fixed effects	None	None	None	None	None	None	None	None

Appendix E. The effect of passive investing on capital allocation efficiency, Interactions

This table reports regression estimates in which the dependent variable is the growth in gross fixed capital formation for the period 2003-2015. The key independent variables are growth in value added, PIP - a proxy for the popularity of passive investing, as derived by Bhattacharya and Galpin (2011) and measures for financial development as controls. The measure of interest is the coefficient of the interaction between value added growth and passive investing. It shows the impact of changes in the popularity of passive investing on capital allocation efficiency, as approximated in Wurgler's (2000) framework. The numeration (1) – (9) corresponds to the number of the model. The models differ by the set of variables included, particularly the measure(s) for financial development and the fixed effects controlled for. STK/GDP is the ratio of stock market capitalization-to-GDP. VO/STK is an aggregate measure of two previous components and represents the ratio of dollar-volume traded divided by market capitalization. T-statistics are reported in parentheses, and *, **, *** show the level of statistical significance (* p<0.10; ** p<0.05; *** p<0.01). R^2 is the R-squared of the model. Data are retrieved from three sources: INDSTAT2 (2018), Datastream (2018) and World Economic Outlook (2018). The sample is comprised of 33 countries and includes common stocks only.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\ln(VA_{ict}/VA_{ict-1})$	0,532	0,554	0.460	0.460	0,383	0,525	0,432	0.430	0,366
	(11.27)***	(10.91)***	(7.86)***	(8.92)***	(6.53)***	(10.18)***	(7.35)***	(8.23)***	(6.21)***
PIP	-0,015	-0.020	-0,023	-0.040	-0,031	-0,038	-0,001	-0,082	-0,071
	(-0.74)	(-0.95)	(-1.12)	(-1.86)*	(-1.47)	(-0.88)	(-0.01)	(-1.71)*	(-1.50)
$\ln(VA_{ict}/VA_{ict-1})$x PIP	0,037	0,115	-0,047	0,004	-0,119	0,166	0,016	0,043	-0,063
	(0.27)	(0.79)	(-0.32)	(0.03)	(-0.87)	(1.12)	(0.11)	(0.31)	(-0.46)
STK/GDP		0,003		0,005		0,012		0,032	
		(0.45)		(0.67)		(0.60)		(1.29)	
$\ln(VA_{ict}/VA_{ict-1})$x STK/GDP		-0,059		-0,036		-0,054		-0,032	
		(-1.24)		(-0.75)		(-1.05)		(-0.62)	
VO/STK			0,012		-0,001		0,030		-0,004
			(1.57)		(-0.14)		(2.47)**		(-0.23)
$\ln(VA_{ict}/VA_{ict-1})$x VO/STK			0,129		0,113		0,132		0,103
			(2.02)**		(1.89)*		(2.05)**		(1.70)*
R^2	0.10	0.10	0.10	0,13	0,13	0.10	0.10	0,13	0,13
Estimation method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Fixed effects	None	None	None	Year	Year	Country	Country	Both	Both

Appendix F. The effect of passive investing on capital allocation efficiency, top decile

This table reports regression estimates in which the dependent variable is the pooled estimated country allocative efficiency for the period 2003-2015, calculated following Wurgler's (2000) approach. The regression is based on the observations in the top decile according to popularity of passive investing. Focusing on the most passive country-years in the sample, allows to explore the effect of high levels of passive investing on capital allocation efficiency. The key independent variable, PIP, is a proxy for the popularity of passive investing, as derived by Bhattacharya and Galpin (2011). The numeration (1) – (9) corresponds to the number of the model. The models differ by the set of variables included, particularly the measure(s) for financial development. STK/GDP is the ratio of stock market capitalization-to-GDP. VO/STK is an aggregate measure of two previous components and represents the ratio of dollar-volume traded divided by market capitalization. T-statistics are reported in parentheses, and *, **, *** show the level of statistical significance (* p<0.10; ** p<0.05; *** p<0.01). R2 is the R-squared of the model. Data are retrieved from three sources: INDSTAT2 (2018), Datastream (2018) and World Economic Outlook (2018). The sample is comprised of 33 countries and includes common stocks only.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\ln(VA_{ict}/VA_{ict-1})$	2,679	2,559	3,458	3,133	3.690	3,158	4,011	3,291	3,515
	(1.98)**	(1.93)*	(2.20)**	(2.65)***	(2.54)**	(2.47)**	(2.58)***	(2.98)***	(2.64)***
PIP	0,166	0.410	0,263	0,583	0,394	0,593	0,374	-0,032	-0,285
	(0.68)	(1.50)	(1.03)	(1.72)*	(1.34)	(2.14)**	(1.37)	(-0.07)	(-0.75)
$\ln(VA_{ict}/VA_{ict-1})$ x PIP	-3,276	-2,382	-4,236	-3,495	-4,825	-3,859	-5,105	-4,473	-4.730
	(-1.54)	(-1.04)	(-1.78)*	(-1.68)*	(-2.25)**	(-1.72)*	(-2.19)**	(-2.24)**	(-2.42)**
STK/GDP		-0.060		-0,033		-0,256		-0,195	
		(-1.66)*		(-0.87)		(-2.19)**		(-1.07)	
$\ln(VA_{ict}/VA_{ict-1})$x STK/GDP		-0,385		-0,343		-0.110		-0,011	
		(-0.86)		(-0.82)		(-0.24)		(-0.02)	
VO/STK			0,018		-0,001		-0,007		-0,108
			(1.27)		(-0.06)		(-0.22)		(-1.61)
$\ln(VA_{ict}/VA_{ict-1})$x VO/STK			-0,199		-0.118		-0,219		-0,083
			(-1.48)		(-0.80)		(-1.59)		(-0.57)
R^2	0,15	0,15	0,15	0,19	0,19	0.19	0,18	0,22	0,23
Estimation method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Fixed effects	None	None	None	Year	Year	Country	Country	Both	Both

Appendix G. The effect of passive investing on capital allocation efficiency, dummies

This table reports regression estimates in which the dependent variable is the growth in gross fixed capital formation for the period 2003-2015. The key independent variables are growth in value added, dummy variables for different values of popularity of passive investing, as derived by Bhattacharya and Galpin (2011) and measures for financial development as controls. To capture the nonlinear effect of different levels of passive investing on allocative efficiency, we look at the impact that an increase in passive investing has at different levels of existing passive investing. To do that we create dummies for different levels of popularity of PIP. We drop the decile that holds the observations with the lowest level of popularity of passiveness and use it as reference point. The measure of interest is the coefficient of the interaction between value added growth and $D^{>65\%}$. It shows the impact of changes in the popularity of passive investing on capital allocation efficiency, as approximated in Wurgler's (2000) framework, at the highest levels of PIU in our sample. The numeration (1) – (9) corresponds to the number of the model. The models differ by the set of variables included, particularly the measure(s) for financial development and the fixed effects controlled for. STK/GDP is the ratio of stock market capitalization-to-GDP. VO/STK is an aggregate measure of two previous components and represents the ratio of dollar-volume traded divided by market capitalization. T-statistics are reported in parentheses, and *, **, *** show the level of statistical significance (* p<0.10; ** p<0.05; *** p<0.01). R2 is the R-squared of the model. Data are retrieved from three sources: INDSTAT2 (2018), Datastream (2018) and World Economic Outlook (2018). The sample is comprised of 33 countries and includes common stocks only.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\ln(\mathrm{VA}_{ict}/\mathrm{VA}_{ict-1})$	0,518	0,546	0,447	0,454	0,374	0.520	0,421	0.430	0,362
	(8.87)***	(8.70)***	(6.64)***	(7.26)***	(5.61)***	(8.21)***	(6.26)***	(6.81)***	(5.42)***
$D^{>65\%}$	0,034	0,032	0,034	0,033	0,038	0.040	0,075	0,013	0,024
	(1.42)	(1.24)	(1.39)	(1.29)	(1.57)	(1.11)	(2.04)**	(0.32)	(0.59)
$\ln(\mathrm{VA}_{ict}/\mathrm{VA}_{ict-1})\mathrm{x}D^{>65\%}$	-0,486	-0,429	-0.480	-0,378	-0,406	-0,412	-0,455	-0.360	-0,388
	(-2.23)**	(-1.93)*	(-2.20)**	(-1.76)*	(-1.93)*	(-1.84)*	(-2.08)**	(-1.66)*	(-1.84)*
$D^{60-65\%}$	-0,021	-0.023	-0,027	-0,028	-0,024	-0,022	-0,002	-0.050	-0,043
	(-1.18)	(-1.24)	(-1.44)	(-1.52)	(-1.28)	(-0.73)	(-0.06)	(-1.54)	(-1.33)
$\ln(\mathrm{VA}_{ict}/\mathrm{VA}_{ict-1})\mathrm{x}$ $D^{60-65\%}$	0,238	0.280	0,191	0,183	0,118	0.296	0,227	0,191	0,135
	(1.99)**	(2.25)**	(1.54)	(1.62)	(1.05)	(2.37)**	(1.83)*	(1.67)*	(1.20)
$D^{50-60\%}$	-0,043	-0,045	-0,045	-0,055	-0,052	-0.050	-0.030	-0,082	-0,075
	(-3.04)***	(-3.13)***	(-3.21)***	(-3.83)***	(-3.64)***	(-2.11)**	(-1.23)	(-3.17)***	(-2.91)***
$\ln(\mathrm{VA}_{ict}/\mathrm{VA}_{ict-1})\mathrm{x}$ $D^{50-60\%}$	0,079	0,127	0,042	0,112	0,047	0,151	0,073	0,132	0,071
	(0.75)	(1.14)	(0.39)	(1.05)	(0.46)	(1.34)	(0.67)	(1.22)	(0.68)
$D^{40-50\%}$	-0,021	-0,023	-0,023	-0,026	-0,023	-0,027	-0,011	-0,047	-0,042
	(-1.44)	(-1.58)	(-1.58)	(-1.86)*	(-1.62)	(-1.20)	(-0.49)	(-2.00)**	(-1.81)*
$\ln(\mathrm{VA}_{ict}/\mathrm{VA}_{ict-1})\mathrm{x}D^{40-50\%}$	-0.010	0,025	-0,039	-0.037	-0,084	0,046	-0,004	-0,027	-0,059
	(-0.10)	(0.26)	(-0.40)	(-0.41)	(-0.92)	(0.48)	(-0.04)	(-0.30)	(-0.63)
$D^{30-40\%}$	-0,021	-0,021	-0,023	-0,018	-0,016	-0.020	-0,012	-0,025	-0,022
	(-1.44)	(-1.49)	(-1.60)	(-1.26)	(-1.11)	(-1.00)	(-0.62)	(-1.23)	(-1.06)
$\ln(\mathrm{VA}_{ict}/\mathrm{VA}_{ict-1})\mathrm{x}D^{30-40\%}$	0,017	0,036	-0,019	-0,043	-0,087	0,059	0,002	-0.030	-0,068
	(0.20)	(0.42)	(-0.21)	(-0.53)	(-1.02)	(0.69)	(0.02)	(-0.37)	(-0.79)
$D^{20-30\%}$	-0,037	-0,038	-0,038	-0,027	-0,027	-0,043	-0,036	-0,035	-0,033
	(-2.18)**	(-2.20)**	(-2.23)**	(-1.59)	(-1.60)	(-2.08)**	(-1.72)*	(-1.70)*	(-1.62)
$\ln(\mathrm{VA}_{ict}/\mathrm{VA}_{ict-1})\mathrm{x}D^{20-30\%}$	0,096	0,108	0.080	0,095	0,074	0,115	0,097	0,088	0,073
	(0.96)	(1.08)	(0.79)	(0.99)	(0.78)	(1.13)	(0.95)	(0.90)	(0.76)

$D^{10-20\%}$	-0,029	-0,029	-0,028	-0,018	-0,017	-0,036	-0,033	(-0.030)	-0,027
	(-1.88)*	(-1.90)*	(-1.84)*	(-1.17)	(-1.13)	(-1.95)*	(-1.77)*	(-1.60)	(-1.48)
$\ln(\mathrm{VA}_{\mathrm{ict}}/\mathrm{VA}_{\mathrm{ict-1}})\mathrm{x}D^{10-20\%}$	-0,092	-0,085	-0,096	-0,094	-0,102	-0.070	-0,075	-0,086	-0,095
	(-1.03)	(-0.95)	(-1.07)	(-1.09)	(-1.19)	(-0.78)	(-0.83)	(-1.00)	(-1.09)
STK/GDP		0,002		0,004		0,009		0,025	
		(0.29)		(0.49)		(0.42)		(1.01)	
xSTK/GDP		-0,062		-0.040		-0,056		-0,034	
		(-1.29)		(-0.83)		(-1.10)		(-0.68)	
VO/STK			0.010		-0,001		0,034		0,002
			(1.32)		(-0.13)		(2.75)***		(0.11)
xVO/STK			0,122		0,107		0,121		0,094
			(1.89)*		(1.75)*		(1.86)*		(1.53)
R^2	0,09	0,09	0.10	0,13	0,13	0.10	0,10	0,13	0,13
Estimation method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Fixed effects	None	None	None	Year	Year	Country	Country	Both	Both

Appendix H. The effect of passive investing on capital allocation efficiency, instrumental variables framework

This table reports regression estimates in which the dependent variable is the estimated country allocative efficiency for the period 2003-2015, calculated following Wurgler's (2000) approach and approximated on a yearly basis. The key independent variable, PIP, is a proxy for the popularity of passive investing, as derived by Bhattacharya and Galpin (2011). PIP is instrumented with *Pension*, which measure the amount of funds in the pension system as percent of GDP on a yearly basis. The second instrument used is *Reform* - a dummy variable that takes the value of 1 starting with the year when there was a reform or a change in the pension system in the country, facilitating a shift towards DC pension planning. The numeration (1) – (8) corresponds to the number of the model. The models differ by the set of variables included, particularly the measure(s) for financial development and the fixed effects controlled for. STK/GDP is the ratio of stock market capitalization-to-GDP. VO/STK is an aggregate measure of two previous components and represents the ratio of dollar-volume traded divided by market capitalization. T-statistics are reported in parentheses, and *, **, *** show the level of statistical significance (* $p<0.10$; ** $p<0.05$; *** $p<0.01$). R^2 is the R-squared of the model. Data are retrieved from six sources: INDSTAT2 (2018), Datastream (2018), World Economic Outlook (2018), the OECD Pensions Indicators database (n.d.), OECD Pensions at a Glance reports (OECD, n.d.) and an appendix in the "*Indexing and active fund management: International evidence*" (2016) paper by Cremers, Ferreira, Matos and Starks. The sample is comprised of 33 countries and includes common stocks only.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8)
1st stage									
Pensions	0,216	0,108	0,211	0,104	0,205	0,155	0,175	0,124	0,129
	(9.35)***	(4.01)***	(9.43)***	(4.77)***	(12.41)***	(2.69)**	(3.72)***	(1.51)	(1.87)*
Reform	0,015	0,016	0,029	-0,007	0,016	0,036	0.030	0,033	0,032
	(0.68)	(0.76)	(1.42)	(-0.38)	(0.86)	(1.16)	(0.99)	(0.90)	(0.84)
2nd stage									
Intercept	0,235	0,246	0,326	0,128	0,384	0,261	0,125	-0,588	-0,532
	(1.42)	(1.42)	(2.59)***	(0.71)	(3.24)***	(0.36)	(0.14)	(-0.47)	(-0.41)
PIP	0,554	1,836	0,495	2,988	0,707	-0,143	0,616	3,211	3,587
	(1.03)	(1.31)	(0.92)	(1.75)*	(1.57)	(-0.06)	(0.24)	(0.75)	(0.79)
STK/GDP		-0.610		-0,967		0,285		0,225	
		(-1.34)		(-1.78)*		(0.72)		(0.54)	
VO/STK			-0,087		-0,232		0,108		-0,032
			(-0.76)		(-1.81)*		(0.55)		(-0.10)
Estimation method	2sls	2sls	2sls	FE IV regression	FE IV regression	FE IV regression	FE IV regression	FE IV regression	FE IV regression
Fixed effects	None	None	None	Time	Time	Country	Country	Both	Both

Appendix I. The effect of passive investing on capital allocation efficiency, 7-6 OLS

This table reports regression estimates in which the dependent variable is the estimated country allocative efficiency for the period 2003-2015, calculated following Wurgler's (2000) approach and aggregated for the first 7 years (2003-2009) and the following 6 years (2010-2015). The key independent variable, PIP, is a proxy for the popularity of passive investing, as derived by Bhattacharya and Galpin (2011). The numeration (1) – (9) corresponds to the number of the model. The models differ by the set of variables included, particularly the measure(s) for financial development and the fixed effects controlled for. STK/GDP is the ratio of stock market capitalization-to-GDP. VO/STK is an aggregate measure of two previous components and represents the ratio of dollar-volume traded divided by market capitalization. T-statistics are reported in parentheses, and *, **, *** show the level of statistical significance (* p<0.10; ** p<0.05; *** p<0.01). R^2 is the R-squared of the model. Data are retrieved from three sources: INDSTAT2 (2018), Datastream (2018) and World Economic Outlook (2018). The sample is comprised of 33 countries and includes common stocks only.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercept	0,365	0,408	0,393	0,472	0.490	1,359	1,167	1,189	1,131
	(3.68)***	(4.13)***	(3.63)***	(4.36)***	(4.26)***	(4.31)***	(3.19)***	(3.73)***	(3.02)***
PIP	0.370	0,538	0.410	0,594	0.511	-0,699	-0,827	-0,357	-0,115
	(1.29)	(1.83)*	(1,12)	(2.02)**	(1.40)	(-1.42)	(-1.40)	(-0.86)	(-0.28)
STK/GDP		-0.100		-0,099		-0,528		-0,463	
		(-2.60)**		(-3.15)***		(-4.64)***		(-3.48)***	
VO/STK			-0.050		-0.092		-0,421		-0,612
			(-0.28)		(-0.52)		(-2.38)**		(-5.59)***
R^2	0,03	0,1	0,03	0,14	0,08	0,58	0,62	0,59	0.73
Estimation method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Fixed effects	None	None	None	Period	Period	Country	Country	Both	Both

Appendix J. The effect of passive investing on capital allocation efficiency, 5-4-4 OLS

This table reports regression estimates in which the dependent variable is the estimated country allocative efficiency for the period 2003-2015, calculated following Wurgler's (2000) approach and aggregated for the first 5 years (2003-2007), the following 4 years (2008-2011) and the last 4 years (2012-2015). The key independent variable, PIP, is a proxy for the popularity of passive investing, as derived by Bhattacharya and Galpin (2011). The numeration (1) – (9) corresponds to the number of the model. The models differ by the set of variables included, particularly the measure(s) for financial development and the fixed effects controlled for. STK/GDP is the ratio of stock market capitalization-to-GDP. VO/STK is an aggregate measure of two previous components and represents the ratio of dollar-volume traded divided by market capitalization. T-statistics are reported in parentheses, and *, **, *** show the level of statistical significance (* p<0.10; ** p<0.05; *** p<0.01). R^2 is the R-squared of the model. Data are retrieved from three sources: INDSTAT2 (2018), Datastream (2018) and World Economic Outlook (2018). The sample is comprised of 33 countries and includes common stocks only.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercept	0,406	0,439	0,364	0,414	0,359	0,433	0,673	0,236	0,727
	(6.00)***	(5.72)***	(4.10)***	(4.24)***	(3.86)***	(0.84)	(1.71)*	(0.41)	(1.79)*
PIP	0,278	0,392	0,186	0,436	0,252	-0,384	-0,354	-0,138	-0,232
	(1.42)	(1.84)*	(0.90)	(1.96)*	(1,01)	(-0.95)	(-0.82)	(-0.33)	(-0.50)
STK/GDP		-0.072		-0,073		0,229		0,296	
		(-0.82)		(-0.78)		(0.56)		(0.69)	
VO/STK			0,091		0,059		-0,011		-0,171
			(1.03)		(0.57)		(-0.06)		(-0.63)
R^2	0,02	0,05	0,03	0,06	0,03	0,41	0.40	0,42	0.40
Estimation method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Fixed effects	None	None	None	Period	Period	Country	Country	Both	Both

Appendix K. The effect of passive investing on capital allocation efficiency, yearly OLS

This table reports regression estimates in which the dependent variable is the estimated country allocative efficiency for the period 2003-2015, calculated following Wurgler's (2000) approach and approximated on a yearly basis. The key independent variable, PIP, is a proxy for the popularity of passive investing, as derived by Bhattacharya and Galpin (2011). The numeration (1) – (9) corresponds to the number of the model. The models differ by the set of variables included, particularly the measure(s) for financial development and the fixed effects controlled for. STK/GDP is the ratio of stock market capitalization-to-GDP. VO/STK is an aggregate measure of two previous components and represents the ratio of dollar-volume traded divided by market capitalization. T-statistics are reported in parentheses, and *, **, *** show the level of statistical significance (* p<0.10; ** p<0.05; *** p<0.01). R^2 is the R-squared of the model. Data are retrieved from three sources: INDSTAT2 (2018), Datastream (2018) and World Economic Outlook (2018). The sample is comprised of 33 countries and includes common stocks only.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Intercept	0.239	0.238	0.286	0.131	0.221	0.541	0.350	0.341	0.324
	(3.26)***	(2.76)***	(3.20)***	(0.77)	(1.28)	(1.48)	(1.06)	(0.84)	(0.92)
PIP	0.550	0.548	0.609	0.634	0.813	0.631	0.644	0.805	0.792
	(2.40)**	(2.16)**	(2.47)**	(2.38)**	(3.06)***	(1.36)	(1.40)	(1.53)	(1.50)
STK/GDP		0.001		0.005		-0.121		-0.095	
		(0.01)		(0.04)		(-0.49)		(-0.35)	
VO/STK			-0.085		-0.205		0.069		-0.103
			(-1.04)		(-2.04)**		(0.62)		(-0.55)
R2	0.01	0.01	0.02	0.07	0.08	0.11	0.10	0.17	0.16
Estimation method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Fixed effects	None	None	None	Time	Time	Country	Country	Both	Both