ERASUMUS UNIVERSITY ROTTERDAM

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The relationship between returns on human capital and equity returns

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Abstract

To determine the optimal portfolio for an agent, the correlation between returns to human capital and returns of the risky asset is crucial. There is no general consensus in the previous literature what the sign and magnitude of this correlation is. However, in most research it is assumed that returns on human capital and equity returns are not correlated. In contrast to this, I find a significant positive relationship on an aggregated level when taking all 25 countries together over the period 1996 – 2020. Country-level correlations differ but point to the direction of a positive relationship between returns to human capital and equity returns. These differences cannot be explained by the flexibility of the labor market. Furthermore, the correlation is larger and stronger during periods of severe economic downturns. The results found in this thesis should decrease the optimal portfolio share invested in the risky asset

Keywords: *Correlation, human capital, optimal portfolio choice, equity returns, labor income.*

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Foreword

I am not going to lie, writing my thesis was quite the hassle. I am a person who thrives in a library, writing my thesis with likeminded people around me. During my bachelor thesis I was living in The Hague and spend most of my days in the central library. Unfortunately, during the COVID period the library was closed most of the time. I found it hard to find motivation and due to extracurricular activities, I always found something to prioritize over writing my thesis. I probably have been a difficult master student to supervise. However, my supervisor Laurens Swinkels always knew how to positively support me during the process. I want to thank professor Swinkels for his unbridled patience, excellent guidance and small talk during our Skype sessions. In the end, I am quite intrigued by the topic I wrote my thesis about and can surely say I learned a lot in the process. This thesis ends my five years of studying at the Erasmus School of Economics and this period has taught me valuable skills. I am confident that these skills will help me complete my second master in Strategic Entrepreneurship, and thesis, at the Rotterdam School of Management and will help me during my entire career.

1. Introduction

According to Ameriks & Zeldes (2004) the portion of U.S. households holding equities grew rapidly from 33 percent in 1989 to 51 percent in 2001. They claim this is due to the growth of individuals who can choose how their retirement fund is allocated over different asset classes. As the individual element is added, an important feature is the investment decisions of individual households' decisions. If households fail to make proper investment decisions, they end up with a low retirement income resulting in relatively low consumption.

Common financial advice is to invest most of financial wealth in stocks and reduce this proportion as the investor ages. The famous "rule of thumb" is to hold $100 - your\ age$ as a percentage of your portfolio in the risky asset (e.g. stocks). Agnew, Balduzzi & Sunden (2003) find that a one-year increase in age leads to a decrease of 0.93% in the portfolio share allocated to stocks. This is strikingly close to the above-mentioned rule of thumb. However, this rule of thumb is not observed in the actual data on portfolio allocation by households, the observed share in the risky asset over the life-cycle is hump-shaped (King & Leape, 1987; Yoo, 1994; Hochguertel, 1998; Storesletten, Telmer & Yaron, 2007). A large body of literature covers the optimal portfolio choice theory and tries to explain this hump-shaped pattern.

Until the 1970s human capital was omitted in optimal portfolio theory. Under quite restrictive assumptions, the optimal share in the risky asset should be constant over the life-cycle of the agent when labor income is not considered (Merton, 1969; Sumuelson, 1969). However, for most of the agents' life, a large portion of total wealth is tied up in his human capital. As labor income is risky (Jagannathan & Kocherlakota, 1996), the optimal share in the risky asset depends on the correlation of returns to human capital with returns on the risky asset. If this correlation is positive, labor income risk crowds out the demand for the risky asset. If the investor is very risk adverse a positive correlation reduces the optimal share of the risky asset to below the level of retired investors, for whom human capital has deteriorated over the years (Viceira, 2001).

As the correlation between returns to human capital and equity returns is crucial for optimal portfolio theory, several research has been done since the 1970s. In many life-cycle models the correlation is assumed to be zero (e.g. Campbell et al., 2001; Gomes, 2020). Some scholars indeed estimate the correlation to be near zero (e.g. Fama & Schwert, 1977; Davis & Willen, 2000a; Cocco et al., 2005). However, there is empirical evidence that points toward the direction of the correlation coefficient being statistically different from zero.

Benzoni, Dufresne & Goldstein (2005) argue that the correlation between returns to human capital and equity returns is an increasing function of time. Over longer horizons returns to human capital and

equity returns should be highly correlated although contemporaneous correlation can be low. When deriving the correlation from the standard Cobb-Douglas production function returns to labor (returns to human capital) and returns to capital (equity returns) are perfectly correlated as well (Baxter & Jerman, 1995). The empirical results of Campbell (1996) and Campbell et al. (2001) also indicate that the relationship between returns to human capital and equity returns is positive.

In contrast to the literature mentioned above, Lustig & Van Nieuwerburgh (2008) argue that the correlation between returns to human capital and equity returns should be negative to explain data on consumption. Empirical evidence for this negative relationship is, among others, provided by Bottazzi, Pesenti & Van Wincoop (1996) who calculate the correlation between returns to human capital and the profit rate for sixteen developed countries. This correlation is estimated to be negative for twelve out of the sixteen countries. Redistribution of income over labor and capital could explain this negative correlation.

Based on the above-mentioned literature on the correlation between returns to human capital and equity returns, a general consensus about the sign and magnitude of the correlation is yet to be reached. Furthermore, the empirical research covers mainly the United States and only few incorporate many countries in their analysis. Bottazzi et al. (1996) analyze more countries but do not provide an explanation for the observed cross-country differences. Moreover, the latest empirical evidence of the correlation coefficient dates back to the 1990s. Since the 1990s the world has experienced some deep recessions which could have altered the relationship between returns to human capital and equity returns. The current literature, at least to my knowledge, does not cover the effect of economic downturns on the correlation between returns to human capital and equity returns. Therefore, I formulate the following research question for this thesis:

Research question: *What is the relationship between the aggregated returns on human capital and equity returns in Europe and the United States over the period 1995-2020 and what are the determinants of this relationship?*

This thesis makes several contributions to the existing body of literature. Previous research mainly focused on the United States, in this paper 25 countries in Europe and North-America are analyzed. Furthermore, the flexibility of the labor market is incorporated to explain the differences in the country-level correlations. Additionally, I consider a more recent time period with several severe global recessions. Finally, I test if the correlation differs during periods of severe economic downturns. Previous research gives reason to the raise doubt if the correlation coefficient is constant over the business cycle. However, to my knowledge, this is not formally tested yet.

The findings indicate that the correlation between returns to human capital and equity returns is positive and statistically different from zero. These results hold when taking the small cap returns as a measure of equity returns. However, country-level correlations differ and the flexibility of the labor market does not explain these differences. In line with prior research, the correlation between returns to human capital and equity returns tends to rise with level of education. The economic reasoning behind this is that skilled employees complement physical capital and raise the intangible assets of companies. Finally, the magnitude of the correlation is stronger for Europe during the periods of severe economic downturns.

The remainder of this thesis is organized as follows. Section 2 gives a brief overview and discussion of the relevant research done on optimal portfolio theory incorporating human capital, the implications of a positive correlation between returns on human capital and equity returns and the empirical research done on this correlation. Furthermore, it sums up the hypotheses tested in this thesis. Section 3 describes the data and methodology used to answer these hypotheses. Section 4 presents and discusses the results and provides the reader with several robustness checks. Finally, section 5 concludes and discusses limitations of this thesis and recommendations for future research.

2. Literature review

This chapter gives an overview and discusses the main concepts and prior research. In section 2.1 the theoretical research regarding human capital and portfolio theory is discussed. Section 2.2 discusses the empirical research on the topic. Finally, in Section 2.3 the hypotheses are formed.

2.1 Portfolio choice with labor income

One of the seminal papers on optimal portfolio choice is Merton (1969). He introduced a model where the individual investor, called an agent, invests in two types of assets: a risky asset and a riskless asset. The risky asset has varying returns whereas the riskless asset has a constant rate of return. The main finding is that the optimal portfolio share in the riskless asset should be constant over the life-cycle of the agent. The same result was found by Samuelson (1969).

However, one crucial omitted variable in these above-mentioned papers is the effect of human capital on the optimal portfolio choice of agents. Human capital is usually defined as the knowledge, skills and capabilities one possesses (Keeley, 2009). Human capital is measured by the discounted value of an agent's future labor income. On an aggregated level, human capital is one of the largest drivers of national income. Although declining, the labor income share is by far over fifty percent of the national income of G20 countries (ILO, 2015). On an individual level the amount of human capital plays a significant role in the asset allocation decisions investors make.

In the joint paper of Bodie, Merton and Samuelson (1992), which was published years after their seminal papers of 1969, they incorporate human capital in their portfolio choice model (Bodie, Merton & Samuelson, 1992). They argue that total wealth exists of both financial wealth and human capital. Several scholars have incorporated human capital in their portfolio choice models (e.g., Bodie et al., 1992; Cocco, Gomes & Maenhout, 2005; Heaton & Lucas, 1997; Koo, 1998).

Human capital is a special kind of wealth as human capital is a nontradable asset in contrast to investments in stocks and bonds. In the following subsections I will discuss some life-cycle models that research the effect of human capital on portfolio optimalization. This research can be roughly classified in riskless labor income and risky labor income.

2.1.1 Riskless labor income

Let's first introduce the model with riskless labor income. Adding to his paper of 1969, Merton (1971) optimizes the portfolio choice considering a constant stream of labor income (Y_1). When solving for the optimal share in the risky asset, he finds the following result for the case without labor income:

$$\alpha_{NY} = \frac{\alpha_Y}{1+\frac{Y_1}{R_f W_0}} \quad (2.1)$$

Where α_{NY} denotes the no labor-income case and α_Y the labor-income case. R_f represents the return on the risk-free asset and W_0 is the total wealth at the beginning of period $t = 0$.

When solving for α_Y we take the following steps:

$$\alpha_Y = (1 + \frac{Y_1}{R_f W_0})\, \alpha_{NY} \quad (2.2)$$

$\frac{Y_1}{R_f}$ represents the present value of the constant stream of labor income. This leads to the following conclusion: $\alpha_Y = (1 + \frac{PV(Y_1)}{R_f W_0})\, \alpha_{NY}$ (2.3)

From equation (2.3) Merton (1971) concludes that the present value of the constant labor-income stream acts like an extra endowment on the riskless asset. The agent reallocates his financial wealth so that the share of his total wealth in the risky asset is the same when compared to the situation where all wealth is tradable. With riskless labor income, labor income acts as a substitute for the riskless asset.

As stated earlier, total wealth consists of both human capital and financial wealth. Due to human capital being a substitute for the riskless asset, a larger proportion of the financial wealth is invested into the risky asset to optimize the portfolio choice compared to the model which does not include human capital. However, the proportion of total wealth invested into the risky asset remains the same. Thus, riskless labor income decreases the demand for the riskless asset and increases the proportion of financial wealth invested in the risky asset.

2.1.2 Risky labor income

In the previous paragraph labor income was assumed to be riskless. In most of the literature on optimal portfolio choice it is assumed that human capital is a closer substitute for the riskless asset. When agents are young, they are advised to invest a large proportion of their financial wealth into the risky asset as their total wealth largely consists of riskless human capital. When the agent ages, the level of human capital decreases and total wealth tilts more to financial wealth. With a decrease in human capital over the life cycle, the proportion of total wealth invested in the riskless asset decreases as well. To rebalance the portfolio again to the optimal level of risky and riskless shares,

the agent increases the proportion of his financial wealth invested in the riskless asset. This decreases the share in the risky asset over the life cycle.

One problem with this investment strategy is the assumption of riskless labor income. Jagannathan & Kocherlakota (1996) point out that labor income is not an incoming flow of constant cashflows. Typically, labor income can vary year by year and therefore uncertainty is embedded in labor income. This makes future labor income risky and has an effect on the optimal portfolio choice. The optimal share of risky assets now depends on the correlation between labor income and returns on the risky asset and the variance of labor income. As labor income is nontradable, the risks associated with it cannot be diversified away.

Bodie et al. (1992) consider the case where the correlation between labor income and returns on the risky asset are perfectly correlated. When this is the case, labor income acts as a substitute for the risky asset in contrast to the case where riskless labor income acts as a substitute for the riskless asset. When labor income is perceived as risky, a part of the total wealth is already invested into a risky asset, the risky asset being human capital. Therefore, less of the financial wealth will be invested in the risky asset (e.g. stocks) and a larger proportion will be invested into the riskless asset (e.g. bonds). This effect is particularly strong when labor income and returns on the risky asset are correlated. When labor income is perceived as risky but not correlated with the risky asset, labor income substitutes the demand for the riskless asset, although less strongly than with complete riskless labor income (Viceira, 2001). The crowding out effect of the risky asset is therefore mostly dependent on the correlation between labor income and returns on the risky asset (e.g. equity returns).

Viceira (2001) finds that for very risk averse investors a positive correlation between labor income and equity returns can even reduce the optimal proportion of stocks held to below the level of retired investors. As retired investors have depleted their human capital during their working life, they experience no labor income risk. If the optimal proportion of stocks held, falls below the level of stocks held by retired investors, labor income risk crowds out equity risk significantly. A small positive correlation already has a large impact on the optimal share in the risky asset (Gomes, 2020). In Figure 1 the optimal share in the risky asset over the life cycle is plotted for different levels of correlation between labor income and returns on the risky asset. A correlation of 0.2 is enough to decrease the optimal risky share by 20 percent. Moreover, Cocco et al. (2005) observe different levels of optimal portfolio share with different magnitudes of correlations as well (Figure 2). Although the models used in Gomes (2020) and Cocco et al. (2005) differ, the correlation and therefore riskiness of labor income plays a crucial part in the optimal risky share an agent should hold. Therefore, the empirical

literature on this correlation between labor income and returns on the risky asset is discussed in the next section.

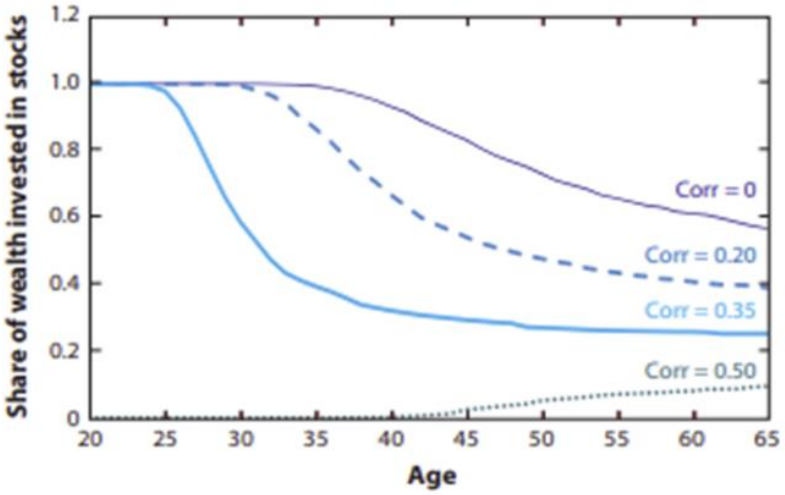

Figure 1: Optimal risky share by different levels of correlation between labor income and returns on the risky asset (Gomes, 2020)

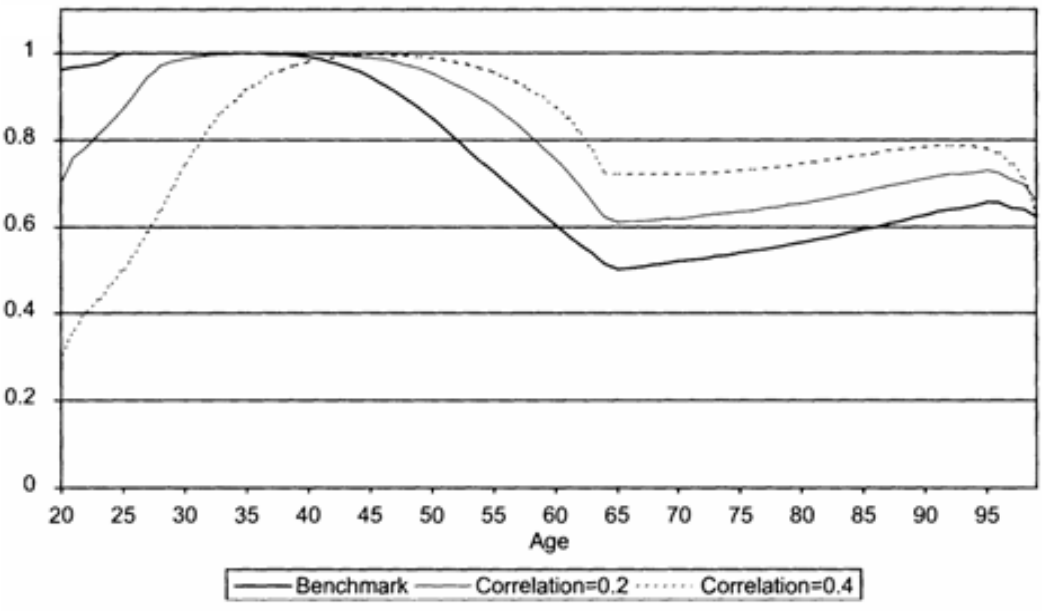

Figure 2: Optimal risky share by different levels of correlation between labor income and returns on the risky asset over different industries (Cocco et al., 2005)

2.2 Empirical evidence on the relationship between human capital and stocks

As discussed in the previous section, the correlation between returns to human capital and equity returns plays a vital role in the optimal portfolio share of the risky asset. The assumption in most optimal portfolio choice models is that the correlation is equal to zero. However, several scholars have argued that this is not true. In this section the empirical evidence and motivation of the correlation between returns to human capital and equity returns is discussed.

A well-known paper is the paper of Fama & Schwert (1977). The motive for this paper was earlier research by Mayers (1973), he extends the two-parameter model of determining capital market equilibrium of known scholars like Sharpe (1964) by including nontradable assets. One of these nontradable assets is human capital. In this extended capital market equilibrium model, Mayers notes that the risk of tradable assets is dependent on the following two relationships:

1) Covariance between its return on all tradable assets
2) Covariance between its return on all nontradable asset, for example human capital

Fama & Schwert (1977) test this new model empirically for the United States. They measure returns on human capital by using the aggregated labor income and they measure the return on the tradable asset by calculating the monthly return on a value-weighted portfolio of NYSE stocks. They find that the correlation between returns on human capital and equity returns is near zero for the United States over the period 1952 – 1972. They conclude that there is no empirical motive to incorporate human capital in the capital market equilibrium model.

Davis & Willen (2000a) investigate the relationship between returns to human capital and equity returns on an individual-income level over the period 1963 – 1994. They consider the difference across groups of agents based on sex, birth cohort and level of education. Although they find some statistically significant correlation coefficients, the majority of them are centered around zero. This is consistent with the earlier results of Fama & Schwert (1977). Cocco et al. (2005) find a near zero correlation as well, the consequence of this correlation is that even very risk adverse agents invest all of their financial wealth in the, more volatile, equity market.

The previous literature investigated the contemporaneous correlation between returns to human capital and equity returns. However, over time returns to human capital and equity returns comove together. Therefore, Benzoni et al. (2005) argue that the correlation between returns to human capital and equity returns is increasing when calculated over a longer time-horizon. Future labor income is affected by the past and current state of the economy. Thus, returns to human capital and returns to equity (proxy for returns to capital) should be highly correlated over the long

horizon even though contemporaneous correlations may be low. To add on their previous research, Benzoni, Dufresne & Goldstein (2007) test the implication of cointegrated labor income and dividends. They find that for younger investors human capital is a substitute for the risky asset and for older investors it is a substitute for the riskless asset. Treating human capital as a different asset class depending on the age of the investor fits the empirical observed hump-shaped life-cycle of portfolio holdings perfectly. Moreover, Baxter & Jerman (1995) argue that returns to human capital and domestic tradable assets should be highly correlated as a large share of national wealth is embedded in human capital. They derive the returns to human capital from the Cobb-Douglas production function. In their theoretical model, returns to human capital are perfectly correlated with the return to capital[1].

The theoretical model mentioned above omits many macro-economic factors. Therefore, Baxter & Jerman (1995) use a model developed by Baxter & Crucini (1994) which incorporates several characteristics of business-cycles within and across countries. Data on the U.S., Japan, the U.K. and Germany and returns are calculated on a quarterly basis over the period 1970-I to 1991-II. They find a correlation of human capital and domestic equity returns of 0.7231 and a correlation between human capital and foreign equity returns of 0.7524. This correlation is largely caused by the fact that Baxter & Jerman derive returns on human capital from observed equity returns. However, as these results contradict the results of Fama & Schwert (1977), Baxter & Jerman (1995) calculate returns to human capital with the same methodology as Fama & Schwert (1977) used. They still find a significant and positive correlation at the two quarters lag of equity returns. Campbell, Cocco, Gomes & Maenhout (2001) split their data sample into different education groups and also find significant positive correlation coefficients when lagging equity returns one year to allow for labor income to adjust, this correlation ranges from 0.33 to 0.52. Noteworthy is that both Campbell et al. (2001) and Davis & Willen (2000a) find that the correlation between returns to human capital and equity returns increases with educational attainment.

To further add to the results of Baxter & Jerman (1995), Campbell (1996) finds a large positive correlation coefficient as well. He used the future labor income growth to measure returns to human capital. With the methodology used in Campbell (1996), returns to human capital and equity returns have the same discount factor. Monthly data ranging from January 1952 to December 1990 and annual data ranging from 1871 to 1990 for the United States is considered. The conditional monthly correlation is estimated at 0.94. When looking at the annual conditional correlation, the correlation coefficient decreases to 0.54. A positive correlation has implications for the optimal portfolio theory:

[1] According to Baxter & Jerman (1995), several scholars argue that equity returns is the best proxy of the return to capital.

the optimal share of domestic asset holding should decrease to the point where investors should hold a short position in the domestic asset (Baxter & Jerman, 1995).

As mentioned earlier, Baxter & Jerman (1995) derived a positive correlation between returns to human capital and equity returns and some empirical evidence points in this direction. However, Lustig & Van Nieuwerburgh (2008) argue that, following neoclassical growth theory, the volatility of consumption is too small compared to the volatility of financial returns. A possible explanation is the human capital component: negatively correlated returns to human capital with returns on financial assets would solve this discrepancy observed in consumption data. This contradicts the literature discussed earlier.

Lustig & Van Nieuwerburgh calculate the correlation by using news on labor income and news on stock returns. They indeed find this negative correlation. This is in line with Boyd, Hu & Jagannathan (2005) who find that during periods of economic expansion, news of rising unemployment positively impacts the stock prices. During periods of contraction the news of rising unemployment negatively impacts the equity market. However, on average the economy experiences more periods of expansion than contraction implying that on average the relationship between news about unemployment and equity markets is negative.

Research done by Bottazzi et al. (1996) also points in the direction of negatively correlated returns to human capital and equity returns. They analyze the returns to human capital and the profit rate on an aggregated level for 16 developed countries[2] on an annual basis over the period 1970 – 1992. The comovement between the profits and labor income growth both move procyclical over the business cycle. However, the correlation between profits and returns to human capital is negative for 12 countries. Bottazzi et al. (1996) explain this result by highlighting the role of shocks independent of the business cycle that leads to redistribution of income over labor and capital. When a redistribution of total income over labor and capital in favor of labor occurs, the return on labor rises and the return on capital falls. Factors that change income distribution drastically are, for example, the political environment and changes in the bargaining power of labor unions.

To summarize, several scholars have investigated the correlation between returns to human capital and equity returns. However, the results differ largely among these scholars. A positive correlation is expected as labor income and stock returns tend to comove over time. However, income redistributions due to external events could diminish this relationship to even a negative correlation coefficient. Although, evidence has been provided that the correlation coefficient between returns to

[2] These countries include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Sweden, Switzerland, the United Kingdom and the United States.

human capital and equity returns is statistically different from zero, many life-cycle models assume that this correlation is zero.

2.3 Hypothesis development

The objective of this thesis is investigating the relationship between returns on human capital and the returns on equity. Furthermore, I investigate if country differences can be explained by taking into account the flexibility of the labor market and checking if a time effect is visible in times of economic downturns. In this section I formulate three hypotheses to finally answer my research question.

Before comparing the relationship over different countries, the sign of the relationship between returns on human capital and returns on equity needs to be determined. Many researchers assume a correlation of zero and empirical research on the individual investor level (e.g. Campbell, Cocco & Gomes, 2001; Davis & Willen, 2000a) have confirmed that the correlation is near zero. However, as presented in Section 2.3 there is no general consensus that the correlation is zero. The first hypothesis revolves around the estimation of the correlation coefficient. As evidence points both to a positive and negative relationship between returns to human capital and equity returns and both have a plausible economic explanation, the first hypothesis states that the correlation is significantly different from zero, but makes no assumptions about the sign of the correlation.

Hypothesis 1: The correlation between the returns to human capital and the equity returns on an aggregated level is different from zero.

Once the relationship between returns on human capital and equity returns is established, the cross-country differences are investigated. Labor income tends to react slower to economic events than stock prices do. Stock markets are forward looking and can react almost immediately on economic events. However, labor income is often subject to a heavily regulated labor market. More flexible labor markets are expected to be able to react immediately to economic events than heavily regulated labor markets. Countries with a less flexible labor market cannot adjust fully to changing business cycles compared to countries with very flexible labor markets. Therefore, I want to investigate if the level of labor flexibility positively impacts the relationship between returns on human capital and equity returns.

Hypothesis 2: The level of labor market flexibility has a positive effect on the correlation between returns on human capital and equity returns.

Finally, I want to investigate if periods of severe economic downturns have an effect on the correlation between returns on human capital and equity returns. Most research is based on the assumption that labor income risk is countercyclical. However, Guvenen, Ozkan & Song (2014) argue that during times of recession the labor income risk becomes more skewed to the left. This implies that the chances of large labor income reductions become larger and chances of rising labor income becomes smaller. Therefore, during recessions households are more likely to experience large drops in labor income. As Catherine (2020) points out, recessions usually coincide with crashes in financial markets. This implies that the relationship between returns on human capital and equity returns strengthens during severe economic downturns. Moreover, Boyd et al. (2005) find that during periods of economic contractions the correlation between news of rising unemployment coincide with falling equity returns. Taken all together, the third and final hypothesis assumes that the correlation between returns on human capital and equity returns is positive during these severe economic contractions and is larger compared to periods of economic stability. The third hypothesis is split in two separate hypotheses:

Hypothesis 3A: The correlation between returns on human capital and equity returns is positive during severe economic downturns.

Hypothesis 3B: The correlation between returns on human capital and equity returns is larger during severe economic downturns compared to periods of economic stability.

3. Data and methodology

In chapter 3 the data and methodology are discussed. The purpose of this thesis is to determine the relationship between returns to human capital and equity returns. Furthermore, I test the effects of labor market flexibility and economic downturns on this correlation. Section 3.1 introduces the methodological approach used for this thesis. In Section 3.2 the variables and data are described. Finally, in Section 3.3 the methodology is explained in further detail.

3.1 Methodological approach

To empirically test the relationship between returns to human capital and equity returns, three different analysis are used. Firstly, I investigate the relationship between returns on human capital and equity returns by calculating the correlation between these variables on a country level. Data regarding human capital and equity returns were necessary to perform this analysis. For labor income the labor income of the period 1995-2020 was available, hence the period 1995-2020 is used. This is the approach to answer the first hypothesis.

After calculating country level correlations, a regression analysis is performed to test if the flexibility of the labor market has an effect on the country level correlation. The dependent variable is the country level correlation which was calculated to test the first hypothesis and cross-sectional data is used. Control variables added are level of education, different industries and social contributions. I run the Ordinary Least Squares (OLS) multiple linear regression model to determine the relationship between the dependent and independent variables. Robust standard errors are used to control for heteroskedasticity. This is the approach to answer the second hypothesis.

Finally, the effect of turbulent economic events on the correlation between returns on human capital and stock returns is investigated. To test the third and final hypothesis the correlation for periods of severe economic downturns is compared with the correlation on during periods of economic stability. A Fisher Z-transformation is used to transform the correlations into normally distributed variables. With the normally distributed correlations a Z-test is performed to test is the difference between correlations is significant.

This thesis is based on 25 countries located in Europe and North-America. The data is collected on an annual basis over the time period 1996 to 2020. An overview of all the countries used in this thesis can be found in Table A.1 of the Appendix.

3.2 Variables and data

3.2.1 Measure of returns on human capital

As returns on human capital are a central topic in this study, it is important to define these well. I follow the approach of Fama & Schwert (1977). They state that human capital is a nontradable asset. The dividend stream of human capital is the labor income. Due to human capital being a nontradable asset, there is no capital gain on human capital. Therefore, labor income represents the returns to human capital. The growth of the real aggregated wages of a country is calculated. To control for changes in population, the growth of the real aggregated wages is divided by the population.

Although aggregated labor income risk only accounts for around ten percent of the total variation in individual-level labor income (Campbell et al., 2001), I choose to use aggregated labor income due to data availability. For most of the countries analyzed in this thesis, there is no detailed database on individual-level income. Therefore, using aggregated labor income the uncertainty of the calculated returns is decreased.

The nominal quarterly wages were extracted from Eurostat for the years 1995 to 2020. As quarterly wages are subject to seasonality the sum of quarterly wages was taken to determine the nominal aggregated wages per year per country.

To calculate the real aggregated wages per year the nominal aggregated wages were corrected for inflation. The national consumer price index for each country gathered by the OESO was used to construct an index number for consumer prices per year for 25 countries. The year 1993 is used as the base year. The data on the consumer price indexes for Bulgaria, Romania and Cyprus were provided by the International Labour Organization (ILO) and Worldbank. For Bulgaria 2000 is used as the base year, for Romania 1996 and for Cyprus 1993. An overview of data availability per country can be found in Table A.2 of the Appendix.

To control for potential increases or decreases in the aggregated wages due to changes in population, the real aggregated wages are divided by the total population. This equals the aggregated wage per capita. The data on population was extracted from Eurostat. I chose to use data on total population instead of data on the total labor force due to reliability of the data. Estimations of the total labor force of each country are provided by the ILO but contain much uncertainty. Therefore, I work with the total population. To check for robustness of the final results, returns on human capital are calculated as well with the estimations of the labor force instead of total population in Section 4.4.

Finally, the annual return on human capital per country is calculated as follows:

$$Return\ on\ human\ capital\ of\ country\ i\ in\ \ year\ t = \frac{Real\ labor\ income\ per\ capita_t - Real\ labor\ income\ per\ capita_{\ t-1}}{Real\ labor\ income\ per\ capita_t} * 100\% \quad (3.2.1)$$

The distribution of the returns on human capital are displayed in Figure 2. The Shapiro-Wilk test is used to check for normality. The variable is tested for normality for each individual country and for all countries together. On a country level the returns to human capital are approximately normally distributed for 19 of the 25 countries. The hypothesis that the returns on human capital are normally distributed is rejected for Cyprus, Greece, Italy, Portugal, Spain and Switzerland. When taking all countries together, the hypothesis of normally distributed returns on human capital is rejected as well. The implication of the rejection of this hypothesis is that for these countries the significance of the correlation between returns to human capital and equity returns is determined by the Kendall correlation.

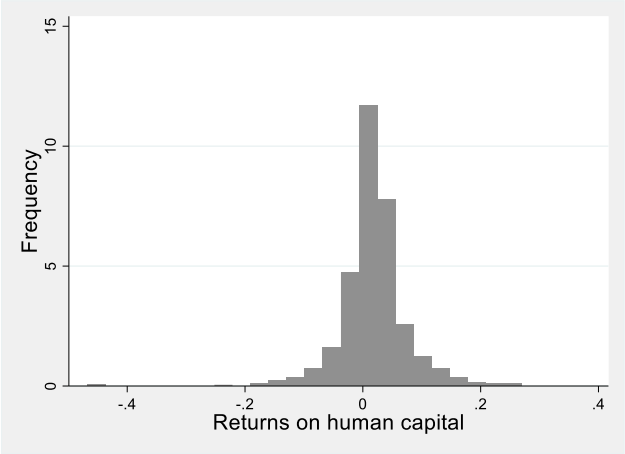

Figure 3: Distribution of human capital returns

3.2.2 Equity returns

In this thesis the equity returns used are returns on the domestic equity indices. As the equity home bias is quite persistent in most countries, domestic equity returns are more relevant to domestic investors. The equity home bias means that investors invest disproportionally into the domestic asset compared to what optimal portfolio theory predicts (Mishra, 2015). The equity return is calculated on an annual basis and is corrected for the domestic consumer price level.

The data on the return of domestic equity indices is extracted from Datastream. All returns are denoted in euros except for the United States, here the returns are measured in dollars. For several European countries the domestic currency is not the euro. However, the labor income data

from Eurostat is measured in euros for all countries and therefore equity returns are denoted in euros as well. The nominal annual stock return is calculated as follows:

$$Nominal\ annual\ stock\ return\ of\ country\ i\ in\ year\ t = \frac{Return\ index\ of\ year_t - Return\ index\ of year_t - 1}{Return\ index\ of year_t - 1} \quad (3.2.2)$$

To get real annual stock returns the nominal annual stock returns are corrected for inflation. The distribution of the annual stock returns is displayed in Figure 3. To check if the equity returns follow a normal distribution, the Shapiro-Wilk test was performed as well. For 22 of 25 countries the equity returns are approximately normally distributed. The hypothesis that the equity returns are normally distributed is rejected at a 5% significance level for Bulgaria, Cyprus and Finland. Furthermore, the hypothesis that the first and second lag of equity returns is normally distributed is rejected as well for the three above mentioned countries. When taking all countries together, the hypothesis of normally distributed equity returns and lags of these equity returns is rejected as well. The implication of the rejection of this hypothesis is that for these countries the significance of the correlation between returns to human capital and equity returns is determined by the Kendall correlation.

Figure 4: Distribution equity returns

3.2.3 Measure of the flexibility of the labor market

As wages tend to be more rigid than stock returns, the flexibility of the labor market is considered. More flexible labor markets tend to have less wage rigidity. Following prior research (e.g. Edmans, Li & Zhang (2014) two measures of labor flexibility are used. I use these measures to construct a measure for labor market flexibility.

The first measure is the OECD Employment Protection Legislation (EPL) index, which is available for 22 of the 25 countries. The EPL consists of 21 items which cover three areas: the protection of regular workers against individual dismissal (EPR), the regulation of temporary forms of employment (EPT) and additional requirements for collective dismissals (EPC). All items are scored between a zero and a six, with 0 meaning very little protection and 6 meaning strong protection of employees. A high score on EPL means low flexibility of the labor market.

To get to a weighted score for the EPL, I take the average of the annual scores on EPR, EPT and EPC. The score tends to not vary much over time. I transform the score to a 10-point scale to match it with the other measure of labor flexibility. After transforming it to a 10-point scale, I subtract this score from the optimal score 10. This way a higher score on the EPL index means higher labor market flexibility. To sum up the transformation, I used the formula 3.2.3.:

$$EPL_{scale10}\ score\ of\ country\ i = 10 - \frac{10 \cdot EPL_{scale6}}{6} \qquad (3.2.3)$$

The second measure is based on data provided by the Fraser Institute's Economic Freedom of the World (EFW). The measure is largely comparable to the EPL measure used but is measured on a scale of 1 to 10. A higher score indicates higher flexibility of the labor market and a lower score more rigid labor markets. It consists of six subcategories:

1) Category 5Bi: Hiring regulations and minimum wage
2) Category 5Bii: Hiring and firing regulations
3) Category 5Biii: Centralized collective bargaining
4) Category 5Biv: Hours regulations
5) Category 5Bv: Mandated cost of worker dismissal
6) Category 5Bv1: Conscription

The correlation between the EPL and EFW measure is 0.701 (Table B.3, Appendix) which indicates that the different measurements of the labor flexibility market are highly correlated. I take the average of the EPL and EFW scores to construct the variable for the flexibility of the labor market. The average of the EPL and EFW scores is abbreviated to FLM (flexibility labor market) The EPL, EFW and the FLM scores are tabulated in Table B.2 of the Appendix.

In Figure 4 a comparison of countries with relatively less flexible labor markets and relatively flexible labor markets is displayed. Returns on human capital are measured by the change in real annual labor growth per capita and the equity returns are measured by the real annual equity

returns. Greece and Luxembourg are countries with a relatively low FLM score, indicating a less flexible labor market in these countries. Whereas the United States and the United Kingdom are countries with a relatively high FLM score, indicating more flexible labor markets. The relationship between returns on human capital and equity returns seems almost nonexistent for the countries with relatively low flexibility of the labor market. When looking at the countries with a more flexible labor market, it seems that the relationship between returns on human capital and equity returns is slightly stronger for the United States and visibly stronger for the United Kingdom. However, the pattern seems unclear.

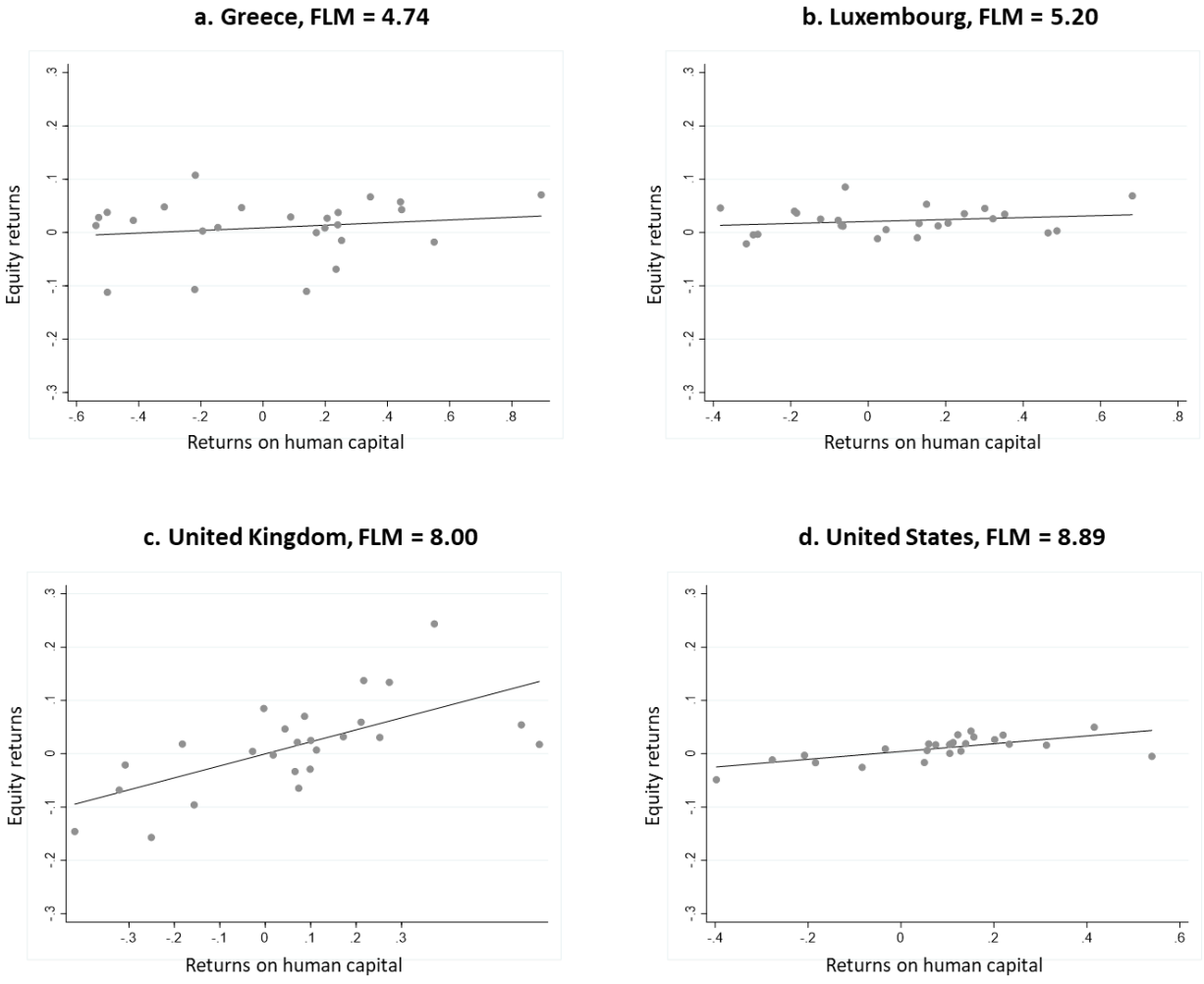

Figure 5: The impact of the flexibility of the labor market on a country level

To further extend the analysis, the countries were divided into four groups. The first group having the most flexible labor markets and the fourth group having the least flexible labor markets. The countries were categorized based on the values of a boxplot based on the FLM scores. The results are displayed below in Figure 6. When categorizing the countries, the relationship is less clear than in Figure 4. There is no obvious pattern visible anymore when the flexibility of the labor market decreases. However, countries with the least flexible labor markets seem to have the weakest

relationship between the returns to human capital and the equity returns. Taken together, the relationship between human capital and the flexibility of the labor market does not seem very different up to a certain level of labor flexibility. However, from a certain level of labor market flexibility the relationship between returns on human capital and equity returns weakens, indicating that the more rigid labor markets cannot react as fast as more flexible labor markets to economic events.

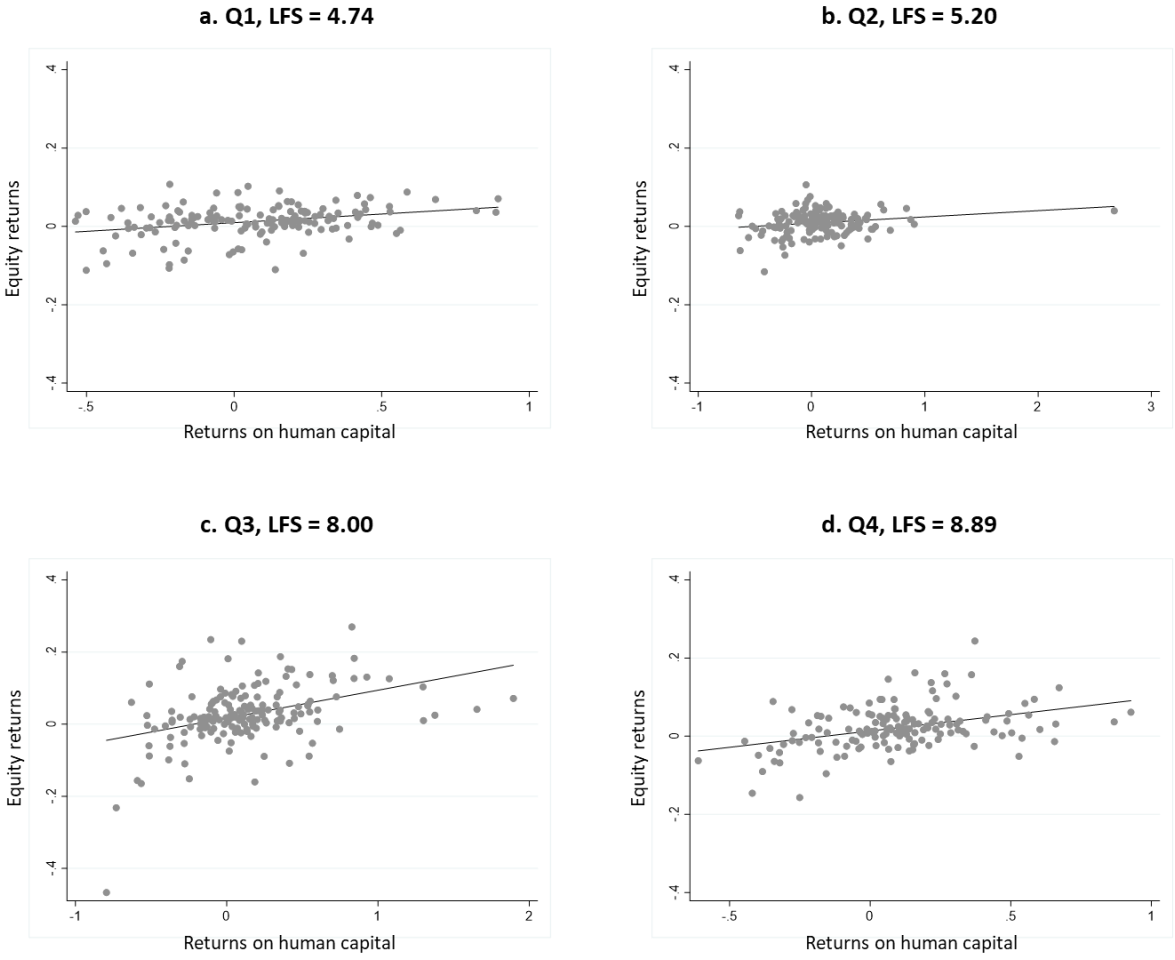

Figure 6: The impact of the flexibility of the labor market when categorizing countries

3.2.4 Other variables

3.2.4.1 Level of education

A variable that has an effect on labor income is the level of education in a country. Davis & Willen (2000a) and Campbell et al. (2001) found that the correlation of returns to human capital and equity

returns rises with level of education. To incorporate the level of education into the regression analysis as a control variable, the percentage of 25-64 years old that obtained tertiary education is added into the analysis. This data is gathered from the OECD database on educational attainment. Tertiary education is all education that exceeds the basic education, it incorporates education focused on theory (e.g. research programmes) and education that focuses on entry of the labor market.

3.2.4.2 Labor income risk

Labor income risk is considered as well. If labor income is riskier, this crowds out the demand for the risky asset (Cocco et al., 2005). Therefore, agents which are subject to riskier labor income invest a smaller proportion of their financial wealth in stocks. Taken this into account, I should control for the riskiness of labor income. I define labor income risk as the potential downside risk of labor income due to industry related events. Furthermore, the level of social security is taken into account as well as this is a proxy for the level of potential income when unemployed.

The riskiness of labor income can vary throughout each economic sector. For example, Campbell et al. (2001) show that employees active in the agriculture have higher variance of labor income shocks than workers in other industries. To control for the variation due to differences in the structure of the labor market, the relative size of each major economic sector for each country is estimated. To determine this, the percentage of employees active in each major economic sector is calculated. This data is provided by the International Labour Organization (ILO). The ILO estimates the total amount of paid employment or self-employment categorized by economic activity on an annual basis. I take into account the following sectors:

1) Agricultural
2) Industry
3) Market services
4) Public sector

For every sector the percentage of the total labor market is calculated on a yearly basis over the period 1996-2019. As the percentage for each sector does not differ largely over time for each country, the average is calculated for each country. The summary statistics of the relative size of each sector is presented below in Table 1. The agricultural sector is by far the smallest sector, accounting on average for 6.30% of the total employment in a country. The market services sector is on average the dominant sector, accounting for more than one third, 38.33%, of the total employment. However, for all the economic sectors the spread between countries is quite large. This indicates that the structure of the economy differs for the investigated countries. To further investigate labor

income risk, the percentage of GDP spend on social contributions is considered as well. This data is provided by the OECD.

Table 1: Summary statistics economic sectors

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Agricultural sector	25	6.30	6.57	1.32	32.30
Industrial sector	25	25.76	5.60	16.24	39.30
Market services sector	25	38.33	5.09	23.06	46.38
Public sector	25	24.34	5.50	12.88	34.00

3.2.5 Summary statistics

In Table 2 the summary statistics are provided for the measures of equity return, returns to human capital, the flexibility of the labor market (FLM) based on data of the OECD Employee Protection Legislation index and Fraser Institute's Economic Freedom of the World, the percentage of GDP spend on social contributions and the percentage of the working population[3] who followed tertiary education. For the flexibility of the labor market, social contributions and level of education the cross-sectional data is provided.

The average equity returns measured over all countries is 9.5% and is similar to average 9.7% equity returns on small cap companies. Small cap company stocks are usually perceived as riskier, the standard deviation of equity returns on small cap companies is larger compared to the standard deviation of equity returns for the country indices. However, the standard deviations are quite similar.

When comparing returns to human capital based on total population to returns on human capital based on labor force, the difference seems minimal. The average 1.8% return on human capital based on total population is slightly larger than the average 1.6% return on human capital based on labor force. The standard deviations are similar as well. When comparing the returns on human capital with equity returns, the variation of the returns on human capital is much smaller than the variation

[3] The working population consists of everyone between 15 and 64 years old.

in equity returns. This is in line with usual statements that equity returns are more volatile, and therefore riskier, than returns on human capital.

When looking at the flexibility of the labor market, there is a large spread between countries. This implies that the sample contains countries with relatively flexible labor markets and countries with relatively rigid labor markets. The country with the most flexible labor market is the United States with an FLM 8.888 and the country with the least flexible labor market is Greece with an FLM of score of 4.577. This large variation between countries is also visible for social contributions. The average amount of GDP spend on social contributions is 10.742%. Denmark is the country that spends the least on social contributions with only 0.147% of GDP spent. This is remarkably low compared to other OECD countries. France spends 16.265% of GDP on social security making it the country that spends the largest percentage of GDP on social contributions. Lastly, the level of education differs among countries. However, an untabulated, trend is the increasing percentage of the working population that has followed tertiary education. This trend is visible for all countries. The average percentage of the working population that has followed tertiary education is 28.586%. The country with the lowest level of education, 13.770% of the working population has followed tertiary education, is Italy. The country with the highest level of education, 40.420% of the working population has followed tertiary education, is the United States.

Table 2: Descriptive statistics

Variable	Observations	Mean	Standard deviation	Minimum	Maximum	Unit
Equity return	655	0.095	0.342	-0.795	2.672	Percentage
Equity return – small cap	406	0.097	0.348	-0.691	2.047	Percentage
Returns to human capital - population	613	0.018	0.057	-0.467	0.270	Percentage
Returns to human capital – labor force	613	0.016	0.056	-0.462	0.302	Percentage
FLM	25	6.280	0.980	4.739	8.888	Score
EPL	22	6.062	1.007	4.577	8.631	Score
EFW	25	6.447	1.157	4.479	9.144	Score
Social contributions	25	10.742	4.030	0.147	16.265	Percentage
Education	25	28.586	7.920	13.770	40.420	Percentage

3.3 Correlation

3.3.1 Country level correlations

To test the hypotheses the correlation between labor income growth and annualized stock returns is calculated. The correlation is calculated per country on a yearly basis. I use the full sample (1995-2020) to calculate the correlation.

The regular correlation method used in most research is the Pearson correlation. Two assumptions of the Pearson correlation are normality in observed variables and a linear relationship between the two variables. The Pearson correlation is the most commonly method used to calculate a correlation coefficient. As mentioned in section 3.2, the returns on human capital and equity returns are for most countries normally distributed. However, for eight countries (Bulgaria, Greece, Finland, Italy, Portugal, Spain and Switzerland) at least one of these variables is not normally distributed. Furthermore, when taking all countries together none of the variables are approximately normally distributed. As Nunnaly (1967) points out, the basic assumptions of the Pearson correlation have to be met when considering statistical significance of the correlation. Therefore, the Kendall correlation is calculated as well. The Kendall correlation is a non-parametric test that does not set any requirements regarding the distribution of the data. To compare my results to results found in other papers, both the Pearson and Kendall correlation are calculated but the Kendall correlation is used to determine if the correlation between returns on human capital and equity returns are statistically different from zero for the eight countries where the assumption of normally distributed variables cannot be met.

As Bottazzi, Pesenti & Van Wincoop (1996) point out, wages react with some time lag to rises in profit. To account for this wage rigidity, the correlation between returns on human capital and equity returns is also calculated for the first and second lag of annualized stock returns. This could imply that wages react one or two years later to certain economic events compared to equity returns or that changes in wages are spread more evenly over the years after an economic event than equity returns. This is in line with prior research done by Campbell et al. (2001). Furthermore, the correlation between labor income growth and stock returns is also used as the dependent variable in the regression analysis. To estimate this effect also over a longer period of time, the sum of the correlation coefficients to t-2 is also used.

3.3.2 The effect of flexible labor markets

To see if the flexibility of the labor market can explain cross-country differences, a regression analysis is performed. The regression method used is the Ordinary Least Squares (OLS) multiple linear regression as the relationship between the dependent and independent variables seems to be linear.

The independent variable is the flexibility of the labor market and the control variables are level of education, different industries and social contributions.

This leads to the following regression model:

$$Corr\ (R_{HC}, R_E) = \beta 1 * Flexibility\ of\ the\ labor\ market + \beta 2 * Education + \beta 3 * Agriculture + \beta 4 * Industry + \beta 5 * Market\ services + \beta 6 * Public\ sector + \beta 7 * Social\ contributions + \varepsilon \quad (3.2.4.)$$

The independent variable is the correlation between the returns on human capital (R_{HC}) and the equity returns. The regression is run for the contemporaneous correlation, the correlation with the first lag of equity returns, the sum of the contemporaneous correlation and the correlation with the first lag of equity returns and the sum of the contemporaneous correlation, the correlation with the first lag and second of equity returns. These independent variables are approximately normally distributed, which is one of the assumptions of multiple linear regression. The correlation between returns on human capital and the second lag of equity returns is not normally distributed and therefore no regression on this variable is run. The magnitudes of the correlations are obtained in Section 4.1.

The flexibility of the labor market is measured by the constructed FLM score mentioned in Section 3.2.3, the score is measured on a 10-point scale. The higher the FLM score, the more flexible the labor market. The different industries variables ($Agriculture$, $Industry$, $Market\ services$ and $Public\ sector$) are estimates of the average percentage of the employed labor force over the period 1996 – 2020 working in those industries. $Social\ contributions$ are measured by the average percentage of GDP spend on social contributions over the period 1996 – 2020. To control for heteroskedasticity, robust standard errors are used in all regression models. The variables are tested on multicollinearity by computing the Variance Inflation factor (VIF), only the industry variables show signs of multicollinearity. However, as the industry variables are control variables this is not an issue.

3.3.3 The effect of economic downturns

The third hypothesis tests the effect of economic downturns. Labor income tends to be more rigid as is usually subject to restrictive labor laws. During severe economic downturns the demand for labor usually decreases rapidly. To check if this affects the relationship between returns to human capital and equity returns, the correlation between these two variables is calculated again for both the periods of no economic downturns and for the periods with economic downturns. Finally, the correlation coefficients are transformed with the Fisher-Z transformation and compared to each

other to draw a conclusion about the effect of economic downturns on the correlation between returns on human capital and equity returns.

To define the severe economic downturns, I follow the description of a recession defined by the National Bureau of Economic Research (abbreviated NBER). They define it as “a significant decline in economic activity that is spread across the economy and that lasts more than a few months” (NBER, 2020). The NBER have listed the US recessions since 1854. For the period 1996-2020 the following periods are marked as recession periods in the US area:

- First quarter 2001 – Fourth quarter 2001: The dot com bubble
- Fourth quarter 2007 – Second quarter 2009: The Great Recession
- First quarter 2020 – ongoing: The COVID-19 crisis

The Centre for Economic Policy and Research (abbreviated CEPR) created a similar list for the euro area ranging from 1970 and onwards (CEPR, 2020). For the period of 1996-2020 the following periods are marked as recession periods:

- First quarter 2008 – Second quarter 2009: The Great Recession
- Third quarter 2011 – First quarter 2013: The European Sovereign Debt Crisis
- Fourth quarter 2019 – ongoing: The COVID-19 crisis

When comparing the recession periods in the U.S. and the euro area, there are two recessions that affected both the American as the European economy: The Great Recession and the COVID-19 crisis. Furthermore, the dot com bubble mainly affected the U.S. and the Sovereign Debt Crisis affected mainly Europe. Therefore, I investigate the effect of economic downturns separately for the U.S. and Europe.

I presume that financial markets are forward looking and anticipate severe economic downturns. Furthermore, I assume that labor markets tend to react to the recession after the peak. I take out all data 6 months prior to the peak of the recession and I take out all data 2 years following the through date. This is summarized per recession in Table 3.

Table 3: Periods of recessions in United States and Europe that were deleted to answer hypothesis 3

Recession	Deleted data for each recession per location	
	United States	*Europe*
Dot com bubble	2000 – 2003	-
The Great Recession	2007 – 2011	2007 – 2011
The European Sovereign Debt Crisis	-	2011 – 2014
COVID-19 Crisis	2019 – 2020	2019 – 2020

To normalize the distribution of the correlation, the Fisher Z-Transformation is used (Fisher, 1921). Then a Z-test is performed to test if the difference between the correlation during severe economic downturns is stronger than during periods of economic stability. The following formula estimates the Z-score:

$$Z = \frac{\left(\frac{1}{2}\ln\frac{1+r_D}{1-r_D}\right)-\left(\frac{1}{2}\ln\frac{1+r_S}{1-r_S}\right)}{\sqrt{\frac{1}{n_1-3}+\frac{1}{n_2-3}}} \qquad (3.2.5.)$$

4. Results

In this section the results are discussed. In section 4.1 the country level correlations are calculated to see test if the relationship between the returns on human capital and stock returns are zero. In section 4.2 the effect of the flexibility of the labor market on the country level correlation is estimated. In section 4.3 the effect on economic downturns is estimated. Finally, in section 4.4 some robustness checks are performed.

4.1 Country level correlations

To estimate the correlation between the returns on human capital and equity returns, the Pearson and Kendall correlation are used as measures of correlation. The Kendall correlation is a non-parametric correlation where no requirements are set for the distribution of the variables. The Pearson correlation is the most commonly used form of correlation. The Pearson correlation has more strict requirements regarding the distribution of the data. Guilford & Fruchter (1973) point out that there is no problem in not meeting all the basic assumptions of the Pearson correlation to still draw conclusions about the magnitude of the correlation. However, when considering statistical importance of the Pearson correlation, the basic assumptions should be met (Nunnaly, 1967). Therefore, the Kendall correlation is used in determining the statistical value of the correlations of the countries that do not meet the requirements of approximately normally distributed variables.

In Table 4 the results for the Pearson correlation are tabulated for all countries and in Table 5 the results for the Kendall correlation are tabulated for the countries that do not meet the assumption of normally distributed data. What is clear for Table 4 is that when taking all countries together, the correlation is 0.1995 and this is positive and statistically different from zero. However, the correlation decreases to 0.1647 when taking the first lag of equity returns and decreases further to 0.1292 when taking second lag of equity returns. Although de correlation decreases when taking lags of equity returns, the correlation is still positive and statistically different from zero. When comparing these results to the magnitude of the Pearson correlations, the same conclusion is drawn. The correlation decreases from 0.3380 to 0.1714 and when taking the second lag to 0.1386. The decrease from equity returns of the same year to taking the first lag is larger compared to the drop in the correlation coefficient using the Kendall correlation. When taking lags of equity returns of more two years, both the Kendall correlation as the Pearson correlation becomes insignificant. As these results do not add anything to the previous results, the results for lags further back than two years are not tabulated.

Together, this indicates that the relationship between aggregate labor income and equity returns is strongest when looking at the returns of the same year, but labor income still tends to

move in the same direction as historical equity returns. This implies that, for example, a major stock market crash is usually paired with a decrease in returns on human capital for the following two years.

When looking at the individual countries, the same relationship is visible. 18 of 25 countries have at least one correlation coefficient that is statistically different from zero. However, for two third of these 18 countries, the correlation between returns on human capital and the equity returns of the same year is significant. The number of countries with a significant correlation coefficient decreases when taking the first and second lag of the equity returns. What is noteworthy is that every significant correlation is positive, indicating a positive relationship between returns on human capital and equity returns. For robustness the Kendall correlation is calculated for all countries, the results are tabulated in Table C.1 of the Appendix. As expected with non-parametric tests the magnitude of the correlation compared to the Pearson correlation shrinks, but the significance of the coefficients stays the same for almost every individual country. Furthermore, the correlation is also calculated for the growth of aggregated labor income without correcting for population. This does not affect the results.

Table 4: Pearson correlation between the growth of the real labor income per capita and the real annual stock return. P- values are denoted in brackets.

Country	$Corr(RHC_t, RE_t)$	$Corr(RHC_t, RE_{t-1})$	$Corr(RHC_t, RE_{t-2})$
All countries	*0.3380*** (0.0000)*	*0.1714*** (0.000)*	*0.1383*** (0.0006)*
Austria	0.0958 (0.6486)	0.4702** (0.0177)	0.2709 (0.1902)
Belgium	0.0437 (0.8356)	0.3800* (0.0610)	0.2886 (0.1618)
Bulgaria[1]	0.4539* (0.0509)	0.1788 (0.4778)	0.1555 (0.5512)
Cyprus[1]	0.2028 (0.3308)	0.2654 (0.1998)	0.1628 (0.4367)
Czechia	0.5441*** (0.0049)	0.0805 (0.7021)	0.3821* (0.0654)
Denmark	0.0694 (0.7417)	0.4216** (0.0358)	0.3066 (0.1360)
Finland[1]	0.4865** (0.0137)	0.3178 (0.1216)	0.1230 (0.5579)
France	0.4561** (0.0219)	0.3056 (0.1374)	0.3381* (0.0983)
Germany	0.0747 (0.7227)	0.2403 (0.2472)	0.1108 (0.5980)
Greece[1]	0.1669 (0.4253)	0.2258 (0.2778)	0.1913 (0.3598)
Hungary	0.1868 (0.3714)	0.0700 (0.7394)	-0.2094 (0.3152)
Ireland	0.2793 (0.1763)	0.3926* (0.0522)	0.2601 (0.2092)
Italy[1]	0.1846 (0.3771)	0.1490 (0.4773)	0.1325 (0.5277)
Luxembourg	0.2006 (0.3362)	0.2312 (0.2661)	0.4306** (0.0316)
Netherlands	-0.0457 (0.8284)	0.3575* (0.0793)	0.2571 (0.2147)
Norway	0.5847*** (0.0021)	0.2551 (0.2184)	0.1649 (0.4308)
Poland	0.5824*** (0.0023)	0.2066 (0.3218)	-0.1434 (0.5039)
Portugal[1]	0.2235 (0.2829)	0.1413 (0.5006)	0.1929 (0.3555)
Romania	0.5401*** (0.0078)	0.2051 (0.3599	0.3049 (0.1790)
Slovenia	0.5074** (0.0189)	0.4635** (0.0396)	0.2651 (0.2727)
Spain[1]	0.3743* (0.0653)	0.3654* (0.0724)	0.2941 (0.1535)
Sweden	0.6901*** (0.0001)	-0.1423 (0.4974)	0.1960 (0.3478)
Switzerland[1]	0.1341 (0.5226)	0.0324 (0.8778)	-0.0319 (0.8797)
United Kingdom	0.6517*** (0.0004)	0.1391 (0.5072)	0.1323 (0.5284)
United States	0.6605*** (0.0003)	0.4026** (0.0460)	0.3060 (0.1369)

*** p < 0.01, ** p < 0.05, * p < 0.1

P-values denoted in parentheses.

RHC_t = the returns on human capital during period t

RE_{t-i} = returns on equity during period t-i

1) As at least one of the variables is not normally distributed for these countries, no statements can be made about the significance of the Pearson correlation coefficient.

Table 5: Kendall correlation between the growth of the real labor income per capita and the real annual stock return.

Country	$Corr(RHC_t, RE_t)$	$Corr(RHC_t, RE_{t-1})$	$Corr(RHC_t, RE_{t-2})$
All countries	*0.1995*** (0.0000)*	*0.1647*** (0.0000)*	*0.1292*** (0.0000)*
Bulgaria	0.3216* (0.0589)	0.0327 (0.8796)	0.1176 (0.5366)
Cyprus	0.1333 (0.3624)	0.1533 (0.2933)	0.0467 (0.7614)
Finland	0.3333** (0.0208)	0.3533** (0.0142)	0.0933 (0.5283)
Greece	0.1200 (0.4137)	0.1400 (0.3383)	0.0467 (0.7614)
Italy	0.1467 (0.3153)	0.2267 (0.1176)	0.1667 (0.2525)
Portugal	0.1267 (0.3875)	0.1467 (0.3153)	0.1067 (0.4691)
Spain	0.2667* (0.0650)	0.3667** (0.0109)	0.2800* (0.0526)
Switzerland	-0.0600 (0.6913)	-0.0933 (0.5283)	0.1133 (0.4409)

*** p < 0.01, ** p < 0.05, * p < 0.1

P-values denoted in parentheses.

RHC_t = the returns on human capital during period t

RE_{t-i} = returns on equity during period t-i

What is clear from this section, is that the correlation between returns on human capital and returns on stock is positive and statistically different from zero. The correlation is strongest for the stock returns of the same year and decreases when taking the lag of the stock return. However, cross country differences in the correlation are visible. In the next section I investigate if the level of labor market flexibility can explain these cross-country differences.

4.2 Relationship between the country level correlation and flexibility of the labor market

In the previous section the correlation between returns on human capital and stock returns was calculated. The correlation measured over all countries is positive and significant. However, cross country differences are present. In this section the effect of flexibility of the labor market on the correlation is estimated.

The OLS regression of equation 3.2.4 is run on several correlations the and sum of correlations. The aim of this regression is to test if more flexible labor markets exhibit a stronger relationship between returns on human capital and equity returns. The Pearson correlation is used to perform the OLS regression. The results with the Kendall correlation can be found in the robustness test section.

In Table 6 the results of the regression analysis on the five different dependent variables are tabulated. The flexibility of the labor market measured by FLM is not significant in all four regressions, implying that the flexibility of the labor market has no effect on the relationship between returns on human capital and equity returns. The level of education has a significant positive effect on the relationship between returns on human capital and equity returns in all regressions. This is in line with previous research by Davis & Willen (2000a) and Campbell et al. (2001). A possible explanation is that a higher level of education results in more skilled employees. Davis & Willen (2001) argue, based on labor demand studies, that skilled employees are a complement to physical capital and intangible assets. Furthermore, the value of a company is determined by its assets. Assets are both physical and intangible assets like intellectual assets and technologies. More skilled employees could imply a higher value of human capital embedded in the company, which raises the equity value of the company. If the level of education drops, the equity value of the company drops. This explains the positive effect of higher level of education within a country on the relationship between returns on human capital and equity returns. Another possible explanation is that educated agents tend to work in industries that are more correlated with the business cycle. However, this is not investigated in this thesis.

The variables used to measure labor income risk have no significant coefficients. On an aggregated level the structure of the economy does not seem to have an effect on the relationship between returns on human capital and equity returns. However, in this research only countries in Europe and North-America are considered. The structure of the economy could be more homogenous as the countries are geographically located near each other and there are few emerging markets analyzed.

Table 6: Cross-sectional regression analysis, dependent variable: Pearson correlation between the returns on human capital and equity returns.

Variables	(1)	(2)	(3)	(4)
Flexibility of the labor market	0.142 (0.088)	-0.077 (0.049)	0.065 (0.082)	-0.008 (0.110)
Education	0.020* (0.010)	0.016*** (0.005)	0.036*** (0.010)	0.041** (0.014)
Agriculture	-0.047 (0.050)	0.039 (0.031)	-0.008 (0.045)	-0.023 (0.058)
Industry	-0.064 (0.057)	0.051 (0.037)	-0.014 (0.057)	-0.007 (0.079)
Market services	-0.104 (0.065)	0.055 (0.042)	-0.049 (0.060)	-0.037 (0.084)
Public sector	-0.067 (0.058)	0.026 (0.034)	-0.041 (0.050)	-0.046 (0.065)
Social contributions	0.020 (0.019)	-0.005 (0.018)	0.015 (0.015)	0.011 (0.023)
Constant	6.264 (5.168)	-3.940 (3.193)	2.323 (4.815)	2.425 (6.526)
Number of countries	*22*	*22*	*22*	*22*
R-squared	*0.382*	*0.301*	*0.529*	*0.350*

*Robust standard errors are denoted in parentheses. * P-value < 0.1, ** P-value < 0.05 and *** P-value < 0.01*

The regression analysis is performed with 4 different independent variables:

1) The contemporaneous Pearson correlation between returns on human capital and equity returns.
2) The Pearson correlation between returns on human capital and the first lag of equity returns.
3) The sum of the contemporaneous Pearson correlation between returns on human capital and equity returns and the Pearson correlation between returns on human capital and the first lag of equity returns.
4) The sum of the contemporaneous Pearson correlation between returns on human capital and equity returns and, the Pearson correlation between returns on human capital and the first lag of equity returns and the Pearson correlation between returns on human capital and the second lag of equity returns.

To summarize, the effect of the flexibility of the labor market is not proven to have a significant effect on the correlation between returns on human capital and equity returns. In line with previous research education seems to have a positive effect on the correlation.

4.3 The effect of economic downturns

In this paragraph the effect of economic downturns on the correlation between returns on human capital and equity returns is investigated. As discussed in section 3.3.3 data the correlation will be calculated for the periods with no recessions and for the periods with recessions. Then the correlations are compared to draw a conclusion about the effect of severe economic downturns on the correlation between returns on human capital and equity returns.

First a Shapiro-Wilk test is performed for the variables returns on human capital, equity returns, first lag of equity returns and second lag of equity returns. The test is performed again as the period of no recessions and period of recessions are shorter than when taken together. The hypothesis that the data is normally distributed in rejected at a 5% significance level for the regions Europe and the Euro area. This violates the assumption that the data is approximately normally distributed of the Pearson correlation. Therefore, the Kendall correlation is calculated as well. In Table 7 the Pearson correlations for three regions (United States, Europe and the Euro area) are tabulated and in Table 8 the Kendall correlations for the three regions. The statistical significance of the correlation estimated by the Pearson and Kendall correlation does not differ extremely for all regions.

Table 7: Pearson correlation between returns on human capital and the equity returns for different regions measured over several periods. Also a Z-test is performed after transforming the correlations using Fisher's Z transformation. P-values are denoted in brackets.

Region	Period	(1)	(2)	(3)
United States	No recessions	0.6293** (0.0159)	0.1255 (0.1556)	0.3014 (0.2950)
		N = 14	*N = 14*	*N = 14*
	Recessions	0.5301* (0.0935)	0.3147 (0.3459)	0.1552 (0.6487)
		N = 11	*N = 11*	*N = 11*
Fisher Z-test	$\rho_{REC} = \rho_{NO\_REC}$	Z = -0.323	Z = 0.430	Z = -0.333
Europe[1]	No recessions	0.2569*** (0.0000)	0.1255** (0.0197)	0.1263* (0.0199)
		N = 348	*N = 345*	*N = 340*
	Recessions	0.3893*** (0.0000)	0.1943*** (0.0025)	0.1273** (0.0488)
		N = 240	*N = 240*	*N = 240*
Fisher Z-test	$\rho_{REC} > \rho_{NO\_REC}$	Z = 1.756**	Z = 0.836	Z = 0.012
Euro area[1]	No recessions	0.0415 (0.5533)	0.1448** (0.0383)	0.1696** (0.0153)
		N = 206	*N= 205*	*N = 204*
	Recessions	0.2743*** (0.0011)	0.3498*** (0.0000)	0.1761** (0.0374)
		N = 140	*N = 140*	*N = 140*
Fisher Z-test	$\rho_{REC} > \rho_{NO\_REC}$	Z = 2.17***	Z = 1.982**	Z = 0.060

*** p < 0.01, ** p < 0.05, * p < 0.1

(1) As at least one of the variables is not normally distributed for these countries, no statements can be made about the significance of the Pearson correlation coefficient.

The following correlations are estimated: (1) corr(human capital t, equity returns t), (2) corr(human capital t, equity returns t-1) and (3) corr(human capital t, equity returns t-2)

Table 8: Kendall correlation between returns on human capital and the equity returns for different regions measured over several periods. P-values are denoted in brackets.

Region	Period	(1)	(2)	(3)
United States	No recessions	0.4066** (0.0487)	0.2527 (0.2284)	0.2747 (0.1889)
		N = 14	*N = 14*	*N = 14*
	Recessions	0.4545* (0.0617)	0.3455 (0.1611)	0.0909 (0.7555)
		N = 11	*N = 11*	*N = -0.411*
Fisher Z-test	$\rho_{REC} > \rho_{NO\_REC}$	Z = 0.127	Z = 0.413	Z = 0.012
Europe	No recessions	0.1200*** (0.0008)	0.1191*** (0.0010)	0.1285*** (0.0004)
		N = 348	*N = 345*	*N = 340*
	Recessions	0.2575*** (0.0000)	0.1911*** (0.0000)	0.1074** (0.0133)
		N = 240	*N = 240*	*N = 240*
Fisher Z-test	$\rho_{REC} > \rho_{NO\_REC}$	Z = 1.693**	Z = 0.873	Z =-0.252
Euro area	No recessions	-0.0108 (0.8193)	0.1228*** (0.0089)	0.1645*** (0.0005)
		N = 206	*N= 205*	*N = 204*
	Recessions	0.1901*** (0.0009)	0.2857*** (0.0000)	0.1533*** (0.0072)
		N = 140	*N = 140*	*N = 140*
Fisher Z-test	$\rho_{REC} = \rho_{NO\_REC}$	Z = 1.838**	Z = 1.540*	Z = -0.104

*** p < 0.01, ** p < 0.05, * p < 0.1

The following correlations are estimated: (1) corr(human capital t, equity returns t), (2) corr(human capital t, equity returns t-1) and (3) corr(human capital t, equity returns t-2)

What is quite surprising is that for the United States the contemporaneous correlation decreases during times of recession. However, this is not statistically different. For Europe the contemporaneous correlation is significantly higher during times of recession, this indicates that during severe economic downturns the relationship between returns on human capital and equity returns strengthens. Due to the severeness of the recession, labor demand could decrease largely and fewer bonusses are paid which could result in lower returns to human capital during times of recession. The same relationship is visible when calculating the correlation of only the Euro area. The results seem robust when using the Kendall correlation. Furthermore, when varying the reaction time of the labor market to one year, the results do not change.

Based on the above-mentioned results, it seems that the relationship between returns on human capital and equity returns is stronger during severe economic downturn. Implying that during severe economic downturns the financial wealth and human capital of an agent diminishes. This could have an effect on the consumption of the agent. However, cross-country differences are present and these results are based on limited amount of data. Therefore, these results should

foremostly give an incentive to further investigate the magnitude of the relationship between human capital and equity returns over the business cycle and the implications this has on household asset allocation.

4.4 Robustness tests

4.4.1 Country level correlations

Using small cap returns instead of equity indices

The country level correlations represent the relationship between the aggregated labor income growth per capita and the equity returns based on a country's index. However, the existence of multinational companies could skew this relationship. As Siegel (1998) points out, a proportion of the publicly traded firms could be multinational companies. For these companies the world economy is more important than the national economy, as they operate in several countries. To check if the presence of multinational companies skews the results, the earlier calculated equity returns are replaced for the real annual equity returns of small cap firms. The MSCI small cap return index was used to calculate the annual equity return of small cap firms using the same method used to calculate the real equity returns in Section 4.1. I assumed that small cap firms tend to operate more nationally instead of internationally, therefore controlling for multinational activity.

When performing the Shapiro-Wilk test the hypothesis that returns on human capital and equity returns are approximately normally distributed is rejected at a 5% significance level for the following countries: Greece, Hungary, Italy, Portugal, Spain and Switzerland. For these countries, conclusions about the significance of the correlation are drawn based on the Kendall correlation. For all other countries the significance of the correlation is based on the Pearson correlation. As data was not available for Bulgaria, Cyprus and Luxembourg these countries are not tabulated.

In Table C.2 of the Appendix the Pearson correlations are displayed for every country and in Table C.3 of the Appendix the Kendall correlations are displayed for the countries that did not meet the assumption of normally distributed returns on human capital or equity returns. When comparing these results with the results obtained in Section 4.1, the same results seem to hold. The Kendall correlation for all countries is positive and significant but decreases when taking lags of equity returns. The magnitude decreases faster than in Table 4.1. On an individual country level the magnitude of the correlation does change, but the statistical significance stays roughly the same. Based on these results the correlation between returns on human capital and equity returns is still statistically different from zero.

Dividing aggregated labor income by labor force instead of total population

To check for differences in the measurement of returns on human capital, I compute the correlations for returns on human capital where the aggregated labor income is divided by the total labor force instead of total population. As the growth of labor income divided by total population and the growth of labor income divided by total labor force is highly correlated for all countries (Table C.4, Appendix), I'd expect that the results of Section 4.1 hold.

When comparing the correlation coefficients, this expectation is true. The magnitude of the correlation coefficients between returns on human capital and equity returns is roughly the same as in Section 4.1 Furthermore, the significance of the individual correlation coefficients only changes slightly. Previously, 18 out of 25 countries exhibited at least one significant correlation coefficient. When changing the labor income per capita to labor income divided by labor force, 17 out of 25 countries exhibit at least one significant correlation coefficient (Table C.5 and Table C.6, Appendix).

4.4.2 Effect of flexibility of the labor market

Using a different measure of the independent variable

In Section 4.2 the flexibility of the labor market did not have an effect on the correlation between returns on human capital and equity returns. The level of education did have a positive significant effect in all regression models. To check the robustness of these results the same regression results were performed with the Kendall correlation as dependent variable. Robust standard errors were used to control for heteroskedasticity. Table E.1 of the Appendix tabulates these results.

The results of Section 4.2 do not change. The coefficient of the flexibility of the labor market is not significant in all models. The effect of education diminishes slightly when compared to the previous results. However, the level of education stays significant in three of the four regression models indicating that the level of education does have a positive effect on the relationship between returns on human capital and equity returns.

Using different measures of the dependent variables

In the regression models of Section 4.2 the measure of the flexibility of the labor market is an average of the EPL and EFW score. When substituting the combined measure FLM with first EPL and then EFW, the results differ. In Table D.2 of the Appendix the results for the measure EPL are tabulated. The effect of the flexibility of the labor market measured by the EPL score on the contemporaneous correlation is positive and significant. However, when taking the correlation with the first lag of equity returns, the flexibility of the labor market has a significant negative effect on the correlation between returns on human capital and equity returns. This could imply that, with this measure of labor flexibility, the labor market "overreacts" by first lowering wages (or firing employees) and the year after raising wages (or hiring employees) again. When taking the sum of the correlations over various periods, the significance of the flexibility of the labor market has disappeared which is in line with the results in Section 4.2. The level of education is positive and significant in most of the regression models which is in line with the previous results found. When using the EFW score as the measure of the flexibility of the labor market (Table D.3, Appendix), the results are quite similar to the results in Section 4.2. Altogether, the results found in section 4.2 seem to be robust.

5. Conclusion and discussion

In this final section the overall conclusion of this thesis is discussed. In section 5.1 the main findings of this thesis are discussed. In section 5.2 the limitations of this research are presented. Finally, section 5.3 concludes with the recommendations on future research in this research area.

5.1 Main findings

Optimal portfolio choice theory has been a topic of ongoing research. Since the 1970s the importance of incorporating human capital in the optimal portfolio choice has been stressed by several well-known authors (e.g. Bodie et al., 1992). As labor income risk can crowd out the demand for the risky asset, the correlation between returns to human capital and equity returns plays a vital role in solving for the optimal share in the risky asset for the individual investor. However, the current literature provides contradicting evidence for the sign and magnitude of this correlation. Furthermore, the current literature mainly focuses on the correlation in the United States and the correlation until the 1990s. Therefore, the objective of this thesis was as follows:

What is the relationship between the aggregated returns on human capital and equity returns in Europe and the United States over the period 1995-2020 and what are the determinants of this relationship?

To answer this research question three main hypotheses were formulated. The first hypothesis considered the sign and magnitude of the correlation between returns to human capital and equity returns. Taken all countries together, the results indicate a significant and positive correlation which support Hypothesis 1. This correlation is significant and positive for the contemporaneous correlation, the correlation with the first and second lag of equity returns. However, the correlation decreases when taking lags of equity returns. Moreover, country-level differences of the magnitude and significance of the correlations are visible. Out of 25 countries, 18 countries display for at least one significant positive relationship between the returns on human capital and equity returns. The results are robust to taking a different measure of equity returns. However, these results also contradict existing literature on the topic (e.g. Fama & Schwertz (1977); Bottazzi et al., 1996; Davis & Willen, 2000a). What is surprisingly about these results is that the methodology used is similar to Fama & Schwertz (1977) and Bottazzi et al. (1996), yet I find contradicting results. A possible explanation is that I used a different period. Fama & Schwertz (1977) used the period 1952 – 1977 which had less severe recessions for the United States than the period 1995 – 2020. As Boyd et al. (2005) point out, during period of economic downturns the relationship between news about unemployment and equity returns tend to become positive and larger while during periods of economic stability the relationship is negative. Following this result, the positive correlation found in this thesis could be driven by the periods of economic turbulence.

Another explanation could be that Fama & Schwertz (1977) use monthly data while I use annual data. Labor income usually does not change on a monthly basis due to already signed employment contracts. On an annual level wages are more likely to change. Furthermore, Catherine (2020) finds a similar high correlation of 0.638 for the United States over the period 1978 – 2010 for the correlation between aggregate labor income shocks and equity returns. Nevertheless, the results in this thesis gives reason to doubt the assumption of many life-cycle models that the correlation between returns on human capital and equity returns is near zero. A correlation of only 0.2, decreases the optimal portfolio share in the risky asset already tremendously.

The second hypothesis tests the effect of the flexibility of the labor market on the observed country-level correlations between returns to human capital and equity returns. The level of education, different industries and aggregated spending on social security were added to the regression as control variables. The results indicate that the flexibility of the labor markets does not seem to have a significant effect on the correlation between returns to human capital and equity returns, this contradicts Hypothesis 2. However, education does have a significant positive effect on the correlation between returns to human capital and equity returns. This is in line with prior research conducted by Campbell (1996) and Davis & Willen (2000a).

The third and final hypotheses states that the correlation between returns to human capital and equity returns is positive and stronger during economic downturns. This is motivated by the result of Guvenen et al. (2014) that during times of recession the labor income risk is skewed to the left, implying that during severe economic downturns the chances of a large fall in labor income increases while the chances of an increase in labor income become smaller. During severe economic downturns the equity returns deteriorate as well (Catherine, 2020), implying a positive and stronger correlation during economic downturns. The results indicate that during severe economic downturns the correlation is indeed positive, which supports Hypothesis 3A. This is not surprising as the correlation during the whole sample period tends to be positive as well. Furthermore, for Europe and the Eurozone at least one correlation is statistically larger compared to periods of economic stability, this is in favor of Hypothesis 3B. Some would argue that the crashes considered in this thesis are not important as life-cycle investing is long term. However, large labor income shocks can be quite persistent. When experiencing a large decrease in labor income, workers recover only one third one year after the drop in their labor income (Guvenen, Karahan, Ozkan & Song, 2015). The amount left is only recovered in the next ten years. This shows that severe economic downturns can have a persistent effect on long-term investing as well.

5.2 Limitations

This thesis has several limitations which are addressed in this section. Firstly, this period includes four recession periods for all regions and three recession periods for each individual region[4]. In the life-cycle model Catherine (2020) uses severe financial crises occurs three times per 100 years. Although, this is a conservative model it indicates that the time period used in this thesis is very turbulent. Boyd et al. (2005) stress that periods of economic expansions usually outweigh the period of economic contractions. With the left-skewed labor income risk during recessions (Guvenen et al., 2014) the correlation between returns to human capital and equity returns could be skewed due to the many periods of recessions that occurred during the period 1996 – 2020.

A second limitation revolves around the decision to estimate the correlation for aggregated returns to human capital. Aggregate labor income variation only accounts for at most ten percent of the total variation of individual-level labor income (Campbell et al., 2001). The idiosyncratic part of labor income risk accounts for most of the variation. Therefore, the individual-level correlation between returns to human capital and equity returns could differ largely from the correlation coefficients estimated in this thesis. Due to data availability it is complex to estimate the correlation coefficient for several countries based on individual-level labor income. However, as the aggregated component of labor income risk is rather small, the implication of highly correlated aggregated returns to human capital and equity returns could have no impact at all on the optimal portfolio choice for the individual investor.

Finally, the last limitation is linked to the measurement of returns to human capital as well. In this thesis I followed the approach of Fama & Schwert (1977). They state that human capital is nontradable and therefore capital gains on human capital cannot be realized and should therefore not be considered. Therefore, the returns to human capital can be appropriately measured by the growth rate of aggregated labor income. If labor income follows a multiplicative random-walk process and the interest rate to discount future labor income is constant over time, the growth rate of labor income is the appropriate measure of returns to human capital. However, Baxter & Jerman (1995) reject the hypothesis that labor income follows a random walk process. This implies that the growth rate of labor income is not the best measure of returns to human capital. Furthermore, in this thesis returns to human capital are measured as the current growth rate of labor income. Campbell (1996) states that the growth rate of future labor income should be considered to estimate the correlation between returns to human capital and equity returns.

[4] The recession periods for the United States are the dot com bubble (2001), the Great Recession (2007 – 2009) and the COVID19 crisis (2020). For Europe and the Eurozone the recession periods are the Great Recession (2007 – 2009), the European Sovereign Debt Crisis (2011 – 2013) and the COVID-19 crisis (2019 – 2020).

5.3 Recommendations

This thesis extends the literature on the correlation between returns to human capital and equity returns, by estimating the correlation over a more recent period and analyzing 25 countries. Future research should extend the analysis to countries outside of Europe and North-America. Most research is focused on the United States and in lesser amount on developed countries. However, it could be interesting to check for differences between developed and developing countries and their country-level correlations between returns to human capital and equity returns. I chose not to extend the research to countries outside Europe and the U.S. due to data availability of several variables. Nevertheless, it would have been an interesting extension.

A second recommendation is to investigate if the country-level correlations can be explained by the political environment and redistributive income shocks. As Juliard (2002) points out, the political environment or redistributive income shocks could influence the correlation between returns to human capital and equity returns. As the flexibility of the labor market did not seem to have an unambiguously effect on the country-level correlations, it is valuable to investigate which variables explain the cross-country differences in the magnitude of the correlation. Due to the complexity of quantifying the political environment and the initial focus on labor flexibility, I decided this was outside the scope of my thesis.

Lastly, a third recommendation revolves around data availability. As aggregated labor income is accessible data, it is convenient to derive returns to human capital from data on aggregated labor income. However, as explained before the variation of labor income is largely determined by the idiosyncratic variation of labor income. Databases like the Panel Study of Income Dynamics (PSID)[5] should be constructed for a large amount of developing and developed countries to empirically estimate the returns to human capital based on individual-level labor income. This way the consequences of the estimated correlation for the optimal portfolio theory can be investigated.

[5] Longitudinal U.S. dataset on individual-level labor income

References

Agnew, J., Balduzzi, P., & Sunden, A. (2003). Portfolio choice and trading in a large 401 (k) plan. *American Economic Review*, *93*(1), 193-215.

Ameriks, J., & Zeldes, S. P. (2004). *How do household portfolio shares vary with age* (pp. 1-87). working paper, Columbia University.

Baxter, M., & Crucini, M. J. (1994). *Business cycles and the asset structure of foreign trade* (No. w4975). National Bureau of Economic Research.

Baxter, M., & Jermann, U. J. (1995). *The international diversification puzzle is worse than you think* (No. w5019). National Bureau of Economic Research.

Benzoni, L., Collin-Dufresne, P., & Goldstein, R. S. (2005). *Portfolio choice over the life-cycle in the presence of'trickle down'labor income* (No. w11247). National Bureau of Economic Research.

Benzoni, L., Collin-Dufresne, P., & Goldstein, R. S. (2007). Portfolio choice over the life-cycle when the stock and labor markets are cointegrated. *The Journal of Finance*, *62*(5), 2123-2167.

Bodie, Z., Merton, R. C., & Samuelson, W. F. (1992). Labor supply flexibility and portfolio choice in a life cycle model. *Journal of economic dynamics and control*, *16*(3-4), 427-449.

Bottazzi, L., Pesenti, P., & Van Wincoop, E. (1996). Wages, profits and the international portfolio puzzle. *European Economic Review*, *40*(2), 219-254.

Boyd, J. H., Hu, J., & Jagannathan, R. (2005). The stock market's reaction to unemployment news: Why bad news is usually good for stocks. *The Journal of Finance*, *60*(2), 649-672.

Campbell, J. Y. (1996). Understanding risk and return. *Journal of Political economy*, *104*(2), 298-345.

Campbell, J. Y., Cocco, J. F., Gomes, F. J., & Maenhout, P. J. (2001). Investing retirement wealth: A life-cycle model. In *Risk aspects of investment-based Social Security reform* (pp. 439-482). University of Chicago Press.

Catherine, S. (2020). Countercyclical labor income risk and portfolio choices over the life-cycle. *HEC Paris Research Paper No. FIN-2016-1147.*

Cocco, J. F., Gomes, F. J., & Maenhout, P. J. (2005). Consumption and portfolio choice over the life cycle. *The Review of Financial Studies*, *18*(2), 491-533.

Datastream (2021). *Country indices.* Retrieved from: Datastream

Datastream (2021). *MSCI Small Cap indices.* Retrieved from: Datastream

Davis, S. J., & Willen, P. (2000a). *Using financial assets to hedge labor income risks: estimating the benefits*. working paper, University of Chicago.

Davis, S. J., & Willen, P. (2000b). *Occupation-level income shocks and asset returns: Their covariance and implications for portfolio choice* (No. w7905). National Bureau of Economic Research

Edmans, A., Li, L., & Zhang, C. (2014). Employee satisfaction, labor market flexibility, and stock returns around the world (No. w20300). *National Bureau of Economic Research*.

Fama, E. F., & Schwert, G. W. (1977). Human capital and capital market equilibrium. *Journal of Financial Economics*, *4*(1), 95-125.

Fisher, R. A. (1921). On the Probable Error of a Coefficient of Correlation Deduced from a Small Sample. *Metron*, *1*, 3-32.

Gomes, F. (2020). Portfolio Choice Over the Life Cycle: A Survey. *Annual Review of Financial Economics*, 12, 277-304.

Guilford, J. P., & Fruchter, B. (1973). Fundamental statistics in education and psychology.

Guvenen, F., Ozkan, S., & Song, J. (2014). The nature of countercyclical income risk. *Journal of Political Economy*, *122*(3), 621-660.

Guvenen, F., Karahan, F., Ozkan, S., & Song, J. (2015). *What do data on millions of US workers reveal about life-cycle earnings risk?* (No. w20913). National Bureau of Economic Research.

Heaton, J., & Lucas, D. (1997). Market frictions, savings behavior, and portfolio choice. *Macroeconomic Dynamics*, *1*(1), 76-101.

Hochguertel, S. (2000). *Households' portfolio choices*. Ph.D. Dissertation, Center for Economic Policy Research, Tilburg University.

ILO (2015). The labour share in G20 economies. *Report prepared for the G20 Employment Working Group, Antalya, February*, 101.

ILOSTAT (2021). *International Labour Organisation*. Retrieved from: https://www.ilo.org/shinyapps/bulkexplorer29/?lang=en&segment=indicator&id=CPI_NCYR_COI_RT_A

Jagannathan, R., & Kocherlakota, N. R. (1996). Why should older people invest less in stocks than younger people. *Federal Reserve Bank of Minneapolis Quarterly Review*, *20*, 11-20.

Keeley, B. (2009). The Value of People. In: *Human Capital: How what you know shapes your life* (20-37). Paris: OECD Publishing.

King, M. A., & Leape, J. I. (1987). Asset accumulation, information, and the life cycle.

Koo, H. K. (1998). Consumption and portfolio selection with labor income: a continuous time approach. *Mathematical Finance*, *8*(1), 49-65.

Lustig, H., & Van Nieuwerburgh, S. (2008). The returns on human capital: Good news on wall street is bad news on main street. *The Review of Financial Studies*, *21*(5), 2097-2137.

Mayers, D. (1973). Nonmarketable assets and the determination of capital asset prices in the absence of a riskless asset. *The Journal of Business*, *46*(2), 258-267.

Merton, R. C. (1969). Lifetime portfolio selection under uncertainty: The continuous-time case. *The review of Economics and Statistics*, 247-257.

Merton, R. C. (1971). Optimum consumption and portfolio rules in a continuous-time model. *Journal of Economic Theory, 3*, 373– 413

Mishra, A. V. (2015). Measures of equity home bias puzzle. *Journal of Empirical Finance*, *34*, 293-312.

Nunally, J. C. (1967). Psychometric theory. New York: McGraw-Hill

OECD (2021), "Education at a glance: Educational attainment and labour-force status", *OECD Education Statistics* (database), https://doi.org/10.1787/889e8641-en (accessed on 28 March 2021).

OECD (2021). *OECD.stat*. Retrieved from: https://stats.oecd.org/Index.aspx?DataSetCode=EPL_OV#

Samuelson, P. A. (1975). Lifetime portfolio selection by dynamic stochastic programming. *Stochastic Optimization Models in Finance*, 517-524

Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *The journal of finance*, *19*(3), 425-442.

Siegel, J. J. (1998). Stocks for the long run by Jeremy Siegel. *NewYork, USA.*

Storesletten, K., Telmer, C. I., & Yaron, A. (2007). Asset pricing with idiosyncratic risk and overlapping generations. *Review of Economic Dynamics*, *10*(4), 519-548.

Viceira, L. M. (2001). Optimal portfolio choice for long-horizon investors with nontradable labor income. *The Journal of Finance*, *56*(2), 433-470.

Yoo, P. S. (1994). *Age dependent portfolio selection* (No. 1994-003).

Appendix A: Analyzed data

Table A.1: Countries used in analysis	
Austria	Luxembourgh
Belgium	Netherlands
Bulgaria	Norway
Cyprus	Poland
Czechia	Portugal
Denmark	Romania
Finland	Slovenia
France	Spain
Germany	Sweden
Greece	Switzerland
Hungary	United Kingdom
Ireland	United States
Italy	

Table A.2: Data availability aggregated labor income, equity returns and returns on small-cap index

Country	**Aggregated labor income (Eurostat, 2021)**	**Equity return index (Datastream, 2021)**	**Small-cap index (Datastream, 2021)**
Austria	1995 – 2020	1993 – 2020	2001 – 2020
Belgium	1995 – 2020	1993 – 2020	2001 – 2020
Bulgaria	1995 – 2020	2001 – 2020	2011 – 2015
Cyprus	1995 – 2020	1993 – 2020	No data available
Czechia	1995 – 2020	1994 – 2020	1999 – 2020
Denmark	1995 – 2020	1993 – 2020	2001 – 2020
Finland	1995 – 2020	1993 – 2020	2001 – 2020
France	1995 – 2020	1993 – 2020	2001 – 2020
Germany	1995 – 2020	1993 – 2020	2001 – 2020
Greece	1995 – 2020	1993 – 2020	2002 – 2020
Hungary	1995 – 2020	1993 – 2020	1999 – 2020
Ireland	1995 – 2020	1993 – 2020	2001 – 2020
Italy	1995 – 2020	1993 – 2020	2001 – 2020
Luxembourg	1995 – 2020	1993 – 2020	No data available
Netherlands	1995 – 2020	1993 – 2020	2001 – 2020
Norway	1995 – 2020	1993 – 2020	2001 – 2020
Poland	1995 – 2020	1994 – 2020	1999 – 2020
Portugal	1995 – 2020	1993 – 2020	2001 – 2020
Romania	1995 – 2020	1997 – 2020	2011 – 2020
Slovenia	1995 – 2020	1999 – 2020	2011 – 2020
Spain	1995 – 2020	1993 – 2020	2001 – 2020
Sweden	1995 – 2020	1993 – 2020	2001 – 2020
Switzerland	1995 – 2020	1993 – 2020	2001 – 2020
United Kingdom	1995 – 2020	1993 – 2020	2001 – 2020
United States	1995 – 2020	1993 – 2020	2001 – 2020

EPL = the Employment Protection Legislisation index provided by the OECD

EFW = Fraser Institute's Economic Freedom of the World

FLM = average of the EPL and EFW score

A higher score on all different measures implies a more flex

Appendix B: Extension descriptive statistics

Table B.1: Shapiro-Wilk test for normality. The Z-scores are displayed for all countries analyzed.

Country	Returns on human capital – total population	Returns on human capital – labor force	Equity returns	MSCI Small cap returns
All countries	*9.2333****	*9.428****	*8.075****	*5.751****
Austria	0.854	0.368	-2.610	0.914
Belgium	-0.829	-0.837	-4.103	0.759
Bulgaria	-0.655	-2.466	2.256*	-0.016
Cyprus	2.816**	2.360**	3.733***	No data available
Czechia	-0.016	0.329	-0.511	1.625
Denmark	0.953	-0.296	-1.445	-1.444
Finland	-0.334	-0.537	2.103*	0.729
France	1.247	0.518	-0.538	-1.571
Germany	0.915	1.394	-0.114	0.130
Greece	2.327**	2.611**	0.788	-0.551
Hungary	0.535	-0.063	0.143	3.121***
Ireland	-0.172	0.623	-0.497	0.984
Italy	1.930*	2.325*	0.579	-0.287
Luxembourg	-0.622	-1.351	0.123	No data available
Netherlands	0.572	-0.126	-1.895	0.656
Norway	1.188	0.381	0.185	0.216
Poland	0.218	0.666	-1.270	0.263
Portugal	2.841**	2.671**	1.174	1.203
Romania	0.932	0.960	0.751	-0.316
Slovenia	1.241	-0.484	-1.219	-0.286
Spain	2.930*	1.587	-0.085	-0.287
Sweden	-0.095	0.553	0.469	0.806
Switzerland	1.658*	1.493	-0.034	-0.723
United Kingdom	0.008	0.026	-0.399	0.820
United States	-0.112	0.276	1.016	0.424

*** p < 0.001, ** p < 0.01, * p < 0.5

Table B.2: Scores of different measurements of flexibility of the labor market per country

Country	EPL	EFW	FLM
Average	*6.10*	*6.45*	*6.82*
Austria	6.13	5.96	6.05
Belgium	4.98	7.01	6.00
Bulgaria	No data available	6.95	6.95
Cyprus	No data available	5.90	5.90
Czechia	6.34	7.69	7.01
Denmark	6.60	7.34	6.97
Finland	7.00	5.19	6.10
France	5.11	5.61	5.36
Germany	5.75	5.27	5.51
Greece	5.00	4.48	4.74
Hungary	6.48	6.83	6.66
Ireland	7.27	7.69	7.48
Italy	4.83	6.32	5.57
Luxembourg	4.58	5.83	5.20
Netherlands	5.89	6.86	6.38
Norway	5.70	4.84	5.27
Poland	6.31	7.08	6.70
Portugal	5.13	5.36	5.24
Romania	No data available	6.62	6.62
Slovenia	5.76	5.64	5.70
Spain	5.32	5.43	5.37
Sweden	6.33	5.94	6.14
Switzerland	6.50	7.90	7.20
United Kingdom	7.73	8.28	8.00
United States	8.63	9.14	8.89

EPL = the Employment Protection Legislation index provided by the OECD

EFW = Fraser Institute's Economic Freedom of the World

FLM = average of the EPL and EFW score

A higher score on all different measures implies a more flexible labor market

Table B.3: Correlation matrix of different measurements of flexibility of the labor market

	EPL	*EFW*	*FLM*
EPL	1.000		
EFW	0.701	1.000	
FLM	0.906	0.937	1.000

EPL = the Employment Protection Legislisation index provided by the OECD

EFW = Fraser Institute's Economic Freedom of the World

FLM = average of the EPL and EFW score

A higher score on all different measures implies a more flexible labor market

Appendix C: Robustness country-level correlations

Table C.1: Kendall correlation between the growth of the real labor income per capita and the real annual stock return.

Country	$Corr(RHC_t, RE_t)$	$Corr(RHC_t, RE_{t-1})$	$Corr(RHC_t, RE_{t-2})$
All countries	*0.1995*** (0.0000)*	*0.1647*** (0.0000)*	*0.1292*** (0.0000)*
Austria	-0.0200 (0.9070)	0.4600*** (0.0014)	0.2533* (0.0798)
Belgium	0.0000 (1.0000)	0.2667* (0.0650)	0.2400* (0.0973)
Bulgaria	0.3216* (0.0589)	0.0327 (0.8796)	0.1176 (0.5366)
Cyprus	0.1333 (0.3624)	0.1533 (0.2933)	0.0467 (0.7614)
Czechia	0.4667*** (0.0012)	0.0667 (0.6572)	0.2174 (0.1433)
Denmark	0.0667 (0.6572)	0.3667** (0.0109)	0.1600 (0.2723)
Finland	0.3333** (0.0208)	0.3533** (0.0142)	0.0933 (0.5283)
France	0.2667* (0.0650)	0.2533* (0.0798)	0.3000** (0.0377)
Germany	0.0133 (0.9441)	0.2000 (0.1682)	0.0600 (0.6913)
Greece	0.1200 (0.4137)	0.1400 (0.3383)	0.0467 (0.7614)
Hungary	0.2600* (0.0721)	0.1000 (0.4982)	-0.1133 (0.4409)
Ireland	0.1333 (0.3624)	0.2133 (0.1412)	0.1600 (0.2723)
Italy	0.1467 (0.3153)	0.2267 (0.1176)	0.1667 (0.2525)
Luxembourgh	0.1133 (0.4409)	0.1667 (0.2525)	0.3000** (0.0377)
Netherlands	-0.0733 (0.6238)	0.3133** (0.0299)	0.2000 (0.1682)
Norway	0.3733*** (0.0095)	0.1800 (0.2158)	0.1533 (0.2933)
Poland	0.4533*** (0.0016)	0.2867** (0.0471)	-0.1087 (0.4719)
Portugal	0.1267 (0.3875)	0.1467 (0.3153)	0.1067 (0.4691)
Romania	0.3518** (0.0201)	0.3420** (0.0278)	0.2381 (0.1390)
Slovenia	0.2952* (0.0655)	0.2526 (0.1273)	0.2164 (0.2079)
Spain	0.2667* (0.0650)	0.3667** (0.0109)	0.2800* (0.0526)
Sweden	0.4533*** (0.0016)	0.0400 (0.7973)	0.2533* (0.0798)
Switzerland	-0.0600 (0.6913)	-0.0933 (0.5283)	0.1133 (0.4409)
United Kingdom	0.4933*** (0.0006)	0.1000 (0.4982)	0.1533 (0.2933)
United States	0.5133*** (0.0004)	0.3667** (0.0109)	0.2733* (0.0585)

*** p < 0.01, ** p < 0.05, * p < 0.1

P-values are denoted in parantheses.

RHC_t = the returns on human capital during period t

RE_{t-i} = returns on equity during period t-i

Table C.2: Pearson correlation between the growth of the aggregated real labor income per capita and the real annual stock return of small cap companies

Country	$Corr(RHC_t, RSC_t)$	$Corr(RHC_t, RSC_{t-1})$	$Corr(RHC_t, RSC_{t-2})$
All countries	0.3137*** (0.0000)	0.2386*** (0.0000)	0.0615 (0.2445)
Austria	0.1846 (0.4493)	0.3733 (0.1271)	0.2767 (0.2823)
Belgium	0.0302 (0.9024)	0.3387 (0.1692)	0.1841 (0.4793)
Bulgaria	Not enough data available	Not enough data available	Not enough data available
Cyprus	No data available	No data available	No data available
Czechia	0.4234* (0.0558)	0.3366 (0.1467)	0.2350 (0.3328)
Denmark	0.3128 (0.2063)	0.5280** (0.0294)	0.3847 (0.1412)
Finland	0.4084* (0.0825)	0.3339 (0.1756)	0.0778 (0.7665)
France	0.4637** (0.0455)	0.2521 (0.3129)	0.0305 (0.9074)
Germany	0.2390 (0.3245)	0.4153* (0.0865)	-0.0505 (0.8473)
Greece	0.3023 (0.2227)	0.3810 (0.1313)	0.3905 (0.1348)
Hungary	0.2469 (0.2806)	0.1817 (0.4432)	0.1426 (0.5604)
Ireland	0.1281 (0.6014)	0.1554 (0.5381)	0.1962 (0.4504)
Italy	0.4028* (0.0873)	0.3990 (0.1009)	0.0258 (0.9218)
Luxembourgh	No data available	No data available	No data available
Netherlands	0.0658 (0.7890)	0.3299 (0.1813)	0.1624 (0.5335)
Norway	0.5711** (0.0106)	0.4626* (0.0532)	0.1480 (0.5707)
Poland	0.4999** (0.0210)	0.4145* (0.0692)	-0.1020 (0.6777)
Portugal	0.2060 (0.3974)	0.0206 (0.9353)	-0.0441 (0.8664)
Romania	0.4723 (0.1992)	0.7067* (0.0500)	0.6828* (0.0909)
Slovenia	0.4102 (0.2728)	0.7124** (0.0474)	0.6861* (0.0888)
Spain	0.3655 (0.1238)	0.4191* (0.0834)	0.1901 (0.4649)
Sweden	0.7450*** (0.0003)	0.1830 (0.4674)	-0.1045 (0.6897)
Switzerland	0.1297 (0.5967)	0.2826 (0.2558)	-0.2370 (0.3597)
United Kingdom	0.6903*** (0.0011)	0.0969 (0.7020)	-0.0248 (0.9247)
United States	0.4136* (0.0784)	0.2328 (0.3535)	0.2122 (0.4135)

*** p < 0.01, ** p < 0.05, * p < 0.1

P-values are denoted in parantheses.

RHC_t = the returns on human capital during period t

RSC_{t-i} = returns on small-cap stocks during period t-i

Table C.3: Kendall correlation between the growth of the aggregated real labor income per capita and the real annual stock return of small cap companies

Country	$Corr(RHC_t, RSC_t)$	$Corr(RHC_t, RSC_{t-1})$	$Corr(RHC_t, RSC_{t-2})$
Greece	0.2026 (0.2558)	0.1765 (0.3434)	0.2667 (0.1628)
Hungary	0.3333** (0.0372)	0.2632 (0.1119)	0.2164 (0.2079)
Italy	0.2749 (0.1075)	0.3464** (0.0489)	0.0882 (0.6505)
Portugal	0.1111 (0.5289)	0.0327 (0.8796)	0.0000 (1.0000)
Spain	0.1930 (0.2629)	0.3595** (0.0408)	0.1471 (0.4338)
Switzerland	-0.0526 (0.7796)	0.1111 (0.5445)	-0.1176 (0.5366)

*** p < 0.01, ** p < 0.05, * p < 0.1

P-values are denoted in parantheses.

RHC_t = the returns on human capital during period t

RSC_{t-i} = returns on small-cap stocks during period t-i

Table C.4: Pearson correlation between the growth of aggregated labor income when aggregated wages are divided by total population and when divided by the labor force

Country			
All countries	*0.9819*** (0.000)*	Italy	0.9672*** (0.0000)
Austria	0.8502*** (0.0000)	Luxembourg	0.8952*** (0.0000)
Belgium	0.8381*** (0.0000)	Netherlands	0.8915*** (0.0000)
Bulgaria	0.8606*** (0.0000)	Norway	0.9859*** (0.0000)
Cyprus	0.9555*** (0.0000)	Poland	0.9957*** (0.0000)
Czechia	0.9976*** (0.0000)	Portugal	0.9851*** (0.0000)
Denmark	0.9043*** (0.0000)	Romania	0.9922*** (0.0000)
Finland	0.9141*** (0.0000)	Slovenia	0.9168*** (0.0000)
France	0.9453*** (0.0000)	Spain	0.9501*** (0.0000)
Germany	0.9471*** (0.0000)	Sweden	0.9953*** (0.0000)
Greece	0.9796*** (0.0000)	Switzerland	0.9931*** (0.0000)
Hungary	0.9877*** (0.0000)	United Kingdom	0.9993*** (0.0000)
Ireland	0.9563*** (0.0000)	United States	0.9833*** (0.0000)

*** p < 0.01, ** p < 0.05, * p < 0.1

P-values are denoted in parantheses.

Table C.5: Pearson correlation between the growth of the real labor income divided by labor force and the real annual stock return.

Country	$Corr(RHC_t, RE_t)$	$Corr(RHC_t, RE_{t-1})$	$Corr(RHC_t, RE_{t-2})$
All countries	*0.3118*** (0.0000)*	*0.1488*** (0.0002)*	*0.1183*** (0.0036)*
Austria	0.1574 (0.4523)	0.3088 (0.1332)	0.2228 (0.2843)
Belgium	-0.1594 (0.4465)	0.3423* (0.0940)	0.2402 (0.2475)
Bulgaria[1]	0.2966 (0.2176)	0.0089 (0.9719)	-0.0729 (0.7808)
Cyprus[1]	0.1206 (0.5660)	0.1958 (0.3483)	0.1900 (0.3630)
Czechia	0.5532*** (0.0041)	0.0812 (0.6997)	0.3813* (0.0660)
Denmark	0.0471 (0.8231)	0.4292** (0.0323)	0.2415 (0.2448)
Finland[1]	0.4602** (0.0206)	0.1750 (0.4028)	0.0635 (0.7629)
France	0.5205*** (0.0076)	0.3713* (0.0677)	0.2834 (0.1698)
Germany	0.0783 (0.7100)	0.1341 (0.5227)	0.3019 (0.1425)
Greece[1]	0.0948 (0.6523)	0.2447 (0.2384)	0.1982 (0.3422)
Hungary	0.1885 (0.3669)	0.0497 (0.8136)	-0.1942 (0.3524)
Ireland	0.1898 (0.3634)	0.3451* (0.0911)	0.2536 (0.2213)
Italy[1]	0.2130 (0.3068)	0.1456 (0.4874)	0.0636 (0.7626)
Luxembourg	0.1128 (0.5915)	0.3467* (0.0895)	0.2455 (0.2198)
Netherlands	-0.0868 (0.6800)	0.2712 (0.1898)	0.0212 (0.9198)
Norway	0.5567*** (0.0038)	0.2147 (0.3026)	0.0990 (0.6379)
Poland	0.6060*** (0.0013)	0.2041 (0.3277)	-0.1510 (0.4812)
Portugal[1]	0.1525 (0.4668)	0.0869 (0.6797)	0.2224 (0.2853)
Romania	0.4973** (0.0158)	0.2093 (0.2499)	0.2999 (0.1866)
Slovenia	0.3400 (0.1316)	0.4627** (0.0400)	0.1268 (0.6050)
Spain	0.3228 (0.1155)	0.4007** (0.0471)	0.2185 (0.2939)
Sweden	0.7159*** (0.0001)	-0.1914 (0.3594)	0.2161 (0.2995)
Switzerland	0.1426 (0.4964)	-0.0191 (0.9279)	-0.0352 (0.8673)
United Kingdom	0.6550*** (0.0004)	0.1386 (0.5089)	0.1174 (0.5762)
United States	0.6897*** (0.0001)	0.3589* (0.0781)	0.2357 (0.2568)

*** p < 0.01, ** p < 0.05, * p < 0.1

RHC_t = the returns on human capital during period t

RE_{t-i} = returns on equity during period t-i

2) As at least one of the variables is not normally distributed for these countries, no statements can be made about the significance of the Pearson correlation coefficient.

Table C.6: Kendall correlation between the growth of the real labor income divided by labor force and the real annual stock return.

Country	$Corr(RHC_t, RE_t)$	$Corr(RHC_t, RE_{t-1})$	$Corr(RHC_t, RE_{t-2})$
Bulgaria	0.3216* (0.0589)	0.0327 (0.8796)	0.1176 (0.5366)
Cyprus	0.1333 (0.3624)	0.1533 (0.2933)	0.0467 (0.7614)
Finland	0.3333** (0.0208)	0.3533** (0.0142)	0.0933 (0.5283)
Greece	0.1200 (0.4137)	0.1400 (0.3383)	0.0467 (0.7614)
Italy	0.1467 (0.3153)	0.2267 (0.1176)	0.1667 (0.2525)
Portugal	0.1267 (0.3875)	0.1467 (0.3153)	0.1067 (0.4691)

*** p < 0.01, ** p < 0.05, * p < 0.1

RHC_t = the returns on human capital during period t

RE_{t-i} = returns on equity during period t-i

Appendix D: Robustness flexibility of the labor market

Table D.1: Cross-sectional regression analysis, dependent variable: Kendall correlation between the returns on human capital and equity returns.

Variables	(1)	(2)	(3)	(4)
FLM	0.128	-0.027	0.101	0.075
	(0.073)	(0.049)	(0.075)	(0.091)
Education	0.010	0.010*	0.020**	0.024**
	(0.007)	(0.005)	(0.008)	(0.010)
Agriculture	-0.033	0.016	-0.017	-0.045
	(0.042)	(0.030)	(0.038)	(0.043)
Industry	-0.046	0.018	-0.028	-0.040
	(0.047)	(0.034)	(0.043)	(0.054)
Market services	-0.076	0.019	-0.057	-0.064
	(0.054)	(0.039)	(0.043)	(0.054)
Public sector	-0.045	0.006	-0.039	-0.057
	(0.047)	(0.033)	(0.044)	(0.052)
Social contributions	0.015	0.003	0.018	0.023
	(0.013)	(0.016)	(0.012)	(0.016)
Constant	4.378	-1.338	3.041	4.376
	(5.168)	(3.193)	(3.843)	(4.580)
Number of countries	*22*	*22*	*22*	*22*
R-squared	*0.342*	*0.151*	*0.332*	*0.295*

*Robust standard errors are denoted in parantheses. * P-value < 0.1, ** P-value < 0.05 and *** P-value < 0.01*

The regression analysis is performed with 4 different independent variables:

1) The contemporaneous Pearson correlation between returns on human capital and equity returns.
2) The Pearson correlation between returns on human capital and the first lag of equity returns.
3) The sum of the contemporaneous Pearson correlation between returns on human capital and equity returns and the Pearson correlation between returns on human capital and the first lag of equity returns.
4) The sum of the contemporaneous Pearson correlation between returns on human capital and equity returns and, the Pearson correlation between returns on human capital and the first lag of equity returns and the Pearson correlation between returns on human capital and the second lag of equity returns.

Table D.2 : Cross-sectional regression analysis, dependent variable: Pearson correlation between labor income growth and annual stock returns, robust standard errors.

Variables	(1)	(2)	(3)	(4)
EPL	0.199*	-0.122*	0.077	-0.039
	(0.093)	(0.060)	(0.089)	(0.126)
Education	0.008	0.023***	0.031**	0.044**
	(0.013)	(0.007)	(0.012)	(0.017)
Agriculture	-0.065	0.053	-0.012	-0.013
	(0.052)	(0.032)	(0.045)	(0.058)
Industry	-0.084	0.068	-0.016	0.007
	(0.060)	(0.039)	(0.055)	(0.076)
Market services	-0.116	0.068	-0.048	-0.023
	(0.069)	(0.042)	(0.059)	(0.079)
Public sector	-0.075	0.035	-0.040	-0.037
	(0.057)	(0.031)	(0.046)	(0.058)
Social contributions	0.024	-0.009	0.015	0.007
	(0.017)	(0.018)	(0.016)	(0.025)
Constant	7.544	-5.061	2.483	1.509
	(5.453)	(3.232)	(4.714)	(6.255)
Number of countries	*22*	*22*	*22*	*22*
R-squared	*0.455*	*0.382*	*0.533*	*0.353*

*Robust standard errors are denoted in parantheses. * P-value < 0.1, ** P-value < 0.05 and *** P-value < 0.01*

The regression analysis is performed with 4 different independent variables:

1) The contemporaneous Pearson correlation between returns on human capital and equity returns.
2) The Pearson correlation between returns on human capital and the first lag of equity returns.
3) The sum of the contemporaneous Pearson correlation between returns on human capital and equity returns and the Pearson correlation between returns on human capital and the first lag of equity returns.
4) The sum of the contemporaneous Pearson correlation between returns on human capital and equity returns and, the Pearson correlation between returns on human capital and the first lag of equity returns and the Pearson correlation between returns on human capital and the second lag of equity returns.

Table D.3: Cross-sectional regression analysis, dependent variable: Pearson correlation between labor income growth and annual stock returns, robust standard errors.

Variables	(1)	(2)	(3)	(4)
EFW	0.061	-0.027	0.033	0.008
	(0.063)	(0.031)	(0.060)	(0.081)
Education	0.026***	0.013**	0.038***	0.041***
	(0.008)	(0.005)	(0.009)	(0.137)
Agriculture	-0.023	0.025	0.001	-0.027
	(0.040)	(0.025)	(0.040)	(0.054)
Industry	-0.028	0.028	0.000	-0.015
	(0.046)	(0.029)	(0.050)	(0.073)
Market services	-0.069	0.032	-0.036	-0.045
	(0.056)	(0.034)	(0.056)	(0.080)
Public sector	-0.044	0.011	-0.032	-0.052
	(0.049)	(0.031)	(0.046)	(0.064)
Social contributions	0.010	0.001	0.011	0.013
	(0.019)	(0.016)	(0.013)	(0.020)
Constant	3.703	-2.334	1.370	2.993
	(4.365)	(2.648)	(4.418)	(6.192)
Observations	*22*	*22*	*22*	*22*
R-squared	*0.3069*	*0.2429*	*0.5188*	*0.3498*

*Robust standard errors are denoted in parantheses. * P-value < 0.1, ** P-value < 0.05 and *** P-value < 0.01*

The regression analysis is performed with 4 different independent variables:

1) The contemporaneous Pearson correlation between returns on human capital and equity returns.
2) The Pearson correlation between returns on human capital and the first lag of equity returns.
3) The sum of the contemporaneous Pearson correlation between returns on human capital and equity returns and the Pearson correlation between returns on human capital and the first lag of equity returns.
4) The sum of the contemporaneous Pearson correlation between returns on human capital and equity returns and, the Pearson correlation between returns on human capital and the first lag of equity returns and the Pearson correlation between returns on human capital and the second lag of equity returns.