Uncertainty and Educational Expenditure in Contemporary Europe[1]

Jenny Kragl,[2] Mrdjan M. Mladjan,[3] and Dina Radermacher,[4]
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Abstract

In this paper, we present a conceptual framework and a theoretical model to argue that education could be used as a tool to lower the variability of future income from labor. We then examine how surveyed household and business uncertainty impacted educational expenditures of governments and households within a sample of 20 member states of the European Union from 2005 to 2021. We present evidence that the effect of uncertainty on expenditure on human capital formation is different from its effect on standard consumption and investments. In agreement with predictions of our theoretical model, we find a positive impact of business and household uncertainty on various levels of educational expenditures for government and households, and evidence of the importance of culture in the uncertainty-educational expenditure relationship. Our findings suggest that investment into culture and into programs which subsidize households' expenditures on education have the potential to improve economic stability and long-term growth prospects of the European nations.

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[2] EBS Universität für Wirtschaft und Recht, EBS Business School, Rheingaustr. 1, 65375 Oestrich-Winkel, Germany, e-mail: jenny.kragl@ebs.edu

[3] Corresponding author; EBS Universität für Wirtschaft und Recht, EBS Business School, Gustav-Stresemann-Ring 3, 65183 Oestrich-Winkel, Germany, e-mail: mrdjan.mladjan@ebs.edu

[4] EBS Universität für Wirtschaft und Recht, EBS Business School, Rheingaustr. 1, 65375 Oestrich-Winkel, Germany, e-mail: dinaradermacher@gmail.com

1. Introduction

The events related to the financial crisis of 2008, the European debt crisis which ensued, and the global spread of COVID-19 have been associated with sharp increases in uncertainty about future economic wellbeing across the world and Europe. The interest of the academic community in the effect of uncertainty on economic activity has followed these events. As uncertainty is not directly observable, a large body of literature attempts to measure uncertainty by deriving its proxies (see, e.g., Bachmann, Elstner, and Sims, 2013; Baker and Bloom, 2013; Jurado, Ludvigson, and Ng, 2015; Baker, Bloom, and Davis, 2016a; and Berger, Emmerling, and Tavoni, 2017). Previous literature typically models a negative effect of uncertainty on consumption (see, e.g., Skinner 1988; Caballero 1990, 1991; Romer, 1990; Deaton, 1992; Carroll, 1994) and investment (see, e.g., Bernanke, 1983; McDonald and Siegel, 1986; Pindyck, 1991), which is supported by empirical studies (for consumption see, e.g., Bloom et al., 2016; Mody, Ohnsorge, and Sandri, 2012; Baker et al., 2020; Spatt, 2020; for investment see, e.g., Bachmann, Elstner, and Sims, 2013; Girardi & Reuter, 2017; Meinen & Röhe, 2017). Some theoretical papers, however, relate uncertainty to a positive response of investment (see for example Hartman, 1972; Abel 1983, 1984, 1985; Sarkar, 2000). While a number of studies examine the effect of uncertainty on consumption and investment into fixed capital, fewer contributions examine its impact on investment into human capital (see, e.g., Levhari and Weiss, 1974; Kodde, 1986; and, Dominitz and Manski, 1996; Jacobs, 2007) as a channel by which episodes of heightened uncertainty could have long-term effects on the productivity of economies and creativity of societies.

In this paper, we present a conceptual framework to understand how educational expenditure could be expected to respond to changes in macroeconomic uncertainty. We use this conceptual framework to set up a theoretical model predicting to argue that environments with higher macroeconomic uncertainty should be characterized by higher educational investment. Moreover, that the sensitivity of educational expenditure to changes in uncertainty should depend on culture. Intuitively, education could be used as a tool to lower the variability of future income from labor, so that individuals and governments would increase educational expenditure to counteract any exogenous increases in macroeconomic risk. This effect could moreover be more pronounced in societies with lower discounting of future and with a greater ability to transform educational improvements into future increases in income, where both factors would in part depend on culture.

We then proceed to verify these theoretical predictions empirically, by studying how uncertainty affected educational expenditure within the European Union in the first two decades of the twentieth century. Given that educational expenditure is clearly different from consumption because it offers compensation in terms of higher income and utility only with a delay, as well as given that it is different from investment into fixed capital because it offers compensation in terms of higher labor rather than income from fixed assets, we firstly examine whether the effect of uncertainty on educational expenditure is different from that on consumption and investment. Secondly, given that educational expenditure is the decision of an individual or the national government that could depend on the value-system of decision-

makers, we examine whether the effect of uncertainty on educational expenditure varies with differences in national cultures. We do so using a sample of 20 European Union (EU) member states – which produced 94% percent of GDP of the Union in 2021 – in the period of 2005 to 2021, and by studying the impact of changes in uncertainty on various components of educational expenditure by governments and households; namely primary, secondary, post-secondary/pre-tertiary, and tertiary, among others.

We apply a forward-looking uncertainty measure constructed like in Girardi and Reuter (2017) using European Commission's monthly aggregate survey results of the Joint Harmonised EU Programme of Business and Consumer Surveys (EU BCS). Girardi and Reuter's (2017) measure uses the same formula as Bachmann, Elstner, and Sims (2013), whose uncertainty indicator is however created using micro-level US and German data, while Girardi and Reuter (2017) apply it to country-level aggregates. Our survey dispersion measure is also based on aggregates of micro-level data and measures uncertainty as dispersion of opinions about future economic developments in the following three to twelve months, where business uncertainty is measured as a dispersion of opinions of managers, and household uncertainty is measured as dispersion of opinions of households in each of the 20 countries in our sample.

We find evidence of a positive impact of both business and household uncertainty on a wide range of measures of educational expenditure of the governments and households. For instance, an increase of ten index points in business uncertainty results in a six percent in total government educational expenditures per capita. Similarly for the effect of household uncertainty, our results suggest that household's spending on tertiary education per capita increases by six percent when the uncertainty measure rises for ten index points.

As an extension, we study whether the impact of uncertainty on educational expenditure is affected by cultural characteristics of individual EU nations. We do so by including interaction terms between the six cultural dimensions of Hofstede, Hofstede, and Minkov (2010), as well as some underlying indicators which are used to construct these, and our measures of uncertainty. We find evidence that culture does affect the way that governments and households decide about educational expenditure when faced with uncertainty.

This paper contributes to existing literature on the effect of uncertainty on the economy in several ways. Firstly, we find evidence for a connection between uncertainty and a less frequently studied measure of spending – expenditure on education – which nevertheless represents an important determinant of the future productivity and wellbeing. Secondly, in a period when the European continent faces several sources of uncertainty (including war, inflation, financial instability, and energy crisis) we examine a unique sample of 20 countries within the European union which produced 94% of GDP of the Union in 2021, and the behavior of both governments and households within them as evidenced by their spending on various sub-components of education. We moreover do so during the period 2005 to 2021 which covers two major crises including one with a novel source of uncertainty: the COVID-19 crisis. Thirdly, by studying how cultural characteristics affect the relationship between uncertainty and educational expenditure, we provide valuable insights for policy makers on how to promote building of human capacities oriented towards a more prosperous future in times when Europe faces various challenges.

This paper is structured as follows. Section 2 reviews related literature. Section 3 presents our conceptual framework summarizing how heightened uncertainty may impact educational expenditures. Section 4 presents our model and its theoretical predictions. Section 5 explains our dataset while Section 6 presents the method and the main results of our empirical analysis. Section 7 gives robustness checks and extensions while Section 8 concludes.

2. Literature

In this section, we review the strand of literature that studies the relationship between education and uncertainty. Moreover, we review the literature that studies the link between culture and education, and culture and economic performance. To the best of our knowledge, our paper is unique in proposing a conceptual framework and a theoretical model that makes the educational choice of households and governments respond to changes in uncertainty with the aim of lowering uncertainty faced by individuals and societies. Moreover, in finding empirical support for these theoretical predictions using data for the European Union in the last two decades.

Both the existing theoretical and empirical work examine education in the context of uncertainty. Levhari and Weiss (1974) is an early theoretical work that studies the effect of uncertainty on investment in human capital. It uses a Fisherian two-period model, similar to the portfolio-choice models in finance, in which future earnings from labor randomly depend on current investment in human capital. For Levhari and Weiss (1974), returns are considered uncertain when they are not risk-free. In their model the mere existence of risk reduces investment in human capital, although they acknowledge that some broader definitions of risk may lead to different results (Ibid., p.959).

While the model of Levhari and Weiss (1974) is a two-period model of risk and schooling investment, Olson, White and Sheffrin (1979) study the effect of uncertainty on investment in human capital if the random stream of schooling-dependent income extends over many periods. Instead of solving this as a complicated stochastic dynamic programming model, they use a tractable model to design equations which they then proceed to estimate using regressions. They assume a cardinal, additively separate, state-independent, von Neumann-Morgenstern utility function with constant relative risk aversion and assume, as in Weiss (1972), that all income is consumed after the moment of investment in schooling and that there is no consumption prior to that period. Moreover, they assume that individuals have access to borrowing to finance their education. Estimating their model using US data in the period 1967 to 1973 they find that an increase in unanticipated income variation associated with college attendance decreases the attractiveness of college as an investment, which is empirical evidence of a negative relationship between income uncertainty and educational expenditure.

Another study which challenges the assumption that individuals who invest in education have ideal planning ability with respect to future income streams for each level of education, and which includes both theoretical and empirical analysis is that of Kodde (1986). This study also describes four reasons why investment in education should instead be risky. One has (1) imperfect knowledge of own abilities and the quality of schooling, and (2) demand and supply of skills in future labor markets is affected by events that cannot be predicted with certainty, which are the two reasons also incorporated in the model of Levhari and Weiss (1974).

Moreover, (3) one is uncertain how long one would live and be able to benefit from future earnings, considered in Razin (1976), and (4) search economics suggests that timing of job offerings and level of offered earnings that one can count on upon graduation are uncertain.

Kodde (1986) constructs a theoretical model where an individual divides time between education and labor supply, there is no non-labor income, and individuals have access to financial markets (can borrow or save). The cost of education is both direct and includes that of foregone earnings. Period-2 wage depends on both the educational level chosen –with positive effect of education on income and diminishing marginal return to education – and the stochastic state of the world. By applying the Von Neumann - Morgenstern framework of expected utility maximization, Kodde (1986) concludes that the sign of the effect of demand for education on education is indeterminate – and could be negative, zero, or even positive – and has to be evaluated empirically.

In the empirical part, Kodde (1986) asked high schools graduates for their expectations of earnings after completing high school if looking for a job immediately after high school and if completing post-secondary education instead. The survey used measured uncertainty by observing the range that each individual specified for the lowest and the highest possible level of future earnings after completing additional education, while income uncertainty without additional education is explicitly referred to as an omitted variable. The empirical findings suggest that higher risk in the income of individuals who pursued further education has a statistically and economically significant effect on increasing the likelihood of pursuing higher education.

Like in Kodde (1986), we also expect that an increase in uncertainty about the future economic situation and, consequently, future income would result in higher educational expenditure. But, our paper is different from that of Kodde (1986) in several aspects. Kodde (1986) is not clear on the intuition behind the positive relationship between uncertainty and educational expenditure. Moreover, Kodde (1986) does not consider the difference in the risk of future income faced by individuals with and without further education. Our conceptual framework, and the theoretical model corresponding to it, instead endogenize the effect of educational choice on uncertainty acknowledging the empirical finding that individuals with higher education face lower wage variability.

A bulk of literature covers the real options theory in the context of investment into human capital and education (see, e.g., Dominitz and Manski, 1996; Card, 2001; Hogan and Walker, 2007; Jacobs, 2007; Bilkic et al., 2012; Hwang et al., 2013). The underlying intuition behind applying the real option theory to human capital regards the schooling choice (education) as a standard option problem (see e.g., Hogan & Walker, 2007). Real options theory [5](see, e.g., Bernanke, 1983) predominantly suggests a depressed effect in investments due to uncertainty as the option of waiting for the sufficient information to choose the optimal investment amount becomes more attractive. This is due to the irreversibility of the investment (see Bernanke, 1983), which may result in increased adjustment costs. Applying this reasoning to human capital, an individual is faced with the option of pursuing further education or delaying this

[5] For the real-option-theory literature see Hartman (1972), Abel (1983) over Bernanke (1983), McDonald and Siegel (1986), Pindyck (1991), Sarkar (2000), among others.

decision and entering the labor market, and in some cases the other way around by staying in school until feeling confident to enter the job market. Education choice is bound to significant uncertainty and risk as education innates these characteristics according to Dominitz and Manski (1996).

Hogan and Walker (2007) provide a similar conclusion in their contribution to the real options theory in human capital investments suggesting that increased risk leads to increased human capital accumulation. The authors observe in a theoretical model, that is in a second step tested with numerical simulations, that, contrary to the traditional real options theory suggesting depressed investment when risk aversion is high, increased risk fosters educational choice. The authors argue that this is due to the heightened payoff of the option of staying in the educational track and independent of the level of risk aversion. The option to prevent a wrong decision by entering the job market and leaving school increases in value, which manifests in higher human capital accumulation (Hogan & Walker, 2007). Thus, in times of heightened uncertainty, an individual forgoes the choice of entering the job market and prefers remaining in school or in higher education until uncertainty is cleared (Hogan & Walker, 2007).

While theory predominantly suggests an inverse relationship between uncertainty and educational spending, empirical work about the effect of risk aversion on investment in human capital is less conclusive. Belzil and Leonardi (2007) empirically study the effect of risk aversion on investment in higher education using Italian panel data and by attributing the level of risk based on survey responses to a lottery question. A key assumption in their empirical framework is that schooling ought to be an investment with associated risk (Belzil and Leonardi, 2007). A person attending college or going to school forgoes present consumption as well as a potential salary that could instead be earned. The person being educated also faces significant psychological pressure in order to have a payoff in the future of the additional time spent being educated (Belzil and Leonardi, 2007). This alludes to the fact that there are different forms of risk associated with the choice of (higher) education: neither is the successful completion of an academic level guaranteed nor is good performance as materialized in grades (Belzil and Leonardi, 2007). Their results suggest that differences in risk aversion do not play a significant role in schooling decisions, but rather the capital accumulation within the family partially determine schooling choices.

Groot and Oosterbeek (1992) study the impact of uncertain future income streams and the chances of unemployment on the ideal investment into education, hence introducing both uncertainty and unemployment into a standard human capital model. They argue that “[w]hen unemployment rates are high the demand for education rises and when the excess supply on the labor market diminishes the demand for education decreases (Groot and Oosterbeek, 1992, p.41)”. By explaining the intertwined connectivity between the job market conditions and the schooling choices, the authors propose that the opportunity costs, expressed as unrealized job earnings due to staying in school, decrease in times of high unemployment (Groot and Oosterbeek, 1992). Further, they state that a person is prone to increase investment levels into human capital during high unemployment rate levels, as by attaining a higher educational level it enriches the opportunities within the labor market (Teulings and Koopmanschap, 1989). Their empirical results show that uncertainty has an adverse effect on the return to education.

Gould, Moav, and Weinberg (2001) suggest that education enables individuals to adopt to technological change with technological enhancements displaying a form of uncertainty. In their model, a person is faced with the trade-off of either learning on the job to attain a "technology-specific" skillset or spend on traditional education to attain a broader skillset (Gould, Moav, and Weinberg, 2001). They show that through technological progress, the specialized workers are confronted with a higher risk of unemployment as their skillset may be rendered redundant. Further, their results suggest that generally educated workers who made high educational investments easily cope with technological progress. In their model, they introduce an element of risk by assuming that the workers are neither aware nor informed about how each sector is impacted by technological change. The evidence indicates that the workers integrate this risk into their decision by building up a "precautionary demand" with regards to educational investments, which results in a higher number of workers that decide in favor of increased general education to prevent this risk (Gould, Moav, and Weinberg, 2001). Thus, education serves as a form of insurance in times of uncertainty or technological progress, through which the individual's current source of earnings may be jeopardized (Gould, Moav, and Weinberg, 2001).

A number of economists have studied the relationship between education and culture in the past decades. Cheung and Chan (2008) find that national characteristics of culture as measured by Hofestede's cultural dimensions (Hofstede, Hofstede, and Minkov, 2010) have a substantial effect on educational spending and teacher-student ratio. Applying a cross-section of 43 countries of 2004, they show that two of the dimensions, namely power distance and individualism, strongly influence teacher-student ratio and educational expenditure (Cheung and Chan, 2008), with a negative effect of power distance and a positive coefficient of individualism on educational spending. French, French, and Li (2015) extend their work by looking at all six Hofstede cultural dimension and integrating PISA performance. Their results confirm Cheung and Chan (2008) results and contribute novel findings by showing an inverse relationship between educational spending and masculinity, and a positive one for long-term orientation (LTO). Figlio et al. (2019) solely focus on the dimension of LTO and examine the link between this cultural characteristic and educational performance of students with immigration background. The results show that individuals stemming from a higher LTO score cultures outperform other students. More broadly, a different strand of literature focuses on the significance of culture in decision-making. This is relevant to our study as it observes how far culture is a factor in the interplay of investments and expenditure. Varsakelis (2001) establishes, in a cross-sectional study of fifty countries, a correlation between cultural dimensions and R&D investment; a negative relationship between power distance and the investment in R&D emerges. Hofstede's cultural dimensions have shown to be an explaining factor in CEO's take-over decisions (Frijns et al., 2013), as well as in the context of ICT adoption rates across different countries with power distance and uncertainty avoidance as the essential correlating dimensions (Erumban and de Jong, 2006). Literature also suggests that national characteristics of culture are determinants of various decisions in the public and corporate sector such as risk-taking and hedging (Li et al., 2013; Lievenbrück and Schmid, 2014).

Very relevant for our paper are also the findings of Fan, Cheng, and Anwar (2020). Using the data from countries 36 states in the period from 2006–2016. In an empirical model with interaction terms, the authors examine the relationship between macroeconomic uncertainty expressed through the World Uncertainty Index (Ahir, Bloom, and Furceri, 2022), entrepreneurial activities and the Hofstede dimension of Uncertainty Avoidance. Fan, Cheng, and Anwar (2020) show that the effect of macroeconomic uncertainty on entrepreneurial activity depends on national culture. In particular, they find that in countries in which uncertainty avoidance is low, uncertainty stimulates entrepreneurial activity. While the presented literature is related to our work, to the best of our knowledge there is currently no study that examines the linkage between survey-based uncertainty about future economic developments, educational expenditures by government and households, and culture.

3. Conceptual Framework

In this section, we first clarify the way we use the concept of uncertainty in our research, given that our measure of uncertainty plays the role of the principal explanatory variable. We then proceed to explain the relevance of our research topic, by emphasizing the difference of educational expenditure from consumption and investment. We do so in particular with respect to the difference in their relationship with uncertainty. We then explain why we can expect that educational expenditure could be used by households and governments to respond to changes in uncertainty with the intention of reducing them. Presenting the logic of how individually faced uncertainty could in fact be endogenized by one's educational choices, we explain the relationship between uncertainty and educational expenditure which we expect to find in the data. Finally, by explaining why educational expenditure can be expected to depend on the long-term orientation of the decision-makers, and how different cultures may be more efficient than others in using education to produce output, we clarify what differences in educational expenditure and the effect of uncertainty on educational expenditure we expect to find across countries with different cultures.

Some previous work has distinguished between risk and uncertainty. Following the work on portfolio diversification of Tobin (1958) and Markowitz (1959), this work typically measures risk as the expected variability of future realizations of a variable (e.g. Lintner, 1965; Pindyck, 1991; Romer, 1990; Kode, 1986).While the exact realization in the future of such a variable is not known, the variability of its outcomes, such as that measured by expected standard deviation of the variable, is known. Even though variance itself as a measure of risk has also been criticized (e.g. Joyce and Vogel, 1970; Cox, 2008), uncertainty is seen by some as yet another phenomenon. Uncertainty, on the other hand, would represent the difficulty to form any expectation about the future, including an expectation of the future variability of a variable (see, e.g., Knight, 1921; Keynes, 1937). The related literature on the relationship between uncertainty and educational spending presented in Section 2 (e.g., Levhari & Weiss, 1974; Olson, White, and Shefrin, 1979; and Kodde, 1986) instead treats risk and uncertainty as synonyms, where uncertainty represents the expected variability of future realizations of a variable. In this paper, we follow that approach, whereby uncertainty is the risk related to the future economic conditions perceived by households or managers. Specifically, the greater is

the dispersion of answers to each question related to the expectations of the economic situation in the following 12 months, the greater we consider the uncertainty about the economic future in an economy. A limitation of our measure is however that we do not have data on what range of possible outcomes each individual foresees, but instead we construct a measure of uncertainty based on the dispersion of answers in the society. By assuming that households and managers can and do talk to their peers, referred to as "collective knowledge" by Kay and King (2020), we can conclude that the same indicator of uncertainty, the dispersion of views within the same group in the society, is also available to them when they make educational spending decisions. We believe that highly dispersed views would indicate, to an individual that gives some credit to the legitimacy of views of one's – informed and rational – peers, that uncertainty about the future is indeed elevated. This justifies our use of such a measure of uncertainty as a determinant of educational spending in our regression analyses.

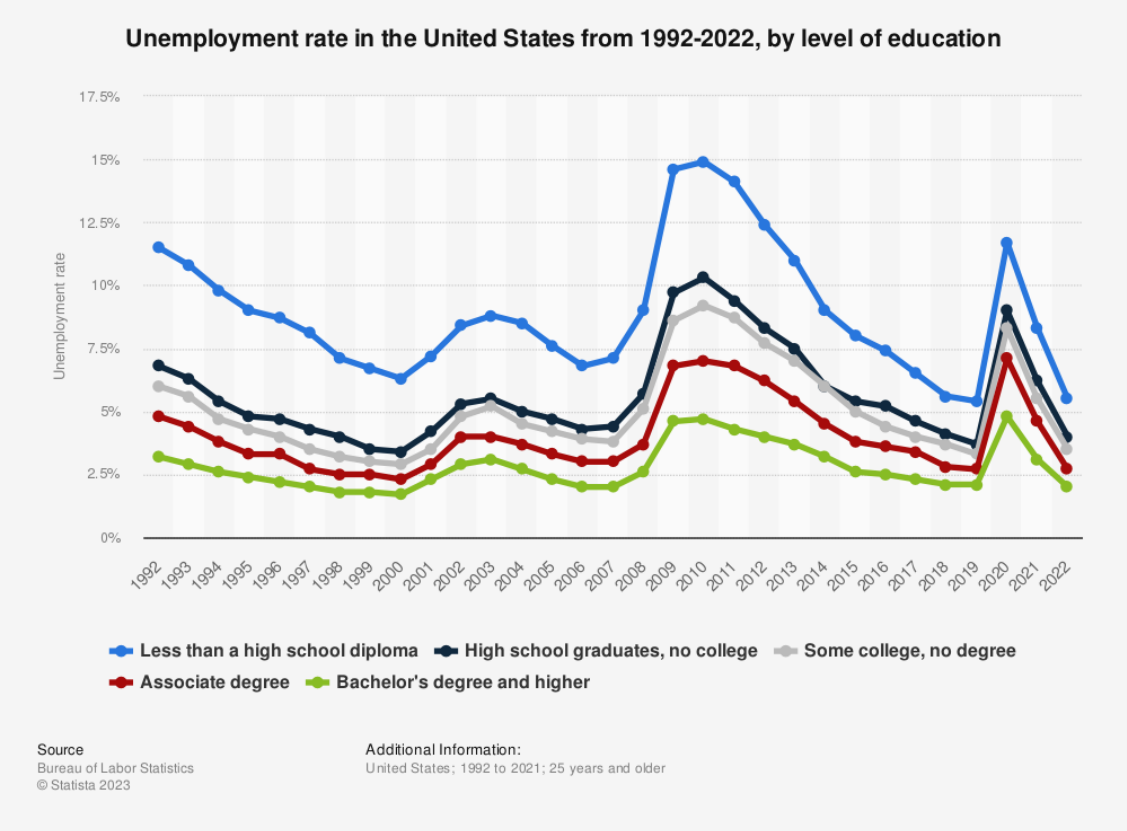
Different from previous work studying the economic effect of uncertainty on consumption and on investment (Radermacher, 2023a; Radermacher 2023b), this study examines the effects of uncertainty on educational expenditure separately. First, education leads to accumulation of knowledge which is an important determinant of competitiveness and long-term prospects of an economy (see, e.g. Mincer, 1984). It is a driver of productivity which features prominently in growth models (Stevens and Weale, 2004). Especially in the more developed economies – to which the EU countries belong – which are at the frontier of technology, growth is driven by innovations of both technology and processes which requires abilities and knowledge that can be developed through education.

Second, even though educational expenditure is in some aspects similar to both consumption and investment, in some important aspects it is different from both of them. Educational expenditure, just like consumption, is a spending that can be incurrent by households rather than businesses and in smaller amounts than most investments. Providers of education are providers of a service, and spending on education is consumption of a service. But, while consumption of for instance hotel services and entertainment gives immediate utility to the consumer, educational expenditure primarily affects the future level of utility by affecting the future earnings from labor. Educational expenditure is also different from investment into different types of fixed capital such as land, other real estate, factories, or machinery because investment into fixed capital gives future income from capital, while educational expenditure can be expected to increase future income from labor. Moreover, in the face of various sources of uncertainty, the prospects of receiving future income from educational expenditure as investment into human capital are different from those to receive income from investment into physical capital. For instance, uncertainty regarding the respect of property rights is more likely to endanger income from physical than from human capital; human capital is something that one can carry with oneself even when physical capital is destroyed or confiscated. Moreover, acquisition of some types of knowledge that make it easier to acquire new skills could give the flexibility to change jobs needed to succeed in an economy whose structure is frequently changing.

Third, we argue that educational expenditure as investment into human capital may be a way to lower the uncertainty about future income that one is facing. This is because it has been documented that the less educated not only face higher unemployment rates, but their

unemployment rates rise to a greater extent during crises (see, e.g., Groot & Oosterbeek, 1992). Figure 3.1 shows unemployment rates for different educational categories of US American population in the past thirty years: ‘less than a high-school diploma’; ‘high school graduates, no college’; ‘some college, no degree’; ‘associate degree’; ‘bachelor’s degree and higher’. We observe that, firstly, groups of individuals with higher educational achievement have lower average unemployment rates in all periods. Secondly, in times of rising unemployment, such as those following the burst of the dotcom bubble in 2000, the burst of the real estate bubble in 2007, and recent COVID-19 related crisis, the unemployment rates of less educated groups rise by more percentage points than the rates of the more educated groups. These two observations appear to hold across all educational groups presented. A similar pattern of differences in the unemployment rate across different educational groups in the European Union can also be observed in Figure 3.2 below. During the recent European Sovereign Debt Crisis, the unemployment rates of the less educated also seem to have risen by more percentage points than those of the more educated.

Figure 3.1: U.S. unemployment by level of education

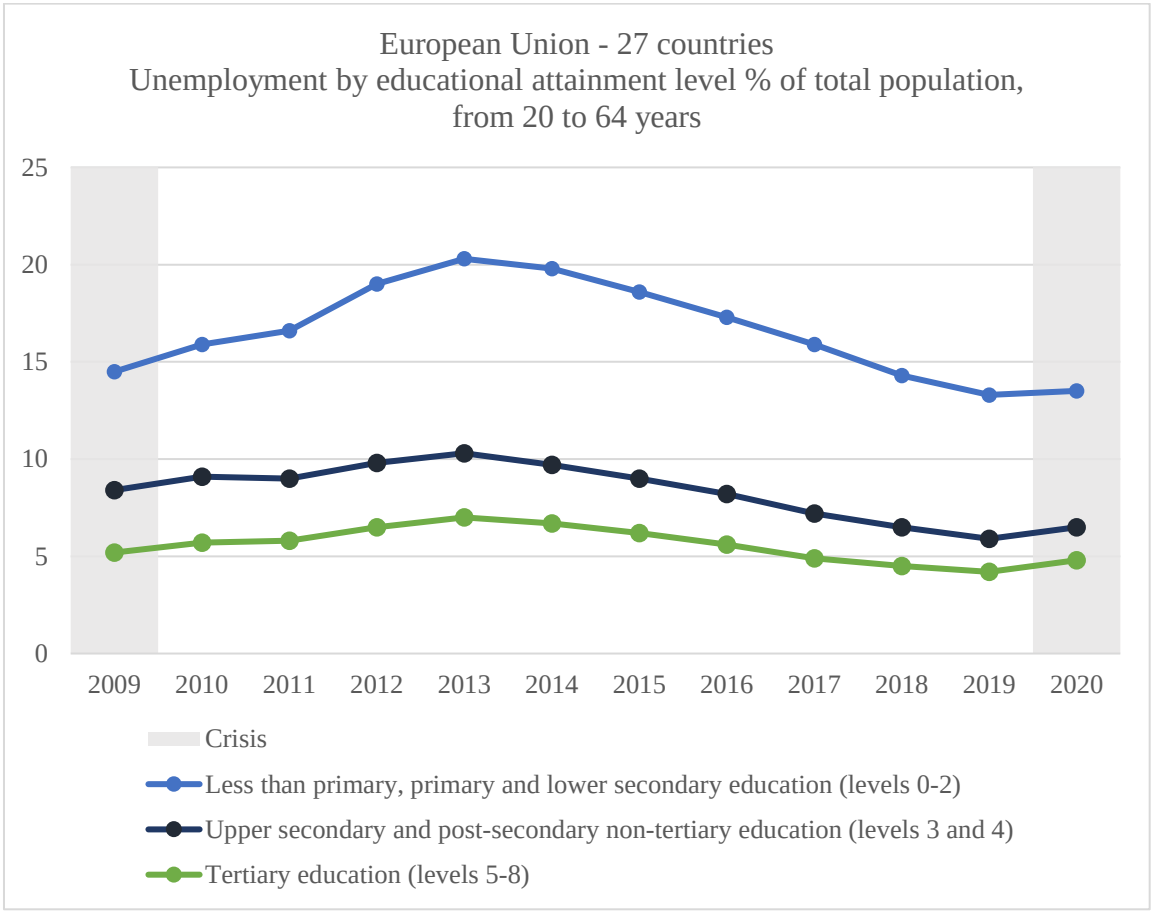


This figure illustrates the historical unemployment rate development from 1992 to 2022 by educational attainment level for the United States. The lines show that for the highest degree of education, the unemployment rate is the lowest. It is also observable that the lower the educational level the steeper the curve during the GFC of 2008. Source: Statista (2023).

The empirical evidence presented suggests that individuals could use education to not only lower their expected unemployment rate in the future, but also to lower the expected variability of this rate that results from crises with the aim of avoiding the larger increases of the

unemployment rate of the less educated (see, e.g., Gould, Moav, and Weinberg, 2001). Moreover, that governments could invest into education to lower the unemployment rate as well as the risk of becoming unemployed during crises for large parts of their population. In other words, individuals and governments may decide to increase educational expenditure in order to lower uncertainty about future income faced by individuals and national economies. For this reason, as long as variability of expected wage is inversely proportional to the educational level, we expect that educational expenditure should rise as a response to an increase in uncertainty, as households and governments would, we hypothesize, attempt to counteract the increase in uncertainty by changing the expected future position in the labor market of individuals and the propensity to unemployment of the labor force as a whole, respectively. In other words, we expect that the optimal response to the rise in the variability of labor income that results from macroeconomic factors would be choosing a higher educational level to endogenize the uncertainty faced and lower it.

Figure 3.2: EU unemployment by level of education



This figure illustrates the unemployment rate by educational attainment level from 2009 to 2020 for the European Union. The development resembles the U.S. picture, with the highest educational level associated with the lowest unemployment rate. Source: Eurostat (2023).

Finally, another implication of our conceptual framework is that decision on educational expenditure can be expected to depend on the culture of an individual or a society. This would be so for at least two reasons. Firstly, investment into human capital gives rise to income only in the future, while it requires immediate sacrifice through payment of education, investment

of time, and in some cases lower participation in the current job market. We therefore expect that the level of educational expenditure is proportional to the long-term orientation of the individual or the society which invests into education: the more a society is long-term oriented, the more it should spend on education or increase its spending on education when faced with rising uncertainty. Secondly, in part for cultural reasons, some individuals and societies may be better in transforming education into output and income. They could for instance work more, or work more efficiently, or be better in developing new working procedures or inventions using their knowledge. For this reason, we expect that the response of educational expenditure to changes in uncertainty should also depend on cultural characteristics of an individual or a society.

4. A Simple Model of Educational Choice

4.1 The Model

Consider a risk averse individual who decides on her investment in education, yielding some verifiable stock of knowledge (education) accumulated through schooling, vocational training, university studies, or training courses. In this spirit, we denote by $e \in [0,0.5]$ the total educational investment an individual makes during her life. The individual's private cost of education is represented by an increasing and strictly convex function, $c(e) = \frac{e^2}{k_1}$. In this cost function, the parameter k_1 reflects the long-term orientation of the individual and the society in which she resides. As k_1 increases, the society is more long-term oriented, thereby implying that the individual can more easily resist current temptations to spend her time differently than on education, for example by keeping in mind the benefits that higher education would bring her in the future. Accordingly, we assume that the individual's cost of education is inversely proportional to that cultural parameter. Equivalently, in the given society, education has a lower (perceived) opportunity cost.

Following the LEN model by Spremann (1987), the individual's preferences are represented by the following utility function:

$$u(w, e) = 1 - \exp(-rw - c(e)), \quad (1)$$

where w denotes her lifetime labor income (wage) and $r > 0$ is this person's Arrow-Pratt measure of absolute risk aversion. We assume that the individual's lifetime income from labor w is given by:

$$w = w_0 + \gamma Q + v \quad (2)$$

In Eq. (2), the variable w_0 represents some basic education-independent wage level, determined by person-, job-, industry-, country- and time-related characteristics, specific to the considered individual. Above and beyond this base wage, the individual's lifetime labor income is increasing by her lifetime output Q with a marginal reward of $\gamma > 0$, representing the proportionality between the individual's output and the wage determined in the local labor

market. Finally, the variable $v \sim N(0, Var(v))$ is a random variable representing factors which affect the individual's wage that are beyond her control ("pure chance"). We suppose that v captures all random elements that arise independently of her lifetime output and education level. We further assume that the individual's lifetime output Q is given by:

$$Q = k_2 e + \varepsilon, \tag{3}$$

which equals the sum of her educational level, weighted by another cultural parameter k_2, and another random variable $\varepsilon \sim N\big(0, Var(\varepsilon)\big)$. The cultural parameter k_2 serves to acknowledge that different cultures may be more or less effective in generating output from a given level of education e. For example, a country that is equipped with advanced technological institutions and facilities will be able to rapidly transform state-of-the-art technological skills into value. In the sequel, we will for short refer to k_2 as the cultural effectivity parameter. The random variable ε represents all non-deterministic elements affecting the individual's lifetime output, for example those related to the individual's educational level, her individual characteristics, or the macroeconomic environment. In line with the foregoing explanation regarding the different error terms, we assume $Cov(\varepsilon, v) = 0$.

Consistent with our conceptual framework, we assume that the total variance in the individual's lifetime labor output Q, $Var(\varepsilon)$, is a function of two distinct types of risk; the exogenous (systemic) macroeconomic risk, σ_m^2, and the individual's idiosyncratic (personal and innate) risk, σ_p^2. Moreover, in line with the discussion in Section 3, the individual's level of education also impacts on the total variance of her lifetime labor output and consequently income, as stated in the following assumption.

Assumption 1.

$$Var(\varepsilon) = f\big(e, \sigma_p^2 \sigma_m^2\big)$$
$$with\ \frac{\partial f}{\partial e} < 0, \frac{\partial f}{\partial \sigma_m^2}, \frac{\partial f}{\partial \sigma_p^2} > 0, \frac{\partial^2 f}{\partial e \partial \sigma_m^2}, \frac{\partial^2 f}{\partial e \partial \sigma_p^2} \leq 0, and\ \frac{\partial^2 f}{\partial \sigma_p^2 \partial \sigma_m^2} \geq 0 \tag{4}$$

According to Eq. (4), both the macroeconomic and the individual's personal risk positively contribute to the variability of an individual's lifetime output and, consequently, her lifetime income. The above formulation moreover implies that the effect which the macroeconomic environment – and its variability σ_m^2 – has on an individual's output may depend on that person's characteristics. As to the latter, notice that different individuals are characterized by different inclinations towards both risky behavior and dedication to work – the individual's personal risk σ_p^2 – thereby potentially resulting in differences across individuals' potential realizations of their life-time output, Q.

Assumption 1 also implies higher individual education is associated with lower total variability of income. Notably, the individual's educational level tends to moreover mitigate the impact of both the systemic risk, σ_m^2, and the individual's idiosyncratic risk, σ_p^2. The former is in line with the evidence presented in Figures 1 and 2 in Section 3, showing that employment status, and consequently output and income, tend to be less cyclical among the more educated.

Similarly, we presume that the effect of education is equivalently beneficial regarding the individual's personal risk.

A remark is in order. We model the variance-reducing effect of education through the random component of output, ε, rather than through the direct random component in the wage, v. Notice that this is in line with the evidence of Figures 1 and 2, testifying that education is in fact related to a lower variability of employment, thereby affecting labor income through changes in output.

For convenience, in the remainder of this section, we revert to the following functional specification for $Var(\varepsilon)$:

$$Var(\varepsilon) = (1 - e^2)\sigma_p^2\sigma_m^2 \tag{5}$$

This allows us to derive an explicit solution for an individual's optimal education level and, subsequently, simplifies the exposition of our comparative-statics results.[6]

Altogether, for a given base wage and educational level and denoting $Var(v)$ by σ_v^2, the total variability of the individual's labor income, w, given in Eq. (2) is given by:

$$Var(\gamma k_2 \varepsilon + v) = \gamma k_2 Var(\varepsilon) + Var(v) = \gamma k_2 (1 - e^2)\sigma_p^2\sigma_m^2 + \sigma_v^2 \tag{6}$$

Under the utility function, given in Eq. (1) the individual chooses her education level to maximize the certainty equivalent:

$$\begin{aligned} &\max_e \; E[w] - c(e) - \frac{r}{2} Var(w|e) \\ = &\max_e \; w_0 + \gamma k_2 e - \frac{e^2}{k_1} - \frac{r}{2}(\gamma^2 {k_2}^2 (1 - e^2)\sigma_p^2\sigma_m^2 + \sigma_v^2) \end{aligned} \tag{7}$$

The first-order condition yields:

$$\gamma k_2 - 2\frac{e^*}{k_1} + r\gamma^2 {k_2}^2 \sigma_p^2\sigma_m^2 e^* = 0 \tag{8}$$

$$e^* = \frac{\gamma k_2}{\frac{2}{k_1} - r\gamma^2 {k_2}^2 \sigma_p^2\sigma_m^2} \tag{9}$$

Reformulation yields the individual's optimal level of lifetime education:
As education levels are assumed non-negative, we have $\frac{2}{k_1} - r\gamma^2 {k_2}^2 \sigma_p^2\sigma_m^2 > 0$.

[6] Using the general formulation in Eq. (4) and applying the implicit-function theorem to the first-order condition of the individual's utility-maximization problem in Eq. (8) yields the same qualitative results. Notice that our functional specification satisfies the assumptions in Eq. (4) with strictly positive cross derivatives. We make a note wherever strict inequality is crucial for the results obtained.

4.2 Comparative Statics and Theoretical Predictions

In this subsection, we analyze the impact of the different model parameters on the optimal level of education (Proposition 1) as well potential modulating (cross) effects (Proposition 2). All formal proofs are relegated to Appendix B.

Proposition 1. An individual's optimal investment in education is strictly increasing in (i) the marginal reward γ, (ii) the personal risk σ_p^2, (iii) the macroeconomic risk σ_m^2, (iv) the individual's risk aversion, r, (v) the cultural long-term orientation k_1, and (vi) the cultural effectivity in utilizing the benefits of education k_2.

Eq. (A.1) in the Appendix proving Proposition 1(i) shows that there are two positive impacts of the marginal reward γ on the optimal level of educational expenditure. In particular, the positive impact on the optimal investment in education of γ that exists in the numerator of Eq. (9) is the *direct* effect arising via the favorable impact of education on the individual's wage (see Eq. (2)). While this feature is in line with standard agency models, in our model the incentive effect moreover atypically manifests itself via an *indirect* channel, thereby reinforcing γ's direct positive effect. More specifically, in the denominator of Eq. (9), γ reduces the variance of an individual's labor income – an effect driven by the favorable effect of education on the variance of labor output (see Eq. (4)).

Part (ii) and (iii) of Proposition 1 reflect that individuals with (ii) higher level of personal risk or (iii) confronted with higher macroeconomic risk opt for a higher level of investment into education, respectively. Intuitively, this allows them to mitigate the effect of the respective type of risk on the variability of their lifetime labor output and, consequently, income (see Eq. (4) and Eq. (2)). In line with the literature, Proposition 1(iv) verifies that more risk averse individuals, who experience lower utility levels when income is more volatile (see Eq(1) and Eq. (7)), opt for a higher level of investment into lifetime education. Intuitively, this lowers the variability their lifetime labor output and consequently their income (see Eq. (4) and Eq. (2)).

Turning to the cultural parameters, part (v) of Proposition 1 reflects the intuition that individuals with a more pronounced long-term orientation would invest more into education because, for them, postponing entering the job market because of attending school has lower opportunity cost than it has for individuals with a less pronounced long-term orientation (see Eq. (7)). As to Proposition 1(vi), Eq. (A.6) in the Appendix shows that the positive effect of cultural effectivity in utilizing the benefits of education, k_2, on the optimal level of educational expenditure evolves through two channels. Firstly, individuals with a larger k_2 invest more into education because any such investment brings them a relatively larger marginal increase in labor income (see Eq. (3) and Eq. (7)). Secondly, these individuals further benefit more from the variance-reducing effect of educational expenditure on lifetime income (Eqs. (4) and (7)).

The following proposition summarizes how our model parameters impact each other's marginal effects on an individual's optimal education level stated in Proposition 1.

Proposition 2. The positive impact of the macroeconomic risk σ_m^2 on an individual's optimal investment in education is strictly enhanced by (i) the marginal reward γ, (ii) the individual's personal risk σ_p^2, (iii) the individual's risk aversion, r, (iv) the cultural long-term orientation k_1, and (v) the cultural effectivity parameter k_2.

All the foregoing effects manifest themselves as positive cross derivatives of an individual's optimal investment into education with respect to the two respective parameters (see the proofs in the Appendix). Accordingly, each pair of considered parameters enforce each other's positive effect on the optimal level of education, respectively.

Regarding Proposition 2 (i), intuitively, the marginal reward increases the variance of lifetime income (see the last term in Eq. (7)). Thus, for any given change in macroeconomic risk, the response of increase in educational expenditure to mitigate it needs to be greater for individuals with greater marginal reward, γ, because the changes in macroeconomic risk result in greater changes in variability of lifetime income for these individuals. At the same time, a given change in educational expenditure leads to a greater increase in lifetime income for individuals with higher marginal reward, γ (see the second term in Eq. (7)), which is another factor that incentivizes a greater increase in optimal educational expenditure in response to a given change in macroeconomic risk among individuals with a higher marginal reward, γ.

In a similar vein, in relation to Proposition 2 (ii), note that the individual's personal risk, σ_p^2, increases the variance of lifetime income (see Eq. (7)). Intuitively, for any given increase in macroeconomic risk the corresponding increase in educational expenditure to mitigate it needs to be greater for individuals with greater personal risk, σ_p^2; the changes in macroeconomic risk result in greater changes in variability of lifetime income for these individuals. Regarding Proposition 2 (iii), more risk averse individuals experience greater reductions in their lifetime utility from variability of their lifetime income (see Eq. (7)). To make these reductions smaller, it is optimal for more risk averse individuals to increase their optimal educational level by more than others for a given change in macroeconomic risk.

Concerning Proposition 2 (iv), intuitively, the response of optimal educational choice to a given change in macroeconomic risk is greater for individuals for whom investment into education is less costly, i.e. for whom education has a lower opportunity cost proxied by the cultural long-term orientation, k_1 (see the third term in Eq. (7)). Finally, with respect to Proposition 2 (v), notice that a given increase in macroeconomic risk results in a greater increase in the variability of lifetime output, and hence income, for individuals with a greater cultural effectivity parameter, k_2 (see the last term in Eq. (7)). This in turn leads to a greater optimal increase in educational expenditure to mitigate this effect. At the same time, a given change in educational expenditure leads to a greater increase in lifetime income for individuals with higher cultural effectivity parameter, k_2 (see the second term in Eq. (7)). This incentivizes an even greater increase in optimal educational expenditure in response to a given change in macroeconomic risk among individuals with higher cultural effectivity parameter, k_2.

It is worth noting that in the standard decision framework where production and thus income risk is typically assumed perfectly exogenous to the individual, an individual's optimal decision is independent of his or her risk aversion as well as the variance of outcomes.[7] Intuitively, there is nothing the individual can do about the exogenous risk and thus it does not matter for her optimal decision. In our model, however, for any risk averse individual, the

[7] In standard agency models, however, the principal's optimal choice is typically affected by risk aversion and outcome variance as it enters her objective through the wage cost associated with the risk imposed on the agent by the imposed pay-for performance scheme.

optimal investment in education depends on his or her idiosyncratic risk, σ_p^2, and the systemic macroeconomic risk, σ_m^2. Specifically, the optimal education level is increasing in both types of risk for risk averse individuals. Intuitively, by investing in education the individual lowers the variability of her lifetime output and income (Eq. (4)), thereby yielding an additional incentive to invest in education. This incentive is further moderated by the person's degree of risk aversion, *r*; the greater the degree of risk aversion, the greater the optimal investment in education, e^*.

4.3 Empirical Implications of the Model

Based on our model, what can we conclude about the expected reaction of an individual to an increase in uncertainty? When we consider lifetime decisions, the existing educational level would correspond to the level of the highest level of macroeconomic risk σ_m^2 previously experienced by the individual. This is because an individual would further invest in her education in any point in life only if her educational level e is lower than the optimal educational choice e^* derived from the level of macroeconomic variability σ_m^2 experienced in that moment. The rise of macroeconomic risk σ_m^2 above the level ever experienced in an individual's lifetime should lead the individual to increase her level of education by spending on education.

Educational spending in a society in times of rising uncertainty would then correspond to the fraction of individuals who have not yet experienced such a high level of uncertainty, and their educational gap: difference between their existing and new optimal educational level. This gap would be even greater if we allow for education to depreciate over time: because of forgetting, and because of the changes in technology and organization of work which require new knowledge to be acquired. Note that rising levels of uncertainty should then produce less educational expenditure in countries that also in the past have undergone episodes of increased macroeconomic risk, making identification of an effect of macro uncertainty on educational expenditure more difficult to find in a time-limited panel of countries that we would use. On the other hand, the importance of previously experienced shocks in uncertainty for increases in current educational expenditure caused by current uncertainty would be inversely proportional to the extent of depreciation of education over time. This gap could be closed by both private and governmental educational expenditure. In the sections that follow, we proceed to test whether, in agreement with the predictions of our conceptual framework and the presented theoretical model, higher uncertainty led to increased educational expenditure in the sample of 20 EU member states and the 2005 to 2021 period.

Another implication of our model relates to the modulating effect of cultural parameters on the relationship between macroeconomic risk and educational expenditure. In all variants of our model, a rise in macroeconomic risk produces a greater increase in educational expenditure the greater is the cultural parameter k_2 that affects how productively societies transform education into output. We could interpret this to mean that increase in educational expenditure when macroeconomic uncertainty rises are more attractive in those societies where the additional education would have a greater effect on an individual's output and consequently her wage.

Moreover, in formulations of our model when cost of education is modeled as $c(e) = \frac{e^2}{k_1 \sigma_m}$, to reflect our expectation that the opportunity cost component of the cost of education is lower

when macroeconomic uncertainty is greater, a rise in macroeconomic risk produces a greater increase in educational expenditure the greater is the cultural parameter k_1 that affects how long-term oriented the societies are. The logic here would be the following: educational increases initiated by increses in macroeconomic risk would be greater in countries where they are less costly in terms of their opportunity cost beacuse of higher "patience"/long-term-orientation.

5. Data

To study the effect of uncertainty on educational expenditures across Europe, we use an aggregate yearly panel data of 20 EU member states[8] from 2005 to 2021. We use several categories of aggregate educational expenditure by household and government - sourced from the European Commission's database Eurostat (Europan Commission – Eurostat, 2023) - as dependent variables. The principal independent variables are household and business uncertainty measures, constructed using the Joint Harmonised EU Programme of Business and Consumer Surveys (European Commission Directorate-General for Economic and Financial Affairs, 2022). Several additional control variables are also included; these are: GDP per capita, gross disposable income per capita, inflation, unemployment, and the interest rate.

Table 5.1: Data and sources of the variables

Data	**Sources**
Government Expenditure EDUC	European Commission *eurostat*, General government expenditure by function (COFOG) [gov_10a_exp], Education, Million Euro
HH consumption EDUC	European Commission *eurostat*, Final consumption expenditure of households by consumption purpose (COICOP 3 digit) [nama_10_co3_p3], Education, Chain linked volumes (2010), million euro
Business Uncertainty Indicator	European Commission, Directorate - General for Economic and Financial Affairs,The Joint Harmonised EU Programme of Business and Consumer Surveys (EU BCS)
HH Uncertainty Indicator	European Commission, Directorate - General for Economic and Financial Affairs, The Joint Harmonised EU Programme of Business and Consumer Surveys (EU BCS)
Inflation	European Commission *eurostat* , HICP - annual data (average rate of change) [prc_hicp_aind]
Unemployment	AMECO, unemployment rate of active population
GDP per capita	European Commission *eurostat* , Chain linked volumes (2015), million euro
Gross disposable income per capita	European Commission *eurostat* , real disposable income per inhabitant
Hofstede's culture dimensions	https://www.hofstede-insights.com/
Thrift	World Value Survey Question

5.1 Educational Expenditure

To capture public and private spending on education, we include the annual data on general government and household expenditure on education and its sublevels (e.g. primary, secondary, tertiary, not-definable by level, etc) for 20 countries by function provided by the European Commission's database Eurostat on an annual basis. On the general government expenditure side, the sublevels of education are: (1) 'Pre-primary and primary education', (2) 'secondary',

[8] The included countries are: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, and Sweden.

(2.5) ‘post-secondary non-tertiary’, (3) ‘tertiary’, (4) ‘education not definable by level’, (5) ‘subsidiary services to education’ (e.g., subsidizing school busses), (6) ‘R&D education’, (7) ‘education not elsewhere classified’ (n.e.c.) (following formulation according to Eurostat). For the classification of household consumption expenditure on education, Eurostat data follows the uniform logic for sublevel (1) to (4). The remaining levels do not apply to household educational expenditure (see

Table 0.2 for full definition according to Classification of the functions of the government – COFOG). Educational expenditures ‘not definable by level’ are especially programs for adult (e.g., vocational training and cultural development; see

Table 0.2). We standardize the educational expenditure variables into per capita terms to adjust for wealth and size of the varying countries in our data set. Out of the 2021 sample of 20 EU member states on governmental educational expenditures, primary amounts to 34%, secondary to 37%, tertiary to 16%, not definable level to 3%, subsidiary services to 7%, and not elsewhere classified 2%. R&D to education and post-secondary amount to the remaining minor shares. For household educational expenditures, the split accounts for 20% in primary, 17% in secondary, 3% in post-secondary, 31% in tertiary, 44% in not definable.

5.2 Uncertainty Indicators

For a long time, stock market volatility has been the standard way of capturing uncertainty in the financial markets. However, in the last two decades, theoretical and empirical concepts have led to various novel measures, which can be classified as newspaper-based, survey-based, econometric-based and market based (Cascaldi-Garcia et al., 2023). We elicit the survey-based strand of literature that includes the application of survey-dispersion measures influenced by the seminal work of Bachmann, Elstner, and Sims (2013) (see, e.g., Girardi and Reuter, 2017; Claveria, 2019, Beckmann et al., 2023). This line of research observes the divergence in how outlook is perceived by households and business stakeholders from various sectors.

Following Girardi and Reuter (2017), we calculate our uncertainty measures using the publicly available, aggregate EU BCS data by the European Commission.. They apply the formula of Bachmann, Elstner, and Sims’ (2013) work, that was originally used on micro-level data, to the monthly macro-level data set of the EU BCS (European Commission Directorate-General for Economic and Financial Affairs, 2022) which includes six surveys: manufacturing industry, construction, consumers, retail trade, services, and financial services (Ibid.). Some surveys are, additionally, conducted quarterly or semi-yearly. Nominal sample size amounts to 32 000 on the consumer survey and 134 000 companies on the business survey side, with the real size being 30% smaller. Sample size by country is presented in the Appendix to this paper.

The data are provided either as the fraction per positive and negative answer at time t in country c, or as balance of these fractions denoting the difference between positive and negative

fraction answers. One of our measures of uncertainty is based on the fraction of answers within the consumer survey, the household uncertainty indicator, while the second measure is based on the responses from the industry, construction, retail trade and services surveys, the business uncertainty indicator. Like Girardi and Reuters' (2017), we use only the forward-looking questions. They address the assessment of future economic developments of the firms and financial situation of the household. Table 5.2 includes the complete list of the forward-looking questions which we use.

Using the detailed split of fraction per answer choice (1), we compute the monthly survey dispersion for each country and point in time, using the following formula (Bachmann, Elstner, and Sims, 2013):

$$DISP_{qt} = \sqrt{fraction_{qt}^{+} + fraction_{qt}^{-} - \left(fraction_{qt}^{\pm} fraction_{qt}^{-}\right)^2}; \quad (10)$$

With $fraction_{qt}^{+}$ indicating the share of aggregated survey respondents that assess an increase or an improvement ("plus") to the respective question at a given point in time t, while $fraction_{qt}^{-}$ indicating the aggregated share of respondents that perceive a future decrease or deterioration ("minus") in the respective matter. The more divergence there is across the answers, the higher is the perceived uncertainty.

Table 5.2: Survey questions for the ex-ante uncertainty measure

Survey	Questions included for the Uncertainty Measure	Response Scheme
Consumer survey	**Q2** How do you expect the financial position of your household to change over the next 12 months? It will…	+ + get a lot better + get a little better = stay the same − get a little worse − − get a lot worse N don't know.
	Q4 How do you expect the general economic situation in this country to develop over the next 12 months? It will...	+ + get a lot better + get a little better = stay the same − get a little worse − − get a lot worse N don't know.
	Q6 By comparison with the past 12 months, how do you expect that consumer prices will develop in the next 12 months? They will…	+ + increase more rapidly + increase at the same rate = increase at a slower rate − stay about the same − − fall N don't know.
	Q7 How do you expect the number of people unemployed in this country to change over the next 12 months? The number will...	+ + increase sharply + increase slightly = remain the same − fall slightly − − fall sharply N don't know.
Industry Survey	**Q5** How do you expect your production to develop over the next 3 months? It will...	+ increase = remain unchanged − decrease
	Q6 How do you expect your selling prices to change over the next 3 months? They will...	+ increase = remain unchanged

		− decrease
	Q7 How do you expect your firm's total employment to change over the next 3 months? It will...	+ increase = remain unchanged − decrease
Service Survey	**Q3** How do you expect the demand (turnover) for your company's services to change over the next 3 months? It will…	+ increase = remain unchanged − decrease
	Q5 How do you expect your firm's total employment to change over the next 3 months? It will...	+ increase = remain unchanged − decrease
	Q6 How do you expect the prices you charge to change over the next 3 months? They will…	+ increase = remain unchanged − decrease
Retail Trade Survey	**Q3** How do you expect your orders placed with suppliers to change over the next 3 months? They will...	+ increase = remain unchanged − decrease
	Q4 How do you expect your business activity (sales) to change over the next 3 months? It (They) will...	+ improve (increase) = remain unchanged − deteriorate (decrease)
	Q5 How do you expect your firm's total employment to change over the next 3 months? It will..	+ increase = remain unchanged − decrease
	Q6 How do you expect the prices you charge to change over the next 3 months? They will…	+ increase = remain unchanged − decrease
Construction Survey	**Q4** How do you expect your firm's total employment to change over the next 3 months? It will...	+ increase = remain unchanged − decrease
	Q5 How do you expect the prices you charge to change over the next 3 months? They will...	+ increase = remain unchanged − decrease

This table lists the forward-looking questions that are included in the calculation of the household and business uncertainty indicator as well as the balance control variable for the empirical model. The forward-looking window for consumers is 12 months and for business managers three months. Further, the response metric for households includes six options, while for business the answering scheme is limited to three options. Source: User guide (European Commission Directorate-General for Economic and Financial Affairs, 2022), p. 27-47.

The survey dispersion calculation renders a dispersion between 0 and 1 for each survey question. The obtained time series are subsequently standardized and rescaled to 100 (following Girardi and Reuter, 2017), with 100 representing the average uncertainty level in each country for the respective time series (2005-2021) with a standard deviation of +/-10. As the raw data are captured monthly, our independent variable is adjusted to yearly averages to match the dependent variables measuring educational expenditure. For the business uncertainty indicator, we follow the weighting scheme[9] used by the European Commission to conduct sentiment indicators with the industry (manufacturing) sector carrying the highest share. Unlike Girardi and Reuter (2017), who form a single uncertainty indicator, we construct separate business and household uncertainty indicators.

Moreover, we elicit the balances data set to construct a control variable that captures the average level of pessimism and optimism respectively (following Balta, Fernandez, and Ruscher, 2013). For the households, we utilize the survey question on financial position of the

[9] Following the scheme of the EU commission and excluding consumer of the weighting, it yields 50% for industry, 38% services, 6% retail trade and 6% construction (European Commission Directorate-General for Economic and Financial Affairs, 2022; authors' calculations).

household for the next 12 month to adjust for the average prospect. For the business surveys, we construct a weighted average following the weighting scheme of the EU BCS user guide (European Commission Directorate-General for Economic and Financial Affairs, 2022) to construct a weighted balance of the analogous questions asked to managers. Separately, we also include as an isolated balance the manufacturing questions regarding future employment of the firm and its future production. The composition of balances follows the following formula (11) for when the metric has only one positive (P) and one negative (M) choice and metric (12) for

$$B = P - M \tag{11}$$

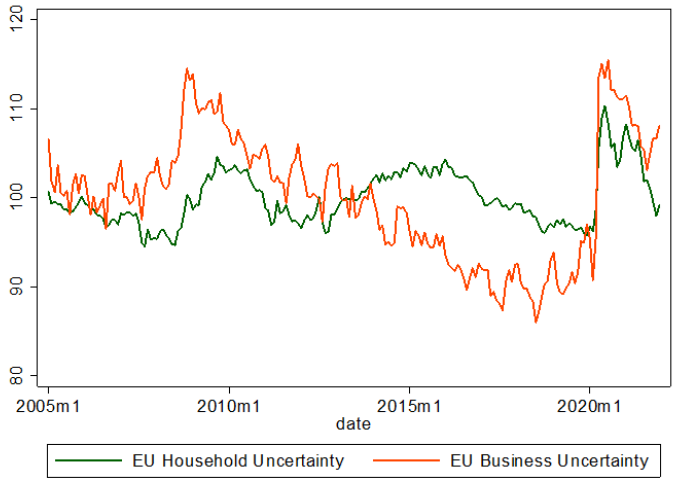
$$B = (PP + ½P) - (½M + MM) \tag{12}$$

when there are two positives (PP) and two negative (MM) answer possibilities (Ibid., p.13).

These formulas show that the final value ranges from -100, with only the negative answers (or the MM for the most negative answer in the household metric),to +100 when all survey respondents select the most positive answer (Ibid.). We take the arithmetic average of the seasonally adjusted balances to construct the household and the business average prospect.

While survey dispersion provides an approximation of uncertainty, it is important to highlight some limitations that are inherent in the measure of survey dispersion. As this survey is an aggregation of disagreements across various industries, it may be that the quantified uncertainty is bound to that sector and may not be a general uncertainty, hence survey respondents may be biased by their situation. Analogous for households, they might be influenced by their personal situation in answering general economic outlook questions. As outlined by Girardi and Reuter (2017), in answering the sector-specific outlook questions, it may be that there is a high divergence due to deviating sets of information and facts.

Figure 5.1: Monthly EU household and business uncertainty

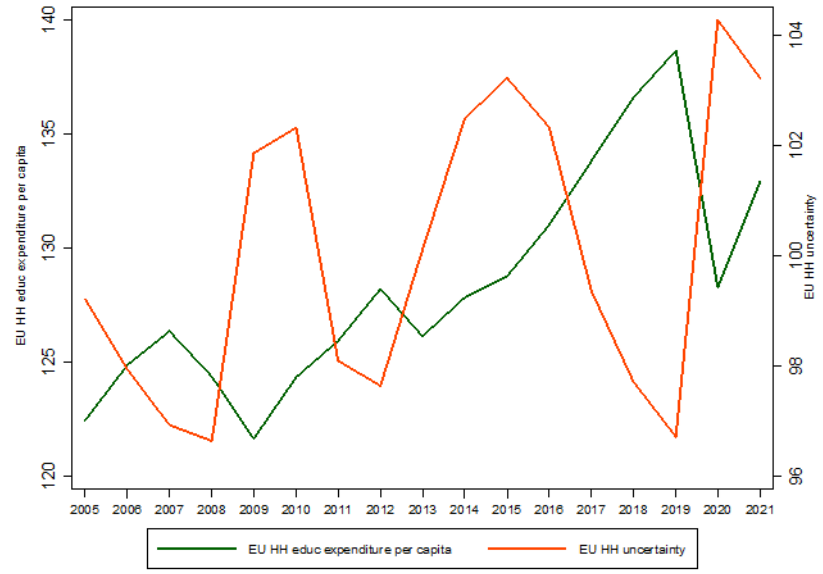


This figure shows the monthly fluctuations of the household and business uncertainty indicator for the 20 EU member states of our sample from 2005 to 2021. Business uncertainty indicator has a wider range between min and max, with only two significant periods of uncertainty shock during the GFC of 2008 and COVID-19. Household uncertainty seems to oscillate more frequently reflecting, in addition to the two mentioned crises, the shock of the European sovereign debt crisis. Notably, the COVID-19 period shows a short recovery of the business uncertainty indicator with a trend that tilts up at the end.

Figure 5.2: EU government educational expenditures and business uncertainty

This figure depicts the EU government educational expenditures in per capita terms with the business uncertainty indicator. It shows notably a strong rise in educational spending during crises times, particularly during the GFC of 2008, with a decrease in spending on education as of 2010. As of 2013 educational spending has continuously risen with a sharper increase since the onset of the COVID-19 crisis.

Figure 5.3: EU household educational expenditures and household uncertainty



This figure illustrates the EU household educational expenditures in per capita terms with the household uncertainty indicator. Intuitively, it shows a negative relationship between both variables, with household spending on education decreasing during times of crises.

It is worth mentioning that the DG ECFIN has enriched the survey with an additional question that is used to measure economic uncertainty. This Economic Uncertainty Indicator

by the European Commission has been introduced in May 2021, with a prior pilot period in 2019 (European Commission Directorate-General for Economic and Financial Affairs, 2022).

The respondents are being asked whether "*The future development of your business situation is currently (++) easy to predict, (+) moderately easy to predict, (-) moderately difficult to predict or, lastly, (--) difficult to predict* (Ibid., p.21)." This question is extracted from the business survey that is analogous for all four surveys: industry, services, retail trade and construction. The equivalent for the household survey exchanges "future development" with "future financial position/situation of your household (Ibid., p.21)." Using the balances of the five surveys, the sector weights[10] that are similarly used for other indicators by the European commission is applied. As the time series only dates to May 2021, the usage of this question is negligent for our study period.

5.3 Cultural Indicators

Hofstede, Hofstede, and Minkov (2010) refer to culture as "the collective programming of the mind that distinguishes the members of one group or category of people from others" (ibid, p.6). Our dataset includes six cultural dimensions of Hofstede, Hofstede, and Minkov (2010) in the context of the relationship between uncertainty and educational expenditure: Uncertainty Avoidance, Power Distance, Masculinity, Individualism, Indulgence, and Long-term orientation. Indulgence and Long-term Orientation have only been added as part of the 2010 edition of Hofstede, Hofstede, and Minkov`s book "Cultures and Organizations: Software of the Mind", in addition to the four existing ones. While the original study has been conducted between 1967 and 1973 executed at IBM that generated a comprehensive data set of a value metric. Hofstede exploited the data of 50 countries in his dataset. The latest construction of the national dimensions is based on a reproduction and augmentation of the IBM study as well as the usage of data from the World Value Survey (Value). It is also important to state that the national scores of the Hofstede model refer to differences in cultural characteristics from one country and can only be referred to in comparison to other countries (Hofstede Insights, 2022).

The Power Distance Index quantifies the amount of societal inequality. In a lower scored Power Distance country, there is little distance between manager and subordinate, with low inhibition threshold to contact and seek advice from the superior. The dependence level is rather low. For a country with a higher index on the Power Distance dimension, one can observe a sizable dependence level between manager and subordinate. Employees are rather obedient and unlikely to disagree with their superiors. They tend to refrain from approaching their superiors or seeking consultation (Hofstede, Hofstede, and Minkov, 2010).

Individualism as opposed to collectivism describes a society that is designed to focus on themselves and their direct relatives rather than seeing the collective society. The distinguishing element is the perception of oneself in "I" vs. "we" (Ibid.).

[10] The sector weights are distributed as follows: Industry 40%, services 30%, consumers 20%, construction 5% and retail trade 5% (European Commission Directorate-General for Economic and Financial Affairs, 2022, p.18).

The Masculinity dimension with the opposite being femininity describes a society in which values such as "tough", "assertive" and "materialistic" make up a masculine world (Ibid., p.140). In a society that is referred to as feminine, both men and women are driven by values of modesty, tenderness, and interest for the disadvantaged individuals (Ibid.).

The Uncertainty Avoidance Index quantifies the level to which nations are inclined towards avoiding ambiguity and uncertainty, the extent to which one feels jeopardized by the unknown. This is measured by observing the urgency of defining and the existence of rules and regulations, the extent of identification with a company, and the level of anxiousness at the workplace (Ibid.).

One of the two dimensions that resulted from the World Value Survey and were added later in the process of re-defining the Hofstede model is the dimension of Long-term Orientation as opposed to Short-Term Normative Orientation. The construction of this measure is based on three components. The survey respondents are asked about thrift behavior, their standpoint towards national pride and, lastly, the relevance to them of serving others (Ibid.). Hence, long-term oriented cultures are driven by their dedication towards the future, while short-term oriented nations base their value set on both the past and the present with a high importance of adhering to traditions. They hesitate towards embracing change as they regard it critically (Ibid.). In the robustness test, we isolate the measure of thrift from the LTO measure to see how this isolated dimension impacts the linkage between uncertainty and educational expenditures. For this, we use the data from the sixth wave of the World Values Survey (Inglehart et al., 2014). The other measure that resulted from the WVS, as well as the sixth and final dimension of national business culture is defined as the Indulgence dimension, with the opposite being restraint. This measure includes three questions from the WVS that allude to "happiness", "life control" and "importance of leisures" (Hofstede, Hofstede, and Minkov, 2010, p.280). A culture with high indulgence carries virtues that foster free fulfillment of desires and prioritizes replenishing the moment and enjoying life. Restrained cultures prevent free gratification by means of regulation and restriction (Ibid.).

The scale of Hofstede's cultural dimensions[11] ranges from 0 to 100. As depicted in Table 5.3 there are considerable differences within Europe that justifies a deeper look at cultural characteristics as the scale for LTO varies between 24 and 83 and with the largest range for masculinity from 5 to 100. Hence, we argue that there are significant differences across countries denoting substantial heterogeneity. For scale for thrift on the other hand varies between zero and one, with a smaller range within our sample relative.

[11] The reported thrift data does not include Austria, Belgium, Denmark, Greece, and Portugal in its data set.

Table 5.3: Descriptive statistics for cultural dimensions

Variable	Obs	Mean	Std. Dev.	Min	Max
long-term orientation	340	59.40	16.85	28.00	83.00
uncertainty avoidance	340	70.75	20.91	23.00	100.00
power distance	340	49.85	19.98	11.00	100.00
individualism	340	60.60	15.59	27.00	80.00
masculinity	340	44.45	27.12	5.00	100.00
indulgence	340	41.00	20.54	0.00	78.00
thrift	255	0.42	0.08	0.23	0.58

5.4 Other Control Variables

We control for unemployment and GDP per capita in the model to account for any changes in educational expenditures that may be driven by those two componentsAs the theoretical and empirical propositions show the individual is facing the option to either stay in school or enter the labor market right away. The option of pursuing further education involves the opportunity costs of forgone earnings which declines in times of crises decrease when unemployment rises (Groot and Oosterbeek, 1992). To control for governmental budget's capacity, we include GPD per capita. To instead control for households' budget, we include real disposable income per capita instead of real GDP per capita. All aforementioned variables are annual and sourced from Eurostat (Europan Commission – Eurostat, 2023).

Additionally, we control for interest rate and inflation for other influences on the purchasing power of households. High or low interest rates could have an impact on the expenditures level as debt is cheaper with low interest rates. Long-term interest rate is sourced from AMECO database (European Comission – AMECO, 2023). For the price level households face, Eurostat provides the annual average rate of changes for the Harmonised Index of Consumer Prices (HICP) (Europan Commission – Eurostat, 2023b).

Table 5.4: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Total educ expenditures per capita	340	1434.1	754.0	505.1	3312.5
Total government educ expenditure (gee) per capita	340	1314.9	757.5	414.9	3216.9
Total household educ expenditure (hee) per capita	340	119.2	65.7	36.2	363.3
gee primary	340	461.2	399.3	57.8	2044.0
gee secondary	340	461.2	257.6	114.6	990.8
gee post-secondary pre-tertiary	340	5.9	8.9	0.0	37.0
gee tertiary	340	248.5	183.8	69.5	805.5
gee n.d.	340	46.9	41.7	0.0	219.0
gee subsidiary services	340	51.7	47.2	3.5	224.9
gee R&D	340	10.9	15.4	0.0	90.9
gee n.e.c.	340	28.6	15.3	0.8	86.0
hee primary	323	27.8	21.8	0.0	97.8
hee secondary	323	23.8	31.2	0.0	171.1
hee post-secondary pre-tertiary	306	6.0	8.6	0.0	32.1
hee tertiary	323	31.5	19.8	0.0	77.6
hee n.d.	340	35.0	24.7	0.0	98.2
Business uncertainty	340	100.0	8.4	84.0	121.0
Household uncertainty	340	100.0	4.8	85.7	112.2
Weighted business balance	335	4.6	9.0	-28.4	26.5
Manufacturing balance - Q5 Firm's production expectations	340	9.5	10.5	-19.4	38.0
Manufacturing balance - Q7 Firm's employment expectations	340	-2.7	11.2	-42.0	24.7
HH balance - Q2 Financial position expectations	340	-3.7	13.4	-67.8	16.5
HH balance - Q7 Unemployment expectations	340	20.8	21.2	-26.9	87.7
GDP per capita	340	24381.8	11630.3	7510.0	50010.0
Gross disposable income per capita	340	18506.3	4933.3	8205.0	30468.0
Unemployment rate (%)	340	8.8	4.5	2.0	27.8
Inflation (%)	340	2.0	1.9	-1.4	15.3
Interest rate (%)	331	1.0	3.6	-12.3	24.4

6. Methodology and Main Results

The aim of this paper is to study the effect of surveyed uncertainty on educational expenditure of governments and households., We examine this relationship in a log-linear empirical model using country-fixed effects and controlling for various factors that may influence educational expenditures. Based on our research questions, the presented conceptual framework and the supporting theoretical model, we formulate the following hypothesis to test in our empirical model.

H1: Heightened uncertainty increases educational spending.

Equation (13) below presents our basic empirical model:

$$\begin{aligned}\ln(EducExpendPerCapita_{ct}) = \quad & \alpha_c + \beta_1 Uncertainty_{ct} \\ & + \beta_2 ln\,(GDPPerCapita)_{ct} + \beta_3 unemployment_{ct} \\ & + \beta_4 inflation_{ct} + \varepsilon_{ct}\end{aligned} \tag{13}$$

With α_c denoting country fixed effects, c the country in the cross-section, t referring to the point in time and ε_{ct} representing the error term. The dependent variable is expressed as $\ln(EducExpendPerCapita_{ct})$, which is the log of educational expenditures in per capita terms for both, government, and households. $Uncertainty_{ct}$ is the respective uncertainty indicator – for households and for businesses, respectively. The uncertainty variable is an index-

based measure with 100 setting the average country level of uncertainty based on the time series of 2005 to 2021. For households' educational expenditure in relation to households' uncertainty, the control variable $ln\,(GDPPerCapita)_{ct}$ is substituted with gross disposable income per capita. We standardize both the dependent $EducExpend_{ct}$, the control variable of GDP, and gross disposable income to per capita terms, and use the natural logarithm form of these variables. In addition, for each government and household, we perform separate regressions for their subcomponents of educational expenditure to examine their isolated impact of uncertainty on expenditure. We control for unemployment rate and inflation in the baseline model.

We start by examining educational expenditure of governments. Table 6.1 shows the empirical results of our baseline model for total governmental educational expenditures (GEE) and subcomponents of GEE. For the study period of 2005 to 2021, our results suggest a positive relationship between business uncertainty and governmental educational expenditures, moreover with statistical significance for all subcomponents except for post-secondary pre-tertiary and R&D. As one standard deviation in the business uncertainty indicator equals 8.4 (min 84 and max 121), we refer to ten index points rise in uncertainty to simplify. A ten-index-points increase in business uncertainty results in a 6 percent increase in total governmental educational expenditures per capita, thus displaying economic significance. The highest uncertainty beta is observed in the not definable subcomponent of educational expenditures. For this subgroup, our estimates suggest a strong increase in educational expenditures (+19% for 10 index points of uncertainty) during heightened uncertainty. The not definable subcomponent includes different forms of training targeting mainly adults, e.g. computer training and language training; the coefficient may mean that it is financed or subsidized by governments during times of uncertainty (see Appendix

Table 0.2 for detailed information on subcomponents of educational expenditure). This uncertainty beta is followed by a strong coefficient for the not elsewhere classified category of educational expenditure, including for example administrative expenditures that are not otherwise disclosed, with a positive impact of 11 percent, however this category represents a minor share in expenditures. Further, the high uncertainty beta for the not definable level, which encompasses for example vocational training and further education mainly for adults, may be explained by the budget constraint governments and households face, as they have less money and shift to more affordable types of education that may be instrumental in a change of professions, especially in times of uncertainty. These results confirm our first hypothesis H1.

It is important to note that the effect of the natural logarithm of GDP per capita on various categories of educational expenditure of governments is always positive and almost always statistically significant. We interpret this as meaning that the positive effect of uncertainty on educational expenditure of governments does not merely speak of some countercyclical fiscal policy, given that fiscal policy is controlled for by using GDP. Instead, it speaks of an effect of uncertainty on top of any effect of cyclicality in governmental spending.

We add the weighted[12] balance as a composite of the analogue questions included in the business uncertainty measure (see Balta, Fernandez, and Ruscher, 2013), to control for the effect of the average expectation of households or businesses about the future. With a higher share in positive answers regarding the business outlook, there is a negative impact on GEE alluding to a countercyclical effect. In times of pessimistic outlook, there might be more need to spend on education from the government's perspective. The results for the balance are statistically significant for total GEE, primary education, subsidiary services to education, and R&D in education. The uncertainty beta decreases for primary education by two percentage points compared to results when no control for the average prospect of the economy is included, yielding a positive impact of uncertainty on primary education of 6%. A sensitivity test in Table 6.2 exchanges the weighted business prospect variable with the balance of the manufacturing survey regarding the future production activity. As this sector displays the largest share in value, we study how this balance regarding an outlook as a control variable affects the relationship. The coefficient of the control variable continues to carry a negative sign with more optimism towards future production resulting in lower governmental expenditure on total education.

We proceed to present the results on the effect of uncertainty on households' educational expenditures. The baseline estimation results for the effect of uncertainty on total private households' expenditure on education, shown in Table 6.3, are statistically insignificant. The results on the other hand suggest a positive impact of elevated uncertainty on expenditure on higher, tertiary, education. This may suggest that households when facing a higher degree of unpredictability increase their spending on tertiary education, for example by continuing to stay in college or to continue their education rather than entering the job market. The real disposable income per capita seems to have a negative effect on tertiary household spending as well as unemployment. Negative contemporaneous correlation between disposable income and spending on tertiary education may indicate that in periods of weak economy people enroll or stay in tertiary education longer. The higher the unemployment the less is spent on education on tertiary and all other education spending levels. This supports the adverse effect observable on the government side as well. The higher the unemployment rate, the greater is the budget constraint of households. Regarding the effect of another control variable, inflation, the results for households are different from those of governments. While in periods of high inflation governments may experience an increase in income from tax, households would simultaneously experience a decline in purchasing power, explaining the predominantly negative impact of inflation on the educational expenditure of households.

When adding the balance of households on being asked about their expectations on their financial position in the next 12 months (Q2; see Balta, Fernandez, and Ruscher, 2013), higher average optimism leads to higher spending on total household education and tertiary as well as not definable expenditures (see Table 6.4). This control variable yields a negative, statistically significant relationship between the uncertainty and not definable expenditures. Higher uncertainty contracts the expenditure on not definable component of education by five percent. One could suspect that this suggests a substitution effect, as government in the face of

[12] Manufacturing (industry) is weighted by 50%, services by 38%, construction by 6% and retail trade by 6%.

heightened uncertainty increases spending within this sub-segment, while households may face different spending priorities when their budget contracts. The effect on tertiary education remains positive and suggests a five percent increase for an increase of ten index points in uncertainty (two standard deviations).

It seems that households prioritize higher education over “nice to have” courses and advanced training confirming the baseline estimation results. One may argue that the observed precautionary saving motive that settles in with heightened uncertainty affects almost all levels of education, except for higher education. This positive effect may speak in favor of a form of insurance that household’s resort to in unpredictable times. Through attaining a higher educational degree households may attempt to lower the expected variability of future income, using education as a shield against uncertainty. We moreover argue that any effect of uncertainty on higher (tertiary) education could be more important than on obligatory education (such as primary) because it is more likely to result in more years spent in school. We are not able to judge based on our results whether there is an impact of uncertainty on the decision to enroll in higher education, as we can merely speak about the level of spending on tertiary education in our data set. Theoretical and empirical frameworks predominantly suggest that households build up a saving cushion when faced with temporary uncertainty, however this seems not to hold for tertiary education. Government plays a supporting role based on the results by increasing educational expenditures compensating the adverse effect of the households in other educational spending subgroups. During COVID-19, there has been a vast variety of subsidized courses, as well as a wide variety of offerings of educational courses.

Table 6.1: Baseline estimation results – GEE I

Variables	(1) total gee	(2) gee primary	(3) gee secondary	(4) gee post-secondary	(5) gee tertiary	(6) gee nd	(7) gee subsidiary	(8) gee R&D	(9) gee nec
Business uncertainty	0.006***	0.008***	0.004***	0.001	0.005***	0.019***	0.005**	0.006	0.011***
	(0.001)	(0.001)	(0.001)	(0.009)	(0.001)	(0.004)	(0.002)	(0.006)	(0.004)
lngdpperCapita	0.881***	1.347***	0.493***	0.560	0.644***	0.133	0.843***	3.976***	0.987***
	(0.050)	(0.108)	(0.082)	(0.655)	(0.097)	(0.344)	(0.186)	(0.438)	(0.304)
unemployment	-0.001	0.001	-0.007***	-0.001	-0.002	-0.015	-0.007	0.057***	0.004
	(0.002)	(0.003)	(0.003)	(0.021)	(0.003)	(0.011)	(0.006)	(0.014)	(0.009)
inflation	-0.003	-0.003	0.001	0.026	-0.004	-0.008	-0.028***	-0.093***	-0.004
	(0.002)	(0.005)	(0.003)	(0.031)	(0.004)	(0.015)	(0.008)	(0.019)	(0.013)
Constant	-2.364***	-8.468***	0.712	-4.518	-1.653	0.219	-5.274***	-39.095***	-7.868**
	(0.526)	(1.135)	(0.863)	(6.836)	(1.016)	(3.626)	(1.954)	(4.615)	(3.199)
Country fixed effect	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	340	340	340	224	340	334	340	323	340
R-squared	0.642	0.461	0.271	0.010	0.225	0.064	0.164	0.324	0.055
Number of countries	20	20	20	16	20	20	20	20	20

This table depicts the regression results for the effect of heightened business uncertainty on governmental educational expenditures showing a positive relationship. Governmental educational expenditures are expressed as log in per capita terms and split by sublevel of education. Note: gee= governmental educational expenditures; sublevels of education are: (1) 'Pre-primary and primary education', (2) 'secondary', (2.5) 'post-secondary non-tertiary', (3) 'tertiary', (4) 'education not definable by level', (5) 'subsidiary services to education', (6) 'R&D education', (7) 'education not elsewhere classified' (n.e.c.). Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 6.2: Baseline estimation results – GEE II

Variables	(1) total gee	(2) gee primary	(3) gee secondary	(4) gee post-secondary	(5) gee tertiary	(6) gee nd	(7) gee subsidiary	(8) gee R&D	(9) gee nec
Business uncertainty	0.005***	0.006***	0.004***	-0.003	0.005***	0.019***	0.003	0.004	0.010**
	(0.001)	(0.001)	(0.001)	(0.009)	(0.001)	(0.005)	(0.002)	(0.006)	(0.004)
lngdpperCapita	0.865***	1.280***	0.501***	0.481	0.639***	0.142	0.795***	3.934***	0.962***
	(0.050)	(0.104)	(0.083)	(0.653)	(0.097)	(0.348)	(0.186)	(0.442)	(0.306)
Manufacturing balance production Q5	-0.001***	-0.004***	0.000	-0.009*	-0.000	0.001	-0.003**	-0.003	-0.002
	(0.000)	(0.001)	(0.001)	(0.005)	(0.001)	(0.003)	(0.001)	(0.003)	(0.002)
unemployment	-0.001	-0.001	-0.007**	-0.003	-0.002	-0.015	-0.008	0.056***	0.003
	(0.002)	(0.003)	(0.003)	(0.021)	(0.003)	(0.011)	(0.006)	(0.014)	(0.009)
inflation	-0.002	-0.001	0.000	0.029	-0.004	-0.009	-0.027***	-0.091***	-0.003
	(0.002)	(0.004)	(0.003)	(0.031)	(0.004)	(0.015)	(0.008)	(0.019)	(0.013)
Constant	-2.129***	-7.500***	0.595	-3.184	-1.581	0.085	-4.580**	-38.494***	-7.511**
	(0.528)	(1.105)	(0.876)	(6.845)	(1.032)	(3.682)	(1.971)	(4.687)	(3.246)
Country fixed effect	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	340	340	340	224	340	334	340	323	340
R-squared	0.650	0.505	0.272	0.024	0.226	0.064	0.175	0.325	0.057
Number of countries	20	20	20	16	20	20	20	20	20

This table depicts the regression results for the effect of heightened business uncertainty on governmental educational expenditures showing a positive relationship. Governmental educational expenditures are expressed as log in per capita terms and split by sublevel of education. Baseline model is enhanced by the control variable balance in survey answers regarding the manufacturing production expectations (Q5). Note: gee= governmental educational expenditures; sublevels of education are: (1) 'Pre-primary and primary education', (2) 'secondary', (2.5) 'post-secondary non-tertiary', (3) 'tertiary', (4) 'education not definable by level', (5) 'subsidiary services to education', (6) 'R&D education', (7) 'education not elsewhere classified' (n.e.c.). Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 6.3: Baseline estimation results – HEE I

Variables	(1) total hee	(2) hee primary	(3) hee secondary	(4) hee postsecondary	(5) hee tertiary	(6) hee nd
Household uncertainty	-0.000	-0.004	0.001	0.001	0.006**	-0.002
	(0.001)	(0.003)	(0.003)	(0.008)	(0.002)	(0.003)
lnrealdisposableincomepC	0.098**	0.395***	0.368***	0.114	-0.304***	-0.041
	(0.048)	(0.125)	(0.105)	(0.289)	(0.095)	(0.108)
unemployment	-0.013***	-0.015**	-0.023***	-0.006	-0.015***	-0.027***
	(0.002)	(0.006)	(0.005)	(0.013)	(0.004)	(0.005)
inflation	0.001	-0.017*	0.007	-0.030	0.006	-0.008
	(0.003)	(0.009)	(0.007)	(0.020)	(0.007)	(0.008)
Constant	3.802***	-0.234	-0.686	-0.358	5.832***	4.155***
	(0.477)	(1.242)	(1.043)	(2.847)	(0.946)	(1.066)
Country fixed effect	YES	YES	YES	YES	YES	YES
Observations	340	306	306	255	306	323
R-squared	0.192	0.137	0.229	0.015	0.067	0.133
Number of countries	20	18	18	15	18	19

This table depicts the regression results for the effect of heightened household uncertainty on household educational expenditures showing a positive relationship for tertiary education. The remaining levels of education are statistically insignificant. Household educational expenditures are expressed as log in per capita terms and split by sublevel of education. Note: hee= household educational expenditures; sublevels of education are: (1) 'Pre-primary and primary education', (2) 'secondary', (2.5) 'post-secondary non-tertiary', (3) 'tertiary', (4) 'education not definable by level'. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 6.4: Baseline estimation results – HEE II

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	total hee	hee primary	hee secondary	hee postsecondary	hee tertiary	hee nd
Household uncertainty	-0.001	-0.005	-0.000	0.001	0.005*	-0.005*
	(0.001)	(0.003)	(0.003)	(0.008)	(0.002)	(0.003)
lnrealdisposableincomepC	0.119**	0.420***	0.386***	0.131	-0.274***	0.030
	(0.047)	(0.126)	(0.106)	(0.293)	(0.096)	(0.105)
hhfinancialpositionbalance	0.003***	0.004	0.002	0.002	0.004**	0.010***
	(0.001)	(0.002)	(0.002)	(0.005)	(0.002)	(0.002)
unemployment	-0.007**	-0.008	-0.018***	-0.002	-0.007	-0.008
	(0.003)	(0.007)	(0.006)	(0.017)	(0.006)	(0.006)
inflation	0.006	-0.011	0.011	-0.027	0.013*	0.008
	(0.004)	(0.010)	(0.008)	(0.022)	(0.007)	(0.008)
Constant	3.638***	-0.417	-0.827	-0.488	5.602***	3.588***
	(0.472)	(1.245)	(1.048)	(2.875)	(0.945)	(1.033)
Country fixed effect	YES	YES	YES	YES	YES	YES
Observations	340	306	306	255	306	323
R-squared	0.220	0.144	0.234	0.016	0.083	0.199
Number of countries	20	18	18	15	18	19

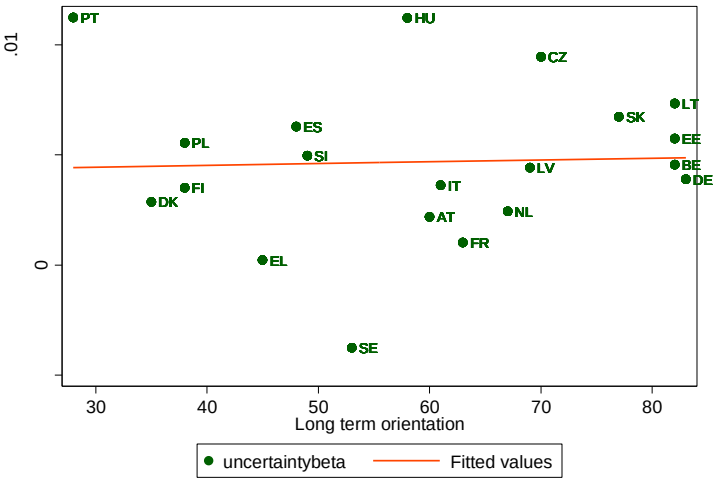
This table depicts the regression results for the effect of heightened household uncertainty on household educational expenditures showing a positive relationship for tertiary education. Not definable level shows an adverse response to a raise in uncertainty. Household educational expenditures are expressed as log in per capita terms and split by sublevel of education. Baseline model is enhanced with the balance in survey answers with regards to the households' expectations of the personal financial situation (Q2). Note: hee= household educational expenditures; sublevels of education are: (1) 'Pre-primary and primary education', (2) 'secondary', (2.5) 'post-secondary non-tertiary', (3) 'tertiary', (4) 'education not definable by level'. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

7. Extension - Uncertainty, Education and Culture

To examine the influence of culture on the connection between uncertainty and educational expenditures, we start by estimating the effect of uncertainty on educational expenditure – uncertainty beta – for each of the countries in our sample. The uncertainty betas are computed by running a separate country regression of the baseline estimation with total educational expenditures, including governmental and household educational expenditures, and business uncertainty controlling for the weighted balance of business outlook. We then plot the uncertainty beta against each cultural dimension to depict how it is mapped according to the increasing score of culture. We are particularly interested in the relationship that long-term orientation and uncertainty avoidance play in the uncertainty-educational expenditure relationship.

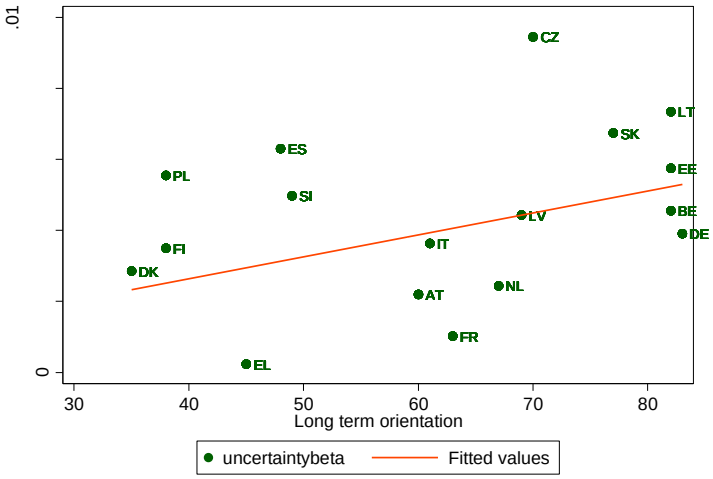
Figure 7.1 depicts each country's value of LTO as a predictor of its uncertainty beta. When removing Hungary, Portugal and Sweden as the outliers with extreme values of uncertainty beta, we see a strongly positive fitted line in Figure 7.2, which suggests that with increasing scores in the long-term orientation dimension, the uncertainty beta increases in value. The more a country is directed towards the three components of LTO - thrift, national pride, and importance to serve others (Hofstede, Hofstede, and Minkov, 2010) – the more educational expenditure rises in response to increases in uncertainty. In the initial factor analysis to construct the LTO measure performed by (Ibid.), thrift has the highest load within the three components. We therefore repeat the same analysis with thrift itself, as obtained from the average answer of respondents to wave six of the World Values Survey (Inglehart et al., 2014) that view thrifting and saving (Ibid.) as a priority in what parents convey in their upbringing of their children. According to Figlio et al. (2019), cultures that have differing thrifting patterns may have an impact on how uncertainty impacts educational expenditures. Following this notion, we analogously depict the uncertainty beta with thrift in Figure 7.3, and remove Hungary and Sweden as the outliers in Figure 7.4. The results suggest that higher thrift cultures respond more positively to educational expenditure when uncertainty rises but seem weaker than when considering the complete LTO measure.

Figure 7.1: Long term orientation and uncertainty beta



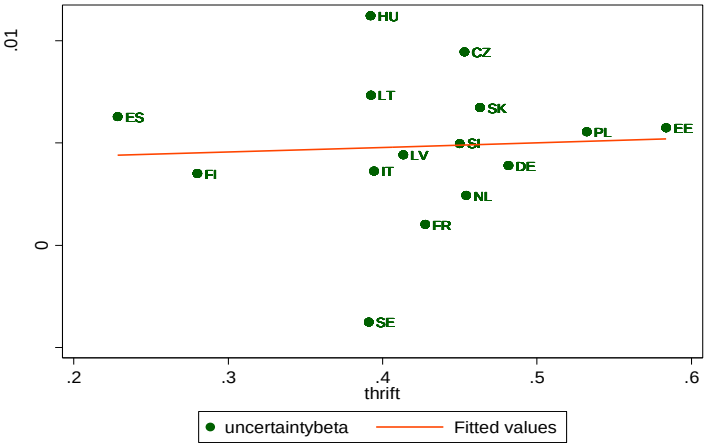
This figure depicts the computed uncertainty beta (relationship between total educational expenditures and business uncertainty) against the cultural dimension of LTO (Hofstede, Hofstede, and Minkov, 2010) for the study period from 2005 to 2021.

Figure *7.2*: Long term orientation and uncertainty beta w/o outliers



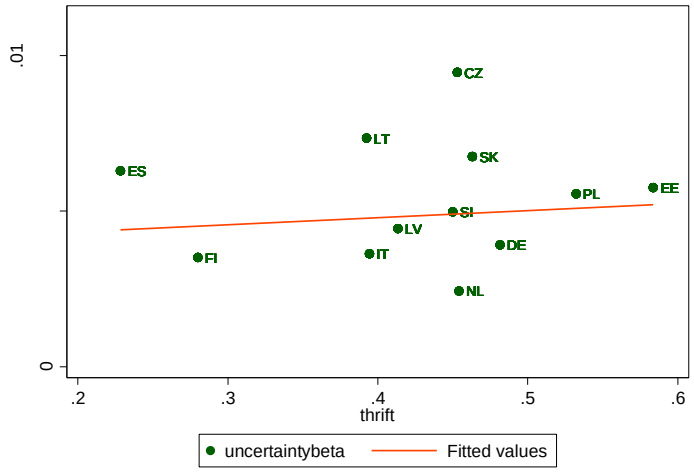
This figure depicts the computed uncertainty beta (relationship between total educational expenditures and business uncertainty) with removed outliers (Hungary, Sweden and Portugal) against the cultural dimension of LTO (Hofstede, Hofstede, and Minkov, 2010) for the study period from 2005 to 2021.

Figure 7.3: Thrift and uncertainty beta



This figure depicts the computed uncertainty beta (relationship between total educational expenditures and business uncertainty) against the cultural dimension of thrift from the WVS (Inglehart et al., 2014) for the study period from 2005 to 2021.

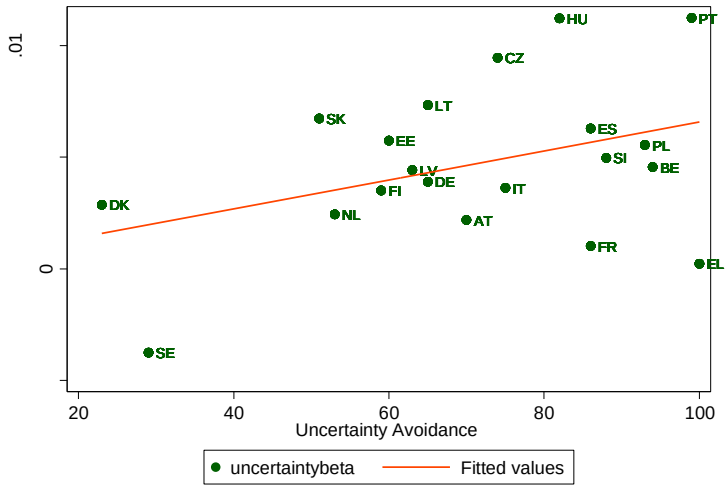
Figure 7.4: Thrift and uncertainty beta w/o outlier (HU&SE)



This figure depicts the computed uncertainty beta (relationship between total educational expenditures and business uncertainty) against the cultural dimension of thrift from the WVS (Inglehart et al., 2014) for the study period from 2005 to 2021. We removed the outliers Hungary and Sweden from the cross-section.

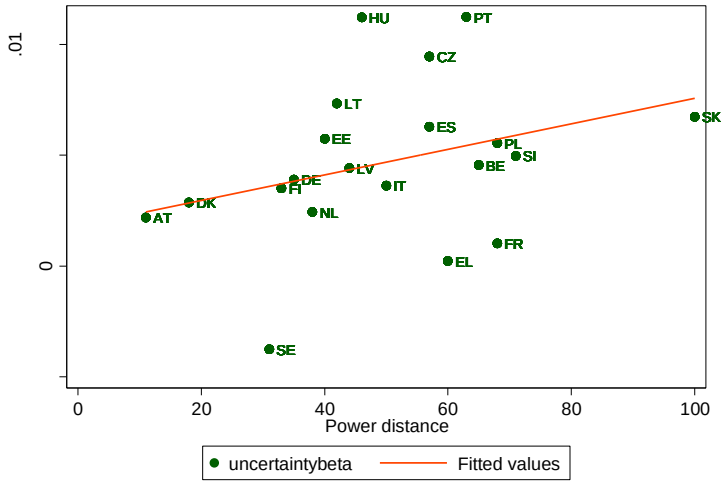
Moreover, we present equivalent figures for the remaining cultural dimensions. Figure 7.5 shows that in countries with higher uncertainty avoidance, educational rises more in response to heightened uncertainty. This agrees with our expectation that education is used a tool to lower individually faced uncertainty. When compared to the finding of Fan, Cheng, and Anwar (2020) that in countries where uncertainty avoidance is high uncertainty depresses entrepreneurial activity, our finding suggests that education is viewed by governments and households as the opposite of entrepreneurial activity. Instead, educational expenditure appears to be a pursuit of stability rather than investment with an option for obtaining a very high return. In countries with greater power distance and greater masculinity, educational expenditure rises more in times of uncertainty, while in countries with greater indulgence and greater individualism it rises less. The interpretation for results for these four cultural characteristics is left for future research. We can only suggest that education requires some self-sacrifice and more indulgent cultures may be less prone to engage in it for that reason.

Figure *7.5*: Uncertainty avoidance and uncertainty beta



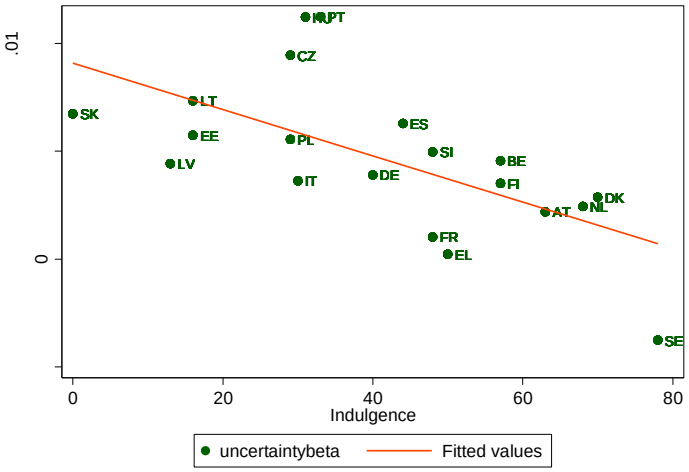
This figure depicts the computed uncertainty beta (relationship between total educational expenditures and business uncertainty) against the cultural dimension of Uncertainty Avoidance (Hofstede, Hofstede, and Minkov, 2010) for the study period from 2005 to 2021.

Figure 7.6: Power distance and uncertainty beta



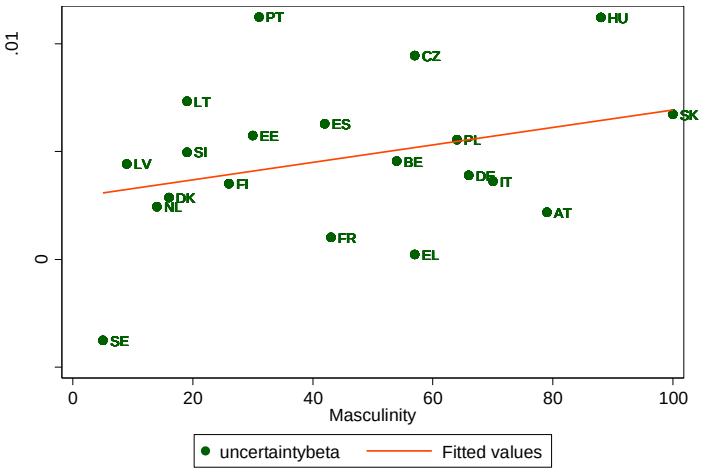
This figure depicts the computed uncertainty beta (relationship between total educational expenditures and business uncertainty) against the cultural dimension of Power Distance (Hofstede, Hofstede, and Minkov, 2010) for the study period from 2005 to 2021.

Figure 7.7: Indulgence and uncertainty beta



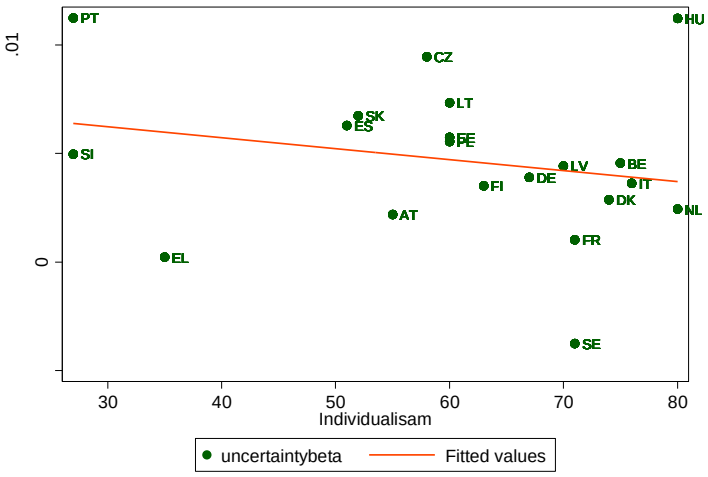
This figure depicts the computed uncertainty beta (relationship between total educational expenditures and business uncertainty) against the cultural dimension of Indulgence (Hofstede, Hofstede, and Minkov, 2010) for the study period from 2005 to 2021.

Figure 7.8: Masculinity and uncertainty beta



This figure depicts the computed uncertainty beta (relationship between total educational expenditures and business uncertainty) against the cultural dimension of Masculinity (Hofstede, Hofstede, and Minkov, 2010) for the study period from 2005 to 2021.

Figure 7.9: Individualism and uncertainty beta



This figure depicts the computed uncertainty beta (relationship between total educational expenditures and business uncertainty) against the cultural dimension of Individualism (Hofstede, Hofstede, and Minkov, 2010) for the study period from 2005 to 2021.

To test the statistical relationship of culture within the uncertainty-education context, we integrate interaction terms into the country-fixed effect model. The empirical framework is formulated as follows including the interaction terms:

H2: National business culture impacts the relationship between educational expenditures and uncertainty.

H3: Educational expenditure rises more in response to heightened uncertainty in cultures which are more long-term oriented (LTO).

Our base model including interaction terms for culture is expressed as follows:

$$\begin{aligned}\ln(EducExpendPerCapita_{ct}) = \quad & \alpha_c + \beta_1 Uncertainty_{ct} + \beta_2 Culture_c \\ & + \beta_3 Uncertainty * Culture_{ct} + \beta_4 ln\,(GDPPerCapita)_{ct} \\ & + \beta_5 unemployment_{ct} + \beta_6 inflation_{ct} \\ & + \beta_7 BCS\ business\ balance_{ct} \varepsilon_{ct}\end{aligned} \tag{14}$$

In our model, we insert each cultural dimension by Hofstede, Hofstede, and Minkov (2010) in the place of culture in equation (14) above: Long-term orientation, uncertainty avoidance, power distance, indulgence, masculinity, and individualism. We further add thrift as a key component of LTO. As cultural variables vary across countries and not over time, the culture component itself cannot be included in the regression with country fixed effects. We thus add the interaction terms to study the cultural effect on the uncertainty betas as depicted for government in Table 7.1 and for household educational expenditures in Table 7.2.

Including the cultural dimensions, almost all uncertainty betas of total governmental educational expenditures remain positive and statistically significant, confirming the main results of a positive effect of heightened uncertainty on educational expenditure by government. The results for LTO and thrift are now somewhat different than what the graphical analysis suggests. LTO depicted in column (1) of Table 7.1 displays an adverse effect on the uncertainty beta. A heightened LTO country score results in a lower positive effect of uncertainty on governmental spending within education. The interaction term for thrift is positive, yet statistically insignificant. On the household side, LTO yields insignificant results, whereas thrift adversely impacts the relationship of uncertainty and household education spending. The non-interacted effect of household uncertainty on household educational expenditure is positive and statistically significant (0.018), but it declines towards zero as the value of the interaction term with thrift (minus 0.043 times the value of the national score for thrift) rises across the range of national scores for thrift (from 0.23 to 0.58) present in the twenty countries in our sample. This finding may suggest that thrift as a value makes people save even when it comes to educational expenditures. This may result from the passing of practical learnings from past generations on how to live the value of thrift, learnings that may have worked better in times when fewer educational options were available. One can argue that the negative effect thrift has on household expenditures is due to the crisis behavior of households. During times of uncertainty, individuals require enough money to sustain themselves. Households are facing a budget constraint as in times of crises, they face more pressing needs to cover. Thus, a rising thrift score has a negative effect on the uncertainty educational expenditures relationship, as households become aware of their engrained virtue delayed gratification. A policy

recommendation would thus be the fostering of a public discussion on whether saving, even when it comes to contracting educational expenditure is indeed a prudent thing to do if one wants to ensure a more prosperous future. Although insignificant, the effect of thrift on the government side is positive, which may be explained with more flexibility in the budget when uncertainty arises, or a better foresight of governments on the beneficial long-term effects of educational expenditure. Governments may respond with high educational expenditures in high uncertainty and thrift positively influences the beta of this relationship. Regarding the remaining cultural characteristics, regression analysis for governmental expenditures confirms the graphical findings presented in the figures above. The results from households do not contradict the graphical findings but are weaker.

Table 7.1: Regression results uncertainty, government education and culture

Variables	(1) LTO	(2) thrift	(3) uncertaintyavoidance	(4) powerdistance	(5) individualism	(6) masculinity	(7) indulgence
Business uncertainty	0.0105***	0.0032	-0.0018	0.0002	0.0155***	0.0047***	0.0098***
	(0.0019)	(0.0039)	(0.0021)	(0.0016)	(0.0019)	(0.0012)	(0.0015)
Business uncertainty*longtermorientation	-0.0001***						
	(0.0000)						
Business uncertainty*thrift		0.0021					
		(0.0087)					
Business uncertainty*uncertaintyavoidance			0.0001***				
			(0.0000)				
Business uncertainty*powerdistance				0.0001***			
				(0.0000)			
Business uncertainty*individualism					-0.0002***		
					(0.0000)		
Business uncertainty*masculinity						0.0000	
						(0.0000)	
Business uncertainty*indulgence							-0.0001***
							(0.0000)
lngdpperCapita	0.8730***	0.8481***	0.8701***	0.8753***	0.8551***	0.8709***	0.8762***
	(0.0470)	(0.0483)	(0.0469)	(0.0471)	(0.0453)	(0.0478)	(0.0468)
unemployment	-0.0027*	-0.0043**	-0.0027*	-0.0026*	-0.0029**	-0.0026*	-0.0034**
	(0.0015)	(0.0017)	(0.0015)	(0.0015)	(0.0014)	(0.0015)	(0.0015)
inflation	-0.0007	-0.0002	-0.0007	-0.0007	-0.0005	-0.0006	-0.0023
	(0.0020)	(0.0021)	(0.0020)	(0.0020)	(0.0019)	(0.0021)	(0.0021)
EU BCS business balance	-0.0020***	-0.0021***	-0.0019***	-0.0019***	-0.0018***	-0.0020***	-0.0020***
	(0.0004)	(0.0005)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Constant	-2.1697***	-1.8366***	-2.1374***	-2.2052***	-1.9964***	-2.1572***	-2.2236***
	(0.4952)	(0.5077)	(0.4941)	(0.4954)	(0.4769)	(0.5034)	(0.4929)
Observations	335	255	335	335	335	335	335
R-squared	0.6873	0.7281	0.6888	0.6873	0.7110	0.6774	0.6906
Number of countries	20	15	20	20	20	20	20

This table depicts regression results with culture interaction terms for GEE and business uncertainty. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 7.2: Regression results uncertainty, household education and culture

Variables	(1) LTO	(2) thrift	(3) uncertaintyavoidance	(4) powerdistance	(5) individualism	(6) masculinity	(7) indulgence
Household uncertainty	-0.004	0.018***	-0.001	-0.007**	-0.004	-0.005**	0.000
	(0.005)	(0.006)	(0.004)	(0.003)	(0.005)	(0.002)	(0.003)
Household uncertainty*longtermorientation	0.000						
	(0.000)						
Household uncertainty*thrift		-0.043***					
		(0.014)					
Household uncertainty*uncertaintyavoidance			0.000				
			(0.000)				
Household uncertainty*powerdistance				0.000**			
				(0.000)			
Household uncertainty*individualism					0.000		
					(0.000)		
Household uncertainty*masculinity						0.000**	
						(0.000)	
Household uncertainty*indulgence							-0.000
							(0.000)
lnrealdisposableincomepC	0.122**	0.042	0.118**	0.124***	0.117**	0.124***	0.119**
	(0.048)	(0.057)	(0.048)	(0.047)	(0.048)	(0.047)	(0.048)
unemployment	-0.007**	-0.013***	-0.007**	-0.007**	-0.007**	-0.007**	-0.007**
	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
inflation	0.006*	0.004	0.006	0.006	0.006	0.005	0.006*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
EU BCS balance HH financial position	0.003***	0.003**	0.003***	0.003***	0.003***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Constant	3.604***	4.247***	3.639***	3.602***	3.658***	3.614***	3.629***
	(0.476)	(0.570)	(0.476)	(0.469)	(0.473)	(0.469)	(0.472)
Observations	340	255	340	340	340	340	340
R-squared	0.221	0.237	0.220	0.231	0.221	0.232	0.221
Number of countries	20	15	20	20	20	20	20

This table depicts regression results with culture interaction terms for HEE and household uncertainty. Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

8. Conclusion

The most recent period in European history has been exceptionally abundant in events that create economic uncertainty: the Great Financial Crisis of 2008 and the European Sovereign Debt Crisis that followed it, both immediate (e.g., lockdowns) and persistent (e.g., reforms of the workplace) shocks of the COVID-19 pandemic on the European economy, rising inflation, war in Eastern Europe, and the energy crisis. In our view, the current environment demands the study of the current effects of uncertainty on the economy.

In this paper, we study the impact of uncertainty on educational expenditure by governments and households across 20 European states – which produced 94% percent of GDP of the Union in 2021 – from 2005 to 2021. We decide to do so because educational expenditure is in our view different from both consumption, in offering compensation in terms of higher utility with a delay, and investment, in offering compensation in terms of higher future income from labor rather than assets. We study the effect of uncertainty on various categories of education, as well as the differences in the effect of uncertainty depending on characteristics of national business culture of households and governments. In a qualitatively presented conceptual framework and the supporting theoretical model, we argue that educational expenditure should rise in response to increases in uncertainty because education could serve as means to protect oneself from any uncertainty or crises by lowering the expected variability of the expected future income. We also argue that culture ought to matter for the relationship between uncertainty and educational expenditure because previous literature suggests that culture could play an important role in decision-making processes (see, e.g., Fan, Cheng, and Anwar (2020). We provide a simple theoretical model supporting these predictions.

The regression results suggest a positive impact of heightened uncertainty on governmental educational expenditures across all subcomponents of educational expenditure, as well as on educational expenditure of households on tertiary education. For households facing a budget constraint with an unpredictable outlook, non-tertiary subcomponents of education were either unaffected or negatively affected. Nevertheless, controlling for disposable income reveals that households do have a wish to spend on education when uncertainty rises, especially on tertiary education, but seem to be facing a constraint in the form of a contracted budget. It appears that governments are less constrained than households when it comes to spending on education in times of uncertainty, perhaps due to counter-cyclical fiscal policy. An extension of the main analysis demonstrates that culture plays a role in the relationship between uncertainty and educational expenditure, while the interpretation of the exact effect of each characteristic of national business culture would require further research.

The implications of our work for policymakers are manifold. Firstly, because there seems to be a willingness by households to invest into tertiary education during times of uncertainty, governments may do well by offering subsidies in the form of student grants or favorable loans in times of heightened uncertainty. Secondly, because culture does influence the effect of uncertainty on educational expenditure, our work demonstrates the potential of cultural civic initiatives as well as governmental cultural policies to influence the productivity and long-term competitiveness of an economy by promoting cultural characteristics which cherish education, especially in times of high uncertainty.

Finally, while the scope of this study is to answer the question on the impact of uncertainty on educational expenditure, and in how far culture plays a role in this relationship, the results pose additional questions for further research. It may also be worth examining how far not merely the expenditure but the numbers of enrolled and graduated individuals from different types of educational institutions are impacted by periods of heightened uncertainty, both overall and across countries with different cultural characteristics. Moreover, the relationship between uncertainty and educational expenditure could be examined more precisely by constructing uncertainty measures perceived by different categories of population different by their employment status, which is what the EU BCS data allows, and by examining their effect on expenditure on categories of education deemed most suitable for that employment group. The mechanisms by which characteristics of national culture affect the impact of uncertainty on educational expenditure demand further study. Especially when studying the effect of culture, expanding our dataset to include different, non-European, cultures may help to give a more complete global picture of the examined relationships.

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Appendix A

Table 0.1: Nominal sample size per state and per survey

Member states	Industry	Services	Consumer	Retail trade	Construction
EU	37,990	47,310	31,810	27,510	21,540
EA	25,280	29,990	24,200	15,530	11,380
BE	930	480	1,850	960	920
BG	1,590	1,430	1,010	1,420	890
CZ	920	870	1,000	380	620
DK	680	2,860	1,100	1,420	860
DE	2,590	3,100	2,020	1,220	1,200
EE	160	3,100	800	190	170
IE	1,390	1,510	1,000	1,490	580
EL	940	730	1,500	490	400
ES	1,760	1,430	2,020	1,080	290
FR	3,850	4,240	1,670	2,860	2,420
HR	510	660	1,000	430	490
IT	5,440	3,100	2,000	1,560	1,000
CY	120	250	600	250	120
LV	830	1,100	1,000	420	300
LT	510	1,010	1,110	510	390
LU	110	-	510	-	110
HU	1,500	1,250	1,000	570	1,500
MT	290	580	1,050	210	140
NL	2,010	3,140	1,140	790	1,180
AT	720	2,370	1,500	1,340	500
PL	3,490	4,300	1,000	4,190	4,000
PT	1,030	1,230	1,300	580	580
RO	2,320	2,880	-	2,480	1,260
SI	810	810	940	810	350
SK	990	990	1,200	530	520
FI	800	820	990	240	210
SE	1,700	3,070	1,500	1,090	540
ME	370	510	1,000	370	360
MK	240	200	1,000	240	200
AL	430	350	1,200	420	210
RS	1,590	1,670	1,020	1,670	980
TR	2,210	4,390	3,930	1,700	1,630

Source: EU BCS user guide, 2022, p.4.

Table 0.2: Education classification for COFOG government

Group	Definition
General description	Government outlays on education include expenditures on services provided to individual pupils and students and expenditures on services provided on a collective basis. Expenditures on individual services are allocated to groups (09.1) through (09.6); expenditures on collective services are assigned to groups (09.7) and (09.8). Collective educational services are concerned with matters such as formulation and administration of government policy; setting and enforcement of standards; regulation, licensing and supervision of educational establishments; and applied research and experimental development into education affairs and services. However, overhead expenses connected with administration or functioning of a group of schools, colleges, etc. are considered to be individual expenditures and are classified to groups (09.1) through (09.6) as appropriate. The breakdown of education is based upon the level categories of the 1997 International Standard Classification of Education (ISCED-97) of the United Nations Educational, Scientific and Cultural Organization (UNESCO). This division includes military schools and colleges where curricula resemble those of civilian institutions, police colleges offering general education in addition to police training and the provision of education by radio or television broadcasting. Expenditures so incurred are classified to groups (09.1) to (09.5) as appropriate.
Pre-primary and primary	- Provision of pre-primary education at ISCED-97 level 0;- administration, inspection, operation or support of schools and other institutions providing pre-primary education at ISCED-97 level 0.Excludes: subsidiary services to education (09.6.0). - Provision of primary education at ISCED-97 level 1;- administration, inspection, operation or support of schools and other institutions providing primary education at ISCED-97 level 1.Includes: literacy programs for students too old for primary school. Excludes: subsidiary services to education (09.6.0).
Secondary	- Provision of lower-secondary education at ISCED-97 level 2;- administration, inspection, operation or support of schools and other institutions providing lower-secondary education at ISCED-97 level 2;- scholarships, grants, loans and allowances to support pupils pursuing lower-secondary education at ISCED-97 level 2.Includes: out-of-school lower-secondary education for adults and young people. Excludes: subsidiary services to education (09.6.0). - Provision of upper-secondary education at ISCED-97 level 3;- administration, inspection, operation or support of schools and other institutions providing upper-secondary education at ISCED-97 level 3;- scholarships, grants, loans and allowances to support pupils pursuing upper-secondary education at ISCED-97 level 3.Includes: out-of-school upper-secondary education for adults and young people. Excludes: subsidiary services to education (09.6.0).
Post-secondary non-tertiary	- Provision of post-secondary non-tertiary education at ISCED-97 level 4;- administration, inspection, operation or support of institutions providing post-secondary non-tertiary education at ISCED-97 level 4;- scholarships, grants, loans and allowances to support students pursuing post-secondary non-tertiary education at ISCED-97 level 4.Includes: out-of-school post-secondary non-tertiary education for adults and young people. Excludes: subsidiary services to education (09.6.0).
Tertiary	- Provision of tertiary education at ISCED-97 level 5;- administration, inspection, operation or support of universities and other institutions providing

	tertiary education at ISCED-97 level 5;- scholarships, grants, loans and allowances to support students pursuing tertiary education at ISCED-97 level 5.Excludes: subsidiary services to education (09.6.0). - Provision of tertiary education at ISCED-97 level 6;- administration, inspection, operation or support of universities and other institutions providing tertiary education at ISCED-97 level 6;- scholarships, grants, loans and allowances to support students pursuing tertiary education at ISCED-97 level 6.Excludes: subsidiary services to education (09.6.0).
Not definable by level	- Provision of education not definable by level (that is, educational programs, generally for adults, which do not require any special prior instruction, in particular vocational training and cultural development);- administration, inspection, operation or support of institutions providing education not definable by level;- scholarships, grants, loans and allowances to support students pursuing education programs not definable by level.
Subsidiary services to education	- Provision of subsidiary services to education; - administration, inspection, operation or support of transportation, food, lodging, medical and dental care and related subsidiary services chiefly for students regardless of level. Excludes: school health monitoring and prevention services (07.4.0); scholarships, grants, loans and allowances in cash to defray the costs of subsidiary services (09.1), (09.2), (09.3), (09.4) or (09.5).
R&D Education	Definitions of basic research, applied research and experimental development are given under (01.4) and (01.5).
Education n.e.c.	Administration, operation or support of activities such as formulation, administration, coordination and monitoring of overall educational policies, plans, programs and budgets; preparation and enforcement of legislation and standards for the provision of education, including licensing of educational establishments; production and dissemination of general information, technical documentation and statistics on education. Includes: education affairs and services that cannot be assigned to (09.1), (09.2), (09.3), (09.4), (09.5), (09.6) or (09.7).

Source: https://vocabularyserver.com/cofog/en/index.php?tema=1&/education. (2018).

Appendix B

Proof of Proposition 1

Recall that, for $e^* > 0$, we have $\frac{2}{k_1} - r\gamma^2 {k_2}^2 \sigma_p^2 \sigma_m^2 > 0$. To prove (i), note that the first derivative of an individual's optimal investment into education, e^*, w.r.t. the marginal productivity is positive:

$$\frac{\partial e^*}{\partial \gamma} = \frac{\partial}{\partial \gamma}\left(\frac{\gamma k_2}{\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2}\right) = \frac{k_2}{(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)} + \frac{2r\gamma^2 k_2^3 \sigma_p^2 \sigma_m^2}{(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)^2} > 0 \quad \text{(A.1)}$$

Regarding the proof of (ii), notice that the first derivative of an individual's optimal investment into education, e^*, w.r.t. the personal risk σ_p^2 is positive:

$$\frac{\partial e^*}{\partial \sigma_p^2} = \frac{\partial}{\partial \sigma_p^2}\left(\frac{\gamma k_2}{\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2}\right) = \frac{r\gamma^3 k_2^3 \sigma_m^2}{(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)^2} > 0 \quad \text{(A.2)}$$

In a similar vein, to prove (iii), note that the first derivative of an individual's optimal investment into education, e^*, w.r.t. the macroeconomic risk σ_m^2 is positive:

$$\frac{\partial e^*}{\partial \sigma_m^2} = \frac{\partial}{\partial \sigma_m^2}\left(\frac{\gamma k_2}{\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2}\right) = \frac{r\gamma^3 k_2^3 \sigma_p^2}{(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)^2} > 0 \quad \text{(A.3)}$$

We prove (iv) by observing that the first derivative of an individual's optimal investment into education, e^*, w.r.t. the individual's risk aversion r is positive:

$$\frac{\partial e^*}{\partial r} = \frac{\partial}{\partial r}\left(\frac{\gamma k_2}{\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2}\right) = \frac{\gamma^3 k_2^3 \sigma_p^2 \sigma_m^2}{(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)^2} > 0 \quad \text{(A.4)}$$

Regarding the proof of (v), we note that the first derivative of an individual's optimal investment into education, e^*, w.r.t. the cultural long-term orientation k_1 is positive:

$$\frac{\partial e^*}{\partial k_1} = \frac{\partial}{\partial k_1}\left(\frac{\gamma k_2}{\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2}\right) = \frac{2\gamma k_2}{k_1^2(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)^2} > 0 \quad \text{(A.5)}$$

Similarly, we prove (vi) by observing that the first derivative of an individual's optimal investment into education, e^*, w.r.t. the cultural effectivity in utilizing the benefits of education/transforming education in value, k_2, is positive:

$$\frac{\partial e^*}{\partial k_2} = \frac{\partial}{\partial k_2}\left(\frac{\gamma k_2}{\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2}\right) = \frac{\gamma}{(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)} + \frac{2r\gamma^3 k_2^2 \sigma_p^2 \sigma_m^2}{(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)^2} > 0 \quad \text{(A.6)}$$

Proof of Proposition 2

To prove (i), note that the cross-derivative of an individual's optimal investment into education, e^*, w.r.t. the macroeconomic risk σ_m^2 and the marginal reward γ is given by:

$$\frac{\partial^2 e^*}{\partial \gamma \partial \sigma_m^2} = \frac{\partial}{\partial \gamma}\left(\frac{r\gamma^3 k_2^3 \sigma_p^2}{\left(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2\right)^2}\right) = \frac{3r\gamma^2 k_2^3 \sigma_p^2}{(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)^2} + \frac{4r^2\gamma^4 k_2^5 \sigma_p^4 \sigma_m^2}{(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)^3} > 0 \quad \text{(A.7)}$$

To prove (ii), note that the cross-derivative of an individual's optimal investment into education, e^*, w.r.t. the macroeconomic risk σ_m^2 and the individual's personal risk σ_p^2 is given by:

$$\frac{\partial^2 e^*}{\partial \sigma_p^2 \partial \sigma_m^2} = \frac{\partial}{\partial \sigma_p^2}\left(\frac{r\gamma^3 k_2^3 \sigma_p^2}{\left(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2\right)^2}\right) = \frac{2r\gamma^3 k_2^3 \sigma_p}{(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)^2} + \frac{4r^2\gamma^5 k_2^5 \sigma_p^3 \sigma_m^2}{(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)^3}$$
$$> 0 \ (\mathrm{A}.8)$$

To prove (iii), note that the cross-derivative of an individual's optimal investment into education, e^*, w.r.t. the macroeconomic risk σ_m^2 and the individual's risk aversion, r, is given by:

$$\frac{\partial^2 e^*}{\partial r \partial \sigma_m^2} = \frac{\partial}{\partial r}\left(\frac{r\gamma^3 k_2^3 \sigma_p^2}{\left(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2\right)^2}\right) = \frac{\gamma^3 k_2^3 \sigma_p^2}{(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)^2} + \frac{2r\gamma^5 k_2^5 \sigma_p^4 \sigma_m^2}{(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)^3}$$
$$> 0 \ (A.9)$$

To prove (iv), note that the cross-derivative of an individual's optimal investment into education, e^*, w.r.t. the macroeconomic risk σ_m^2 and the cultural long-term orientation, k_1, is given by:

$$\frac{\partial^2 e^*}{\partial k_1 \partial \sigma_m^2} = \frac{\partial}{\partial k_1}\left(\frac{r\gamma^3 k_2^3 \sigma_p^2}{\left(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2\right)^2}\right) = \frac{4r\gamma^3 k_2^3 \sigma_p^2}{k_1^2(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)^3} > 0 \quad \text{(A.10)}$$

To prove (v), note that the cross-derivative of an individual's optimal investment into education, e^*, w.r.t. the macroeconomic risk σ_m^2 and the cultural effectivity parameter, k_2, is given by:

$$\frac{\partial^2 e^*}{\partial k_2 \partial \sigma_m^2} = \frac{\partial}{\partial k_2}\left(\frac{r\gamma^3 k_2^3 \sigma_p^2}{\left(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2\right)^2}\right) = \frac{3r\gamma^3 k_2^2 \sigma_p^2}{(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)^2} + \frac{4r^2\gamma^5 k_2^4 \sigma_p^4 \sigma_m^2}{(\frac{2}{k_1} - r\gamma^2 k_2^2 \sigma_p^2 \sigma_m^2)^3} > 0 \ \text{(A.11)}$$