Review of Finance (2008) 12: 465–496
doi: 10.1093/rof/rfm026
Advance Access publication: 6 October 2007

Are Economists More Likely to Hold Stocks?*

CHARLOTTE CHRISTIANSEN[1], JUANNA SCHRÖTER JOENSEN[2] and JESPER RANGVID[3]
[1] *CREATES, University of Aarhus;* [2] *University of Aarhus;* [3] *Copenhagen Business School*

Abstract. Using a large panel data set containing detailed information on educational attainments as well as financial and socioeconomic variables for individual investors, we show that economists are more likely to hold stocks than otherwise identical investors. First, we consider the change in stockholdings associated with (*i*) completing an economics education and (*ii*) an economist moving into the household. Second, we model stock market participation using a probit model with unobserved individual heterogeneity. Third, instrumental variables estimation allows us to identify the causal effect of an economics education on stock market participation. Throughout, we focus explicitly on the effect of a *change* in educational status on the likelihood of holding stocks.

JEL Classification: G11, I29, J24

1. Introduction

It is puzzling why so many households (more than half) choose not to participate in the stock market.[1] In fact, in a standard portfolio model with no trading costs and constant relative risk aversion, all investors hold the

* The authors would like to thank the Danish Social Science Research Council for financial support. Christiansen acknowledges support from *CREATES* funded by the Danish National Research Foundation. We appreciate useful comments from Marco Pagano (the editor), an anonymous referee, Magnus Dahlquist, Lars Norden, Andrei Simonov, Per Strömberg, Raman Uppal, Helena Skyt Nielsen, Michael Svarer, and Jesper Bagger, as well as from participants at the CEPR/Studienzentrum Gerzensee European Summer Symposium on Financial Markets, the EFA and EFMA conferences, the Symposium on Asset Allocation at Copenhagen Business School, the Arne Ryde Workshop at Lund University, the International Conference on Finance at the University of Copenhagen, and seminars at the University of Aarhus, Aarhus School of Business, the Stockholm Institute for Financial Research, and the Universitat Pompeu Fabra. The usual disclaimer applies. We are grateful to Anne Keller and Maria K. Humlum for their competent research assistance.

[1] Hong et al. (2004) report that 51% of US households did not hold stocks, either directly or indirectly, in 1998. Guiso et al. (2003) find that 76% of European households did not hold stocks

same portfolio of risky assets (the "market portfolio") which includes *all* the risky assets in the economy. Indeed, in that model, household portfolios will only differ due to the investor's risk aversion and the correlation of nonfinancial income with the return on the portfolio of risky assets (Viceira, 2001; and Massa and Simonov, 2006). Empirically, however, it turns out that stock market participation is strongly correlated with income, wealth, and the level of education of the investor (Mankiw and Zeldes, 1991; Haliassos and Bertaut, 1995; Bertaut, 1998; Guiso et al., 2003; and Vissing-Jørgensen, 2004). Specifically, investors with a university degree have a higher propensity to invest in stocks compared to less educated investors. The explanation most often proposed is that "education reduces the fixed costs of participating, by making it easier for would-be investors to understand the market's risk-reward trade-offs, execute trades etc." (Hong et al., 2004, pp. 138). In this paper, we take the literature one step further by evaluating whether *the type* of education an investor has is important for stock market participation.

Our starting point is that there are costs associated with stock investments that go beyond the monetary ones, for example, costs that reflect time spent on understanding risk-return trade-offs and information about stock markets. Inspired by Mankiw and Zeldes (1991), Haliassos and Bertaut (1995), Bertaut (1998), Peress (2004), Vissing-Jørgensen (2004), and Guiso and Jappelli (2005) we examine the hypothesis that if some agents are better able to gather and understand information about stock markets, their effective costs of stock market participation are lower, hence their probability of participating in the stock market is higher. Hypothesizing that economists are such agents, we exploit a unique data set that allows us to investigate whether stock market participation increases after an investor has learned about economics. Our most important result is that the probability of participating in the stock market increases after an investor completes an economics education, also upon controlling for many observed and unobserved background characteristics. Thus, the effect of information and education on stock market participation is not fully accounted for by the length of the investor's education—the variable used so far in the literature. The kind of education and information the investor receives is also important.

This paper also makes a methodological point because we focus explicitly in all our tests on whether *a change in educational status* affects the likelihood of an investor holding stocks. We do so because in principle our overall result that economists have a higher probability of holding stocks could be accounted for by reasons other than an informational advantage. For

in 1998, and, as shown in this paper, 77% of all Danes did not invest in stocks, either directly or through mutual funds, in 1998.

instance economists could be less risk averse or more optimistic than other investors. In order to evaluate whether it is really information about economics that makes economists more prone to holding stocks, we examine changes in stock market participation occurring when an individual becomes an economist, the underlying hypothesis being that an economics education is more likely to change an investor's knowledge about investment opportunities than changing his or her risk aversion or optimism. By making such extensive use of the panel nature of the data and by exploiting two different sources of exogenous variation, we differ from the related literature on the determinants of stock market participation, which generally relies on static probit models. We show that this type of static probit models may oversize the effects of education.

We analyze a unique data set that provides very detailed information on investor education and stock market participation decisions, as well as a host of other detailed control variables. Specifically, we use a representative sample of 10% of the Danish population for which we have annual data for the 5-year period 1997–2001. In total, we have annual observations of more than 400,000 individual investors allowing us to focus on economists while simultaneously preserving enough observations to conduct reliable inferences. In addition to the sheer number of investors, our data set has several advantages over, for instance, the PSID and CEX data sets, which are often used in studies of US individuals' stock market participation decisions. First, our register-based data do not suffer from the "recall bias" documented in Vissing-Jørgensen (2002).[2] Second, we have very detailed information on the educational choices of investors, allowing us to provide more detailed information about the relation between stock market participation and education than is generally found in the literature. Next, the data contain the total value of many of the assets that investors hold, enabling us to control for variables that many existing studies of stock market participation do not have access to, such as the value of real estate and holdings of bonds. Finally, we have a large number of socioeconomic control variables, enabling us to account for these potentially important background characteristics.

Our benchmark statistical model is a probit model with unobserved investor effects that are allowed to be correlated with observed investor characteristics. Using this model, we find that becoming an economist raises the probability of stock market participation by about two percentage points which, viewed in the light of an overall participation rate of 23%, is an economically sizable

[2] The "recall bias" refers to the fact that some respondents in surveys report moving from being nonstock holders to becoming stock holders while simultaneously reporting that they have not made any stock market investments.

effect, besides being statistically significant. Robustness tests also verify that the amount of information about economics matters. Investors with a long economics education have a higher probability of participating in the stock market than investors with a shorter one. Moreover, among highly educated investors, economists have a significantly higher stock market participation probability than investors with other educational backgrounds.

The overall result also holds true when other estimation strategies are used. For instance, a difference-in-differences method shows that the change in the stock market participation probability that occurs when an individual completes an economics education is significantly positive. Likewise, an investor becomes more likely to participate in the stock market when an economist moves into the household. Also, an instrumental variables (IV) approach confirms that an economics education has a causal effect on stock market participation. The IV estimates rely on a university opening nearby as the instrument, which means identification relies on a subsample of individuals who acquire an economics education because of the new nearby university. This allows us to concentrate on the effects of an exogenous variation in the acquisition of an economics degree.

Guiso and Jappelli (2005) include an indicator for an economics education in their analysis of financial awareness. They find that an economics education increases financial awareness. There are several differences between our approach and theirs. First, we pay special attention to the role of information about economics, whereas an economics education is only one of many determinants included in the regressions in Guiso and Jappelli (2005). Unlike us, Guiso and Jappelli (2005) do not account for the endogeneity of the economics indicator variable. We account for the endogeneity by comprehensively exploiting the panel structure of the dataset and by using the exogenous variation in the data (when an investor moves in with a economist and when a new university opens nearby). Second, Guiso and Jappelli focus on financial awareness, defined as knowledge about (even if only by hearsay) a financial asset, such as a stock or a bond. We, instead, study whether an economics education actually increases stock market participation. Finally, our data are register based, and, hence, much more comprehensive than the survey data used by Guiso and Jappelli (2005).

Our investigation is related to several other streams of the literature besides the stock market participation literature. For instance, our work is related to that of Bernheim and Garrett (2003) and Bernheim et al. (2001), who show, respectively, that financial education in the workplace significantly increases the probability of savings in general, and that households who were exposed to financial curricula during high school have higher savings rates than others. This paper is also related to the studies that show that investor information

affects portfolio choice, e.g. Coval and Moskowitz (1999, 2001) and Grinblatt and Keloharju (2000), who show that investors invest in the stocks of the companies they are most familiar with. Our paper is also related to the recent literature on social interaction and stock market participation because learning about financial markets and risk-return trade-offs can also take place more informally if the investor learns from peers. Hong et al. (2004) show that households that interact with their neighbors or attend church are more likely to invest in the stock market, while Duflo and Saez (2002) document that the decision of workers to participate in retirement plans is influenced by their colleagues' choices. This is in accordance with our finding about the effect of having a spouse or marrying someone with an economics education.

Understanding the motives behind why people participate in the stock market is important, because their choice has far-reaching economic implications for consumption behavior, welfare, choice of portfolio, and the design of regulation. Mankiw and Zeldes (1991) document that there are differences in the consumption patterns of stock holders and nonstock holders. Cocco et al. (2005), who calibrate the welfare losses from not participating in the stock market, report that these losses are considerable, often exceeding 1.5–2% of annual consumption. Furthermore, Palacios–Huerta (2001) finds that the stock market participation puzzle helps explain the international diversification puzzle. Likewise, Basak and Cuoco (1998), Parker (2001), Guvenen (2005), and Malloy et al. (2005) find that limited asset market participation helps explain the equity premium puzzle, while Guvenen and Kuruscu (2006) find that the resulting market incompleteness is important for understanding the behavior of asset prices. Finally, public support for stockholder rights protection is likely to depend upon the degree of stock market participation in the economy, see for instance Pagano and Volpin (2006).

The remainder of this paper is structured as follows. The next section describes our data set and Section 3 analyzes the effect of changes in investor status when an investor becomes an economist and when an economist moves into the investor's household. The probit model with individual investor effects and the associated empirical results are discussed in Section 4, while Section 5 presents the instrumental variables analysis. Additional robustness tests are discussed in Section 6. Next, in Section 7, we analyze the amount of investors' portfolios that are invested in stocks. Finally, Section 8 concludes.

2. Data

We use a very rich register-based panel data set comprising a random 10% sample of the Danish population that covers the period 1997–2001.[3] The data set, which is hosted by the Danish Institute of Governmental Research (AKF), originates from Statistics Denmark, whose data are gathered mainly from administrative registers.

For each individual, we have access to the value of a number of financial variables that apply at the end of each year (originally collected for tax reporting purposes): Gross noncapital income, cash holdings, stock holdings, bond holdings, taxable property value, the compulsory (labor contract-based) pension contributions, and contributions to private pension funds.[4]

Exact information about the educational history of each individual is available, including whether the individual is currently taking an education (both students and apprentices). The individuals are divided into 11 groups based on the subject of the highest level of education completed. The economics group consists of individuals with an economics degree at university level (BA, masters, PhD), individuals with a short-cycle higher education in economics, and individuals with a relevant apprenticeship education in the financial services industry, e.g. bank clerks. The educational groups are as follows (the lower part of Table I presents the proportion of the sample in each group): educator/teacher, humanities/arts, agriculture/food/forestry/fishing, business/commercial (excluding economics), social sciences (excluding economics), health care, natural sciences/technical educations, police/armed forces/transportation, high school, basic school/preparatory school, and economics.

The data source also contains information on a number of socioeconomic factors that are applied as control variables, including age, gender, marital status, and children. We also have access to various types of information about the investor's cohabitant/spouse (in the following the spouse).

Our sample is restricted to individuals over the age of 18 years (the age of majority) and excludes individuals born before 1920 because education was not compulsory before then and the educational information available is very poor. With these restrictions applied, there are observations on 405,271

[3] In 1997, financial institutions started to automatically register holdings of stocks, whereas before 1997 investors had to self-report their holdings of stocks to the tax authorities.

[4] Investments in equity (respectively fixed income) mutual funds are included in the individuals' holdings of stocks (respectively bonds). Mixed mutual funds (both bonds and stocks) are counted in the stock holdings. The mixed mutual funds account for around 5% of the Danish mutual funds. So, the stock holdings are slightly overvalued at the expense of the bond holdings. Investments through mutual funds only make up 5.8% of total investments.

Table I. Descriptive statistics

The table shows summary statistics for the entire sample (column 1) and for economists (column 2). For indicator variables the proportion of the sample included in the group is shown. Otherwise, the table provides the mean and standard deviation in parentheses.

Variables	Mean All	Mean Economists
Age	45.34	40.92
	(16.63)	(12.76)
Married	0.5152	0.5664
Male	0.4982	0.5395
Children 0–6 years	0.1420	0.2187
Children 7–18 years	0.1709	0.1965
Noncapital income	235,636	373,736
	(224,694)	(583,887)
Cash holdings	−18,273	−41,119
	(487,937)	(598,725)
Taxable property value	366,822	541,370
	(861,801)	(1,246,691)
Private pension contribution	2,497	3,290
	(20,654)	(21,117)
Public pension contribution	11,372	32,284
	(33,445)	(86,643)
Bond market participation rate	0.0821	0.1286
KFX return	0.2005	
	(0.2225)	
Student, government grant	0.0743	0.0750
Student, Wage	0.0362	0.0243
Length of education	11.31	14.13
	(3.007)	(2.526)
Educator/teacher	0.0500	
Humanities/arts	0.0190	
Agriculture/food/forestry/fishing	0.0598	
Business (excl. economics)	0.1267	
Social Science (excl. economics)	0.0334	
Health care	0.0622	
Natural sciences/technical educations	0.1898	
Police/armed forces/transportation	0.0112	
High school	0.1026	
Basic school/Preparatory school	0.3257	
Economics	0.0246	

individuals in the five-year period covered. The data form an unbalanced panel data set, since some people enter the sample when they turn 18 and others leave the sample as they die or move abroad. In total there are 1,870,324 observations of individual investor decisions and individuals are observed for 4.6 years on average.

2.1 DESCRIPTIVE STATISTICS

Summary statistics are provided in Table I, where the first column covers the entire sample and the second column only covers the economists.

The average person in the sample is 45.3 years old and has 11.3 years of education. The samples contain the following: 49.8% males, 51.5% married, 14.1% have children less than 7 years of age, and 17.1% have children between the ages of 7 and 18. Also, 7.4% are students receiving a government grant, and 3.6% are apprentices.

A rather large proportion of the sample, 31.7%, have only basic education (18.7% have seven years of schooling and 13.0% have 9 years), while a small group, 5.9%, has also attended preparatory school (10 years).[5] High school and apprenticeship educations account for 44.2% of the sample (12 years). Of the sample 3.5% has a short-cycle higher education (14 years) and 10.3% have a bachelor degree/medium-cycle higher education (16 years). A relatively small proportion, 4.2%, holds a master's degree (18 years), and even fewer, 0.2%, have a PhD (20 years).

The average noncapital income is DKK 235,637 and the average individual in the sample has DKK −18,273 in cash at year end.[6] Twenty-five percent of the individuals in the sample take out private pension schemes (private pension contributions are registered from 1999 onwards). This proportion is rather small, because many Danish employees (71%) have pension schemes in their labor contracts. The average amount paid to compulsory pension schemes is DKK 11,372, whereas the average amount spent on private pension schemes is DKK 4,128 per year across all individuals in the sample. Sixty percent are home owners and the average taxable property value across all individuals equals DKK 366,822. Also, 8.2% of the individuals participate in the bond market, that is, own bonds at year end (excluding mortgage-backed bonds and bond debt).

There are 46,038 observations of economists' investment decisions. The average economist is younger than other investors (40.9 years) and has a longer education (14.1 years). Furthermore, their financial situation is on average better than that of other investors. A larger proportion of economists, 13%, participate in the bond market.

[5] Compulsory 7 year school attendance was replaced by 9 years of compulsory school attendance in 1972 and applies to cohorts born in 1959 and onwards.

[6] Real 2002 DKK amounts are used and the rate of exchange at the end of 2002 was 7.0784 DKK/USD.

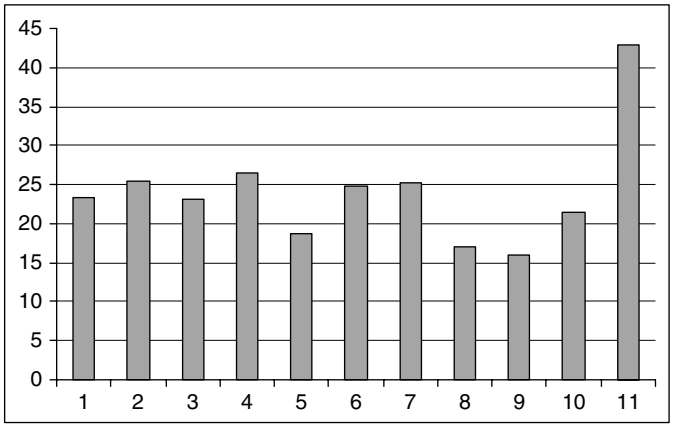

Figure 1. Stock market participation rates across educational groups.
The figure shows the proportion (in percentage) of investors who hold stocks across educational groups, 1997–2001. Subject 1: Education. Subject 2: Humanities/arts. Subject 3: Agriculture/food/forestry/ fishing. Subject 4: Business/commercial (excluding economists). Subject 5: Social sciences (excluding economists). Subject 6: Health care. Subject 7: Natural sciences/technical educations. Subject 8: Police/armed forces/transportation. Subject 9: High school. Subject 10: Basic school/preparatory school. Subject 11: Economics.

2.2 STOCK MARKET PARTICIPATION RATES

An investor is defined as participating in the stock market if the investor holds stocks with a value in excess of DKK 1,000 (around USD 141) at year end.[7] This is how we obtain the stock market participation indicators for each individual for each year.[8]

Figure 1 shows that the average rate of participation varies greatly across the educational groups and in particular, at around 42% is much higher for economists compared to 25% or less for the other educational groups.

Figure 2 shows the time series of stock market participation rates for the entire sample and for economists. The overall participation rate is remarkably stable at around 23% with the rate for economists increasing in the sample period from a low of 37% to a high of 47%.

[7] Investors are defined as participating in the stock market if they have stocks in excess of a small threshold value. This excludes individuals who, for example have been given a single stock by their employer as a Christmas present. Previous studies have applied a zero threshold value. Our conclusions are robust to the exact choice of threshold value.

[8] We stress that our stock market participation variable reflects an active decision by the investor to buy stocks or mutual funds. We do not consider a mandatory contribution to a public pension scheme as an active stock market participation decision, as, in Denmark, the investor has no say over such contributions during the period under investigation.

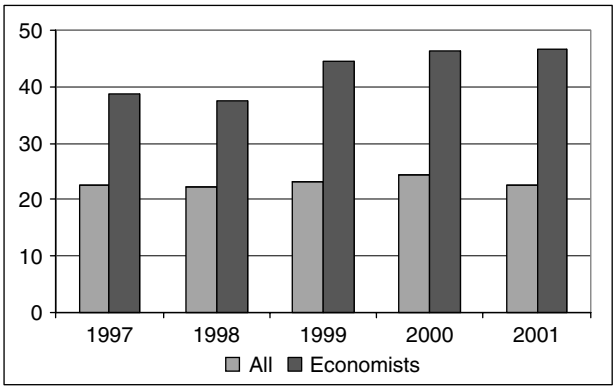

Figure 2. Stock market participation over time.
The figure shows the time series of the proportion (in percentage) of investors (all and only economists) who hold stocks.

More males, 24.9%, than females, 21.3%, participate in the stock market.

3. Changes in Investor Status

In this section we analyze the effect on stock market participation when the status of an investor changes due to the investor either becoming an economist or moving in with an economist. This allows us to make explicit use of the panel nature of the data.

3.1 BECOMING AN ECONOMIST

The basic hypothesis is that more economists hold stocks because they have studied economics and consequently have an informational advantage compared to other investors. We evaluate whether an investor changes behavior in the stock market after receiving a formal economics education.

We select a subsample of individuals who completed their degrees in 2000, and let $Econ_i = 1$ for individuals completing an economics education and $Econ_i = 0$ for the remaining individuals.[9] We are interested in estimating the average effect on stock market participation for the investors who complete an economics education: $E\left[S_{it}^1 - S_{it}^0 | Econ_i = 1\right]$ for $t > 0$, where S_{it}^1 is the stock market participation indicator for investor i at time t when the investor

[9] In order to observe the investors and all the control variables both in the year before and the year after they graduate, we only consider investors graduating in the penultimate year of the sample, namely 2000. Four hundred and twenty three individuals completed an economics education in 2000, whereas 6,670 individuals completed another education in 2000.

completes an economics education and equivalently S_{it}^0 is the stock market participation indicator when the investor completes another education. Since an investor's stock market participation cannot be observed both when the investor completes and does not complete an economics education, the central problem of evaluating this effect is the construction of counterfactuals.

The difference-in-differences estimator compares the change in participation rates for investors completing an economics education with the changes in participation rates for investors who do not complete an economics education. The implicit identifying assumption is that if none of the investors had completed an economist education, the change in stock market participation rates would have been the same for the two groups of investors, that is, the change in the stock market participation rate of the investors not completing an economist education serves to benchmark common year and/or age effects among the investors. The resulting estimator is

$$E[S_{i1}^1 - S_{i,-1}^0 | Econ_i = 1] - E[S_{i1}^0 - S_{i,-1}^0 | Econ_i = 0] = 0.06. \quad (1)$$

The stock market participation rate of investors who complete an economics education increases significantly (t-value 3.59) by six percentage points when they complete their educations.[10]

In Equation (1) we do not control for investor-specific background characteristics. Let $After_i = \mathbf{1}[t > 0]$ denote the indicator of whether the observation is after the individual graduated. The difference-in-differences estimator of the effect of becoming an economist on the stock market participation is the estimated coefficient to $After_i * Econ_i$ in a regression of S_i on $After_i$, $Econ_i$, $After_i * Econ_i$, and various additional control variables (see e.g., Heckman et al., 1999 for details). Table II presents the results based on no additional control variables (column 1), on socioeconomic and financial control variables (column 2), and on socioeconomic, financial, and educational group control variables (column 3). We describe the control variables below. The magnitude is slightly smaller when additional control variables are included in the regression, as it goes from six percentage points to around four percentage points, but the effect due to becoming an economist remains significant.

[10] An alternative measure is the before-after estimator that compares the participation rates of investors the year before and the year after they complete an education as an economist. The before-after estimator is also significantly positive and amounts to 0.10.

Table II. Difference-in-differences estimation

The table shows the difference-in-differences estimates for the effect of becoming an economist (columns 1–3) and from getting an economist spouse (columns 4–6). The difference-in-differences estimates are calculated in a regression framework and are based on applying no additional control variables (columns 1 and 4), on socioeconomic and financial control variables (columns 2 and 5), and on socioeconomic, financial and educational group indicator control variables (columns 3 and 6) (standard errors in parentheses). ***, **, * indicate parameter significance at the 1, 5, and 10% levels of significance, respectively.

	Difference-in-differences estimator, (standard errors)					
	Economist			Economist Spouse		
	(1)	(2)	(3)	(4)	(5)	(6)
Difference-in-differences estimate						
After*Econ(Spouse)	0.06** (0.02)	0.05** (0.02)	0.04* (0.03)	0.05** (0.02)	0.04** (0.02)	0.04* (0.02)
Additional control variables:						
Socioeconomic and financial variables		+	+		+	+
Educational subject indicators			+			+

3.2 AN ECONOMIST MOVES IN

A related approach is an investigation of the exogenous information shock when an investor moves in together with an economist. The hypothesis is that an investor with a spouse who is an economist has lower participation costs because of information sharing within the household. We thus expect an increase in the investor's probability of holding stocks.

Let $D_i = 1$ for investors who move in together with an economist at $t = 0$, and $D_i = 0$ for the investors who do not live with an economist during the observation period. The difference-in-differences estimator compares the changes in participation rates for investors moving in with an economist with the changes in participation rates for investors who do not move in with an economist. 675 investors move in with an economist in 2000. The difference-in-differences estimator is given by replacing $Econ_i$ with D_i in Equation (1), and amounts to 0.05, cf. column 4 in Table II. The stock market participation rate of investors that move in with an economist increases by five percentage

points, most likely as a result of their social interaction with the economist.[11] We also estimate the difference-in-differences estimator when controlling for the investors' own financial, socioeconomic, and educational background. The results are shown in Table II (columns 5–6). The effect on the stock market participation probability of moving in with an economist decreases when more explanatory variables are included (to 0.04), but still remains significant.

4. Are Economists Really More Likely to Hold Stocks?

In this section, we present results from a probit model where we evaluate whether economists also have a higher probability of participating in the stock market after controlling for differences in *observed* background characteristics as well as allowing for *unobserved* individual heterogeneity.

4.1 MODEL

Let the utility that investor i derives from participating in the stock market at time t be given by U_{it}, and normalize the utility that the investor derives from nonparticipation to be equal to zero for all investors, $i = 1, ..., N$, and time periods, $t = 1, ..., T_i$. The investor participates in the stock market if and only if he or she gets greater utility from participation than from nonparticipation: that is, if and only if $U_{it} > 0$. We divide the investor's utility into two parts. The representative utility, which is a linear function of the observable characteristics, βX_{it}, and the unobservable part, ε_{it}. The stock market participation decision can therefore be modeled as

$$S_{it} = \mathbf{1}\left[\beta X_{it} + \varepsilon_{it} > 0\right], \tag{2}$$

where S_{it} denotes the indicator for active participation in the stock market of individual i at time t. If the error terms are assumed independent and identically standard normally distributed, $\varepsilon_{it} \sim N(0, 1)$, we obtain the standard univariate probit model used in the related literature.

Individual heterogeneity

In order to investigate whether economists differ from other groups of investors with respect to differences in unobserved characteristics, we allow for unobserved individual heterogeneity. It is essential to allow the unobserved

[11] As a robustness check, we also did a "before-after" estimator. The "before-after" estimator compares the participation rates of investors the year before and the year after they move in with an economist. This estimate is also significantly positive, 0.04.

individual heterogeneity to be correlated with the observed individual characteristics, since there is substantial evidence that there are ability differences across educational groups, see for instance Willis and Rosen (1979), Carneiro et al. (2003), and Arcidiacono (2004). We use a random individual effects model that specifies the distribution of the individual effects conditional on the means of the time-varying explanatory variables, as suggested by Mundlak (1978).[12] Accounting for individual effects in this manner is fairly standard; see for example Wooldridge (2001) for a more detailed discussion.

Specification of individual heterogeneity

We decompose the error term in the standard probit model in Equation (2) into an individual specific part and an individual time-specific part, $\varepsilon_{it} = \alpha_i + u_{it}$, and specify the individual effect, α_i, as a linear projection on the within-individual means of the time-varying explanatory variables, $\overline{F_i}$. Thus, the portion of unobserved individual specific factors that affect utility is given by

$$\alpha_i = \alpha \overline{F_i} + c_i, \tag{3}$$

where $c_i \sim N\left(0, \sigma_c^2\right)$. This reflects the investor's propensity to participate in the stock market, and depends both on observed (through $\overline{F_i}$) and unobserved (through c_i) individual specific factors. Substituting Equation (3) into the standard probit model in Equation (2) yields the following model for the stock market participation decision

$$S_{it} = \mathbf{1}\left[\beta X_{it} + \alpha \overline{F_i} + c_i + u_{it} > 0\right], \tag{4}$$

where $u_{it} \sim N(0, 1)$, and the error components u_{it} and c_i are assumed to be independent for all $i = 1, .., N$ and all $t = 1, ..., T_i$. Hence, σ_c^2 measures the variance in unobserved utility across individuals relative to the variance across time for each individual. The contribution of the individual-specific variance to the total variance is given by $\rho = \frac{\sigma_c^2}{\sigma_c^2+1}$. Thereby, ρ is indicative of the relative importance of the unobserved individual effect. The inclusion of the observed individual fixed effects, $\overline{F}_i$, has the additional advantage that it takes care of all selectivity that is dependent on observed time-invariant factors, thus ensuring that the unobserved random individual effects c_i are uncorrelated with the explanatory variables.

[12] A more general correlation structure could be allowed for by specifying the distribution of the individual effect conditional on all explanatory variables, as suggested by Chamberlain (1980). Given the size of our unbalanced panel data set, this turns out to be computationally infeasible.

Marginal effects

The larger its marginal effect is, the more important the explanatory variable is for the decision to participate in the stock market. The marginal effect of an explanatory variable on the choice probability equals the change in the probability caused by a change in the relevant explanatory variable holding all other variables fixed at their mean values except length of education which is fixed at nine years (basic schooling). For continuous variables the marginal effects concern infinitesimal changes, for indicator variables, they concern changes from 0 to 1, and for discrete variables they concern a one unit increase. Note that the marginal effects of the explanatory variables are calculated as the average partial effects on the stock market participation choice probability conditional on the unobserved random individual effects being at their mean values, $c_i = 0$.

4.2 EXPLANATORY VARIABLES

In the estimations, the principal explanatory variables are the educational group indicators. In addition to this, we apply a number of control variables; see also the discussion in Section 2 above.

The following financial control variables are applied: Bond market participation indicator (1 if participation), noncapital income, cash holdings, taxable property value, compulsory pension contribution, and private pension contribution (an indicator function captures that the private pension contribution is not registered in the first two years of the sample). Furthermore, to control for business cycle effects, we apply the return on the KFX index (the Danish blue-chip index, currently denoted the OMXC20) in the year prior to the investor's stock market participation decision. The KFX index then captures all the relevant information that is year specific and affects the individuals' stock market participation decisions.[13]

The socioeconomic explanatory variables are: Age, marital indicator (1 if married), gender (1 if male), indicator for having children under 7 living at home (1 if yes), and an indicator for having children between 7 and 18 living at home (1 if yes).

To accommodate for the fact that some investors are students at year end and thereby somewhat misplaced in the educational group for the highest completed education so far, we apply an indicator variable for being a

[13] We have also estimated the model with year-specific effects, but without the KFX index since we cannot separately identify year effects and the effect of the KFX index, which varies over time, but not over individuals in a cross-section. This does not change the other estimated coefficients considerably.

student receiving a government grant and another indicator for undertaking an apprenticeship education (student with wages). Furthermore, we presume that households share information. Therefore, we include an indicator for whether the investor's spouse is an economist. Finally, we apply the length of the highest completed education as a control variable.

Note that the panel data structure is pivotal for this estimation strategy. The effect of time-invariant variables, like gender, is identified by time-demeaning of the random effects, as in a standard random effects model. However, the effect of time-varying variables is to a large extent identified by their variation over time. The effects of the educational indicators are identified by investors completing their education during the observation period, and their fixed effects are identified by all investors who have the education (both those who completed the education before and during the observation period).[14]

4.3 RESULTS FROM THE INDIVIDUAL HETEROGENEITY PROBIT MODEL

The results from the probit model with unobserved individual heterogeneity are shown in Table III. The first column of Table III contains the coefficient estimates and the second column contains the marginal effects on the probability of participating in the stock market. The first part of the table concerns the explanatory variables, whereas the second part concerns the individual effects.

The coefficient to the economics indicator is strongly significant and positive. From this we conclude that economists have a higher probability of holding stocks than investors with basic schooling (the reference group). The marginal effect of being an economist on the probability of stock market participation is 1.7 percentage points, and is by far the largest marginal effect for the educational group indicators. Thus, becoming an economist increases the probability of holding stocks by around two percentage points compared to those with only 9 years of basic schooling. The increase of 1.7 percentage points is seen relative to the overall participation rate of approximately 23%, that is, it corresponds to 7.6% of total participation, which means it is also economically significant. When we control for detailed background characteristics and allow for individual effects, the effect of becoming an economist is reduced from the 4 to 6 percentage points found using the differences-in-difference method in Section 3 to around two percentage points. It is important that the one and only kind of education that leads to a significant increase in the stock

[14] We verify that there is sufficient variation in the variables. Most importantly, 8,765 investors are economists for the entire period, 1,736 become economists during the period, and the remaining 394,770 investors stay noneconomists for the entire period.

Table III. Probit model for stock market participation with individual effects

The table shows the parameter estimates and the marginal effects from the probit regression with individual effects. The dependent variable is the stock market indicator. The comparison groups are unmarried women, with no children under 18 living at home, not taking an education, and have basic schooling as highest completed education. The first column provides the parameter estimates and the second column the marginal effects (standard errors in parentheses).***, **, * indicate parameter significance at the 1%, 5%, and 10% levels of significance, respectively. The marginal effects of the explanatory variables are calculated as the average effects on the choice probability of stock market participation conditional on the unobserved random individual effects being at their mean values, $c_i = 0$. σ_c indicates the cross-individual standard deviation relative to the within-individual standard deviation, and ρ indicates the proportion of total variance contributed by the individual specific variance component.

Explanatory Variables	βs	$d\phi_s/dx$
Intercept	−6.2471***	
	(0.0518)	
Age	0.0386***	0.0004
	(0.0006)	(0.0000)
Married	−0.2232***	−0.0021
	(0.0149)	(0.0002)
Male	0.1237***	0.0011
	(0.0125)	(0.0001)
Children 0−6 years	0.0945***	0.0010
	(0.0152)	(0.0002)
Children 7−18 years	0.0179	0.0002
	(0.0149)	(0.0001)
Bond market participation	−0.0933***	−0.0008
	(0.0111)	(0.0001)
Non capital income/1,000,000	0.5621***	0.0052
	(0.0228)	(0.0004)
Cash holdings/100,000	0.0029***	0.0000
	(0.0008)	(0.0000)
Taxable property value/100,000	−0.0460***	−0.0004
	(0.0083)	(0.0001)
Compulsory pension contribution /10,000	0.0061***	0.0001
	(0.0009)	(0.0000)
Private pension contribution/10,000	0.0168***	0.0002
	(0.0014)	(0.0000)
KFX	0.4083***	0.0038
	(0.0112)	(0.0002)
Student, government grant	−0.0980***	−0.0008
	(0.0183)	(0.0002)
Student, wage	−0.1056***	−0.0009
	(0.0200)	(0.0002)
Spouse education, economics	0.1558***	0.0018
	(0.0470)	(0.0007)
Length of education	0.0022	0.0000
	(0.0087)	(0.0001)

Table III. (Continued)

Explanatory Variables	βs	$d\phi_s/dx$
Educator/teacher	−0.2461***	−0.0017
	(0.0893)	(0.0004)
Humanities/arts	−0.0608	−0.0005
	(0.1026)	(0.0008)
Agriculture/food/forestry/fishing	−0.0017	0.0000
	(0.0764)	(0.0007)
Business/commercial (excl. economics)	0.0250	0.0002
	(0.0690)	(0.0007)
Social science (excl. economics)	0.0328	0.0003
	(0.0657)	(0.0007)
Health care	−0.0961	−0.0008
	(0.0753)	(0.0005)
Natural sciences/technical educations	0.0568	0.0005
	(0.0652)	(0.0007)
Police/armed forces/transportation	−0.0828	−0.0007
	(0.1121)	(0.0008)
High school	−0.0718	−0.0006
	(0.0526)	(0.0004)
Economics	0.7149***	0.0174
	(0.0835)	(0.0044)
Mean(married)	0.3853***	0.0035
	(0.0198)	(0.0003)
Mean(children 0–6 Years)	−0.0482*	−0.0004
	(0.0278)	(0.0003)
Mean(children 7–18 Years)	−0.1933***	−0.0018
	(0.0228)	(0.0002)
Mean(bond market participation)	4.7770***	0.0439
	(0.0278)	(0.0026)
Mean(noncapital income/1,000,000)	−0.4641***	−0.0043
	(0.0291)	(0.0004)
Mean(cash holdings/100,000)	0.0460***	0.0004
	(0.0008)	(0.0000)
Mean(taxable property value/100,000)	0.4265***	0.0039
	(0.0098)	(0.0003)
Mean(compulsory pension contribution/10,000)	0.0546***	0.0005
	(0.0016)	(0.0000)
Mean(private pension contribution/10,000)	0.2042***	0.0019
	(0.0038)	(0.0001)
Mean(spouse education, economics)	0.0023	0.0000
	(0.0638)	(0.0006)
Mean(length of education)	0.0695***	0.0006
	(0.0096)	(0.0001)
Mean(educator/teacher)	0.2122**	0.0020
	(0.0991)	(0.0009)
Mean(humanities/arts)	−0.1247	−0.0011
	(0.1161)	(0.0011)
Mean(agriculture/food/forestry/fishing)	0.3324***	0.0031
	(0.0837)	(0.0008)
Mean(business/commercial (excl. economics))	0.3127***	0.0029
	(0.0738)	(0.0007)

Table III. (Continued)

Explanatory Variables	βs	$d\phi_s/dx$
Mean(social science (excl. economics))	0.0779	0.0007
	(0.0794)	(0.0007)
Mean(health care)	0.2154***	0.0020
	(0.0826)	(0.0007)
Mean(natural sciences/technical educations)	0.1008	0.0009
	(0.0702)	(0.0006)
Mean(police/armed forces/transportation)	0.5105***	0.0047
	(0.1331)	(0.0012)
Mean(high school)	0.2753***	0.0025
	(0.0613)	(0.0006)
Mean(economics)	1.2598***	0.0116
	(0.0918)	(0.0009)
σ^c	2.9984	
	(0.0064)	
ρ	0.8999	
	(0.0004)	
Log likelihood	−440884	
LR test of $\rho = 0$	840000	
Number of observations	1870324	
Number of investors	405271	

market participation probability is an economics education. Becoming an educator/teacher significantly lowers the probability of participating in the stock market by 0.2 percentage points.

Most of the financial variables are significant and have a positive marginal effect on the stock market participation probability. The positive effect from income confirms common knowledge from the literature that income plays a prominent role in determining whether an investor participates in the stock market or not. The marginal effect from the lagged return of the KFX index to the stock market participation probability is also significantly positive. This corresponds well with the notion that when the stock market is rising, investors are more interested in investing in stocks.

The probability of investing in stocks increases when the investor's spouse is an economist. This is consistent with information sharing in households, as well as the hypothesis that information about economics increases the probability of investing in stocks. This also corroborates the findings from the difference-in-differences estimators for investors who move in with an economist, cf. Section 3 above.

Turning to the second part of Table III, we find that the unobserved individual effects are positively correlated with some of the educational fixed effects, and the highest correlation is with the economics education. The interpretation is that investors who are more prone to invest in stocks also have a higher propensity for being economists. Investors with an education within educator/teacher, agriculture/food/forestry/fishing, business/commercial, health care, and police/armed forces/transportation are also more prone to hold stocks. Furthermore, the unobserved individual effects are positively correlated with all the financial variables' fixed effects (except nonfinancial income), and most strongly with the fixed effect of bond market participation. Unobserved individual heterogeneity is important: The contribution of the individual-specific variance component to the total variance is large and significant and amounts to 90%, $\widehat{\rho} = 0.9$.

To conclude, even though economists have unobservable characteristics that make them more prone to holding stocks, there is a significant positive marginal effect on the probability of participating in the stock market by acquiring a formal economics education. Indeed, the marginal effect from an economics education is larger than for any other education, and it is the only that is significantly positive.

Consequences of allowing for unobserved individual effects

The stock market participation literature is generally based on the standard probit model in Equation (2) which does not account for unobservable individual effects or make full use of the panel dimension of the data. As the individual effects are significant, a standard probit model would be misspecified. The major difference between the results from the standard probit model and the probit model with individual effects is that the absolute sizes of the estimated marginal effects are reduced. For instance, the standard probit model would imply that the effect of becoming an economist increases the probability of holding stocks by as much as 18 percentage points compared to having only 9 years of basic schooling (results available upon request). This should be compared with the marginal effect of 1.7 percentage points reported in Table III. In other words, the standard probit model exaggerates the coefficient estimates. We believe this is an important methodological message in our paper.

Conditional fixed effects logit model

An alternative way to investigate the causality question is to estimate a conditional fixed effects logit model. It has the same drawbacks (and advantages) as our parameterized random effects probit, since both methods

allow correlation between the individual effect and the observable variables in a restricted time-invariant fashion. Moreover, the fixed effects logit model has the additional drawback that it suffers from the incidental variables problem, since consistency relies on the assumption that $S_{i1}, ..., S_{iT_i}$ are independent conditional on (X_i, α_i).[15] The parameterized random effects probit model, on the other hand, allows unrestricted serial dependence in S_{it} (also conditional on X_i and α_i).[16] As expected, the fixed effects logit provides conclusions similar to the ones in Section 4.3, only with slightly higher point estimates (results available upon request). For instance, the only positive and significant marginal effect from the educational subject indicators is that from being an economist, which increases the probability of participating in the stock market by 4.6 percentage points.[17]

5. Instrumental Variables Analysis

An advantage of the individual effects probit model is that it uses the total sample and it investigates the effect of *all* educational subjects on stock market participation decisions. A disadvantage is that it imposes strict assumptions on the distribution of the unobserved variables. Thus, we use an IV approach to estimate the causal effect of an economics education on the stock market participation decision. Following general practice, the IV analysis is restricted to the subsample that is likely to be affected by the instrument. In compensation, the IV analysis takes care of any bias in the estimated effect caused by unobserved variables that drive both the stock market participation decision and the decision to get an economics education.

The estimated coefficient to the economics indicator can suffer from endogeneity bias arising from two sources: selection on outcomes and/or selection on unobservable variables. First, if individuals who aspire to obtain substantial financial gains by making stock investments choose an economics education in order to enhance their rate of success, it may lead to an upward bias. Second, unobserved ability bias arises if the most talented investors choose an economics education, and we fail to control for this talent. In this case, the estimated effect of having an economics education will also be upwardly biased. Similarly, the estimated effect could be biased if economists

[15] The incidental parameters problem, first noted by Heckman (1981), refers to the fact that estimation of the N individual effects together with β leads to inconsistent estimates of β with T fixed and $N \to \infty$.

[16] See for instance Wooldridge (2001) for a thorough discussion of these issues.

[17] Note that the effect of the male indicator is not identified by the fixed effects logit, as no individuals change gender during the observation period. Hence, this had to be dropped from this estimation.

are less risk averse or have an innate interest in finance. The IV approach deals with both sources of endogeneity, and accordingly, all the issues posed.

We use the opening of a new university as an instrument for choosing an economics education. Aalborg University opened in September 1974 in the County of Northern Jutland, which is in a remote part of Denmark. Before then, the closest university was in Aarhus (about 120 kilometers away from Aalborg). The new university made it possible for nearby high school graduates to acquire a university economics education level without having to move. Since mobility costs may be substantial, the opening of the university induces exogenous variation in the costs of choosing an economics education (that is independent of individual characteristics).

5.1 IV ESTIMATION SAMPLE

We select a subsample of individuals who lived in the County of Northern Jutland and who completed high school around the time of the university opening, namely in June 1972, 1973, 1974, and 1975.[18] The subsample comprises 577 individuals who made 2,795 stock market investment decisions. In the 1972–1973 (1974–1975) cohort 31% (35%) of the individuals participate in the stock market from 1997–2001 and 3% (5%) are economists. t-tests confirm that these differences are significant. The fact that we observe both the stock market participation decisions and educations of these individuals approximately 25 years after their high school graduations, illustrates the long time series dimension of our panel data and the detailed information about the investors that we have access to.

5.2 IV ESTIMATION AND IDENTIFICATION

To take into account the nonlinearity in both the stock market participation decision and the decision to get an economics education, the IV analysis is done by estimating the bivariate probit model:

$$S_{it} = \mathbf{1}\left[\beta_S \widetilde{X}_{it} + \delta Econ_{it} + \xi_{it} > 0\right] \tag{5}$$

$$Econ_{it} = \mathbf{1}\left[\beta_E \widetilde{X}_{it} + \gamma Z_i + \nu_{it} > 0\right], \tag{6}$$

[18] To make our estimations more efficient and robust to the possibility that individuals speculate in the university opening, either by postponing or speeding up their educational decisions, we have included all the cohorts of high school graduates from 1972 to 1975 in the main analysis. Including only the 1973 and 1974 cohorts in the analysis does not change the conclusions.

where $Econ_{it}$ denotes the indicator for individual i having completed an economics education at time t and $\widetilde{X}_{it}$ contains the background characteristics of investor i, excluding the educational-group indicators. The error terms are assumed independent and identically bivariate standard normally distributed, $\binom{\xi_{it}}{v_{it}} \sim N_2\left(\binom{0}{0}, \left[\binom{1\ \rho}{\rho\ \sigma^2}\right]\right)$, that is, it is the (seemingly unrelated) bivariate probit model. Z_i is an indicator for whether individual i completed high school in 1974–1975. Z_i is used as an instrument for acquiring an economics education.

Z_i is a valid instrument if the coefficient to Z_i is significant in the economics education selection Equation (6), and Z_i is independent of ξ_i and v_i. That is, the university opening should influence stock market participation only through the effect it has on the probability of obtaining an economics education. This condition is inherently untestable. The opening of Aalborg University is an exogenous shock that induces nearby high school graduates to choose an economics education. Whether the individual is born such that he or she graduates from high school in 1972–1973 or in 1974–1975 is independent of the individual's ability, interest in finance, and risk preferences. Therefore, it is reasonable that the observed difference in stock market participation for these two high school cohorts about 25 years after graduation arises because more individuals in the latter cohort were induced to choose an economics education because of the university opening.

5.3 IV RESULTS

Table IV shows the results from the IV analysis. The second column refers to the selection Equation (6). The significantly positive coefficient to the university opening indicator implies that significantly more individuals acquire an economics education as a result of the university opening. This is in correspondence with the simple t-tests we mentioned above; here, we show that the difference is significant also when conditioning on the background characteristics of the individuals.

The first column in Table IV displays the estimates of the stock market participation Equation (5). Most importantly, the marginal effect of an economics education is significantly positive (and amounts to 0.49, however, with large standard errors). The effect of having an economics education is significant and positive when we account for the possible endogeneity bias in the effect of the economics education. Since the identification stems from exogenous variation in the cost of acquiring an economics education, we conclude that the economics education has a strong causal impact on the decision to participate in the stock market for those individuals affected by the university opening. We interpret this as hard evidence that it really is

Table IV. Analysis

The table shows the results from the IV analysis based on a subsample of investors from the County of Northern Jutland who graduated from high school in 1972–1975. The columns show the parameter estimates (standard errors in parentheses) and their marginal effects [in square brackets] from the bivariate probit model. The first column concerns the stock market participation equation and the second column concerns the economics selection equation.***, **, * indicate parameter significance at the 1%, 5%, and 10% levels of significance, respectively.

Explanatory Variables	Stock market Participation βs (Std. Err) [$d\Phi_s/dx$]	Economics Selection β_E (Std. Err) [$d\Phi E/dx$]
Intercept	−0.1653	−4.2329
	(0.4843)	(0.9500)
	[0.0000]	[0.0000]
Age	0.0024	0.0189
	(0.0093)	(0.0172)
	[0.0009]	[0.0012]
Married	0.0214	0.2019*
	(0.0593)	(0.1133)
	[0.0077]	[0.0120]
Male	0.0703	0.1720
	(0.0547)	(0.1044)
	[0.0254]	[0.0110]
Children 0–6 years	0.1171	0.1629
	(0.0735)	(0.1205)
	[0.0431]	[0.0116]
Children 7–18 years	0.1151**	−0.4021***
	(0.0586)	(0.1040)
	[0.0414]	[−0.0281]
Bond market participation	0.7230***	0.4839***
	(0.1063)	(0.1454)
	[0.2799]	[0.0456]
Noncapital income/1,000,000	−0.2860**	0.5610***
	(0.1270)	(0.1680)
	[−0.1030]	[0.0357]
Cash holdings/100,000	0.0074*	−0.0029
	(0.0038)	(0.0064)
	[0.0027]	[−0.0002]
Taxable property value/100,000	0.0164***	−0.0029
	(0.0040)	(0.0075)
	[0.0060]	[−0.0002]
Compulsory pension contribution /10,000	0.0463***	0.0122
	(0.0092)	(0.0127)
	[0.0168]	[0.0008]
Private pension contribution/10,000	0.1000***	−0.0753**
	(0.0165)	(0.0318)
	[0.0363]	[−0.0048]
KFX	0.0674	−0.0254
	(0.1299)	(0.2379)
	[0.0244]	[−0.0016]

Table IV. (Continued)

Explanatory Variables	Stock market Participation βs (Std. Err) [$d\Phi_s/dx$]	Economics Selection β_E (Std. Err) [$d\Phi E/dx$]
Spouse education, economics	−0.3598***	0.8034***
	(0.1385)	(0.1528)
	[−0.1192]	[0.0996]
Length of education	−0.0503***	0.0706***
	(0.0115)	(0.0225)
	[−0.0182]	[0.0045]
Economics	1.3521**	
	(0.5586)	
	[0.4939]	
University opening indicator		0.2446**
		(0.0986)
		[0.0152]
Observed probability, P_1	0.3324	0.0394
Predicted prob. (at mean), P_1	0.3298	0.0276
Log likelihood	−2, 032.2924	
Pseudo R-square		
Number of observations	2795	
Number of investors	577	

information (from the economics education) that makes economists more likely to invest in stocks.

At first glance, it might seem that the estimated effect of an economics education is rather high.[19] It is, however, very reasonable for the following reason: The estimated effect of an economics education of 0.49 corresponds to an effect of 49 *percentages*, and not 49 percentage *points*. For instance, if the increase in the stock market participation probability is, say, 3.5 percentage points on average for the sample of high school graduates in the County of Northern Jutland, it could be three percentage points for noneconomists and approximately 4.5 percentage points for economists. The reason the marginal effect of the economist indicator in Table IV measures percentages, while that of the probit model of Table III measures percentage points, is that the former is a (weighted average of) local average treatment effect(s) (LATE): $\frac{E[S_{it}|\widetilde{X}_{it}, Z_i=1]-E[S_{it}|\widetilde{X}_{it}, Z_i=0]}{E[Econ_{it}|\widetilde{X}_{it}, Z_i=1]-E[Econ_{it}|\widetilde{X}_{it}, Z_i=0]}$, that is, it measures the difference in the stock market participation probability between those individuals who graduated from high school after the opening of Aalborg University and those who

[19] We thank an anonymous referee for pointing this out to us.

graduated before relative to the difference in the corresponding probability of becoming an economist.

Robustness of IV estimates

In an appendix that is available upon request, we document that the IV estimates are both internally valid and (qualitatively) robust. The appendix also includes a map of Denmark that shows where Aalborg University is located.

Regarding the strength of the instrument and the sensitivity of the IV estimates, we compare our estimates from the bivariate probit model to conventional IV (2SLS) estimates and treatment effects estimates from a control function approach that assumes linearity in the stock market participation Equation (5), but allows nonlinearity in the economics selection Equation (6). The 2SLS estimates are significantly positive, but very high and imprecise. The control function approach, however, gives estimates very similar to the bivariate probit model. This suggests that it is important to allow for nonlinearity in the selection Equation (6), but not the outcome Equation (5). We expect that the imprecision in the 2SLS estimates arises because the linear probability model provides a poor approximation for the two binary decisions relative to the probit model—in particular the binary choice of an economics education.

Regarding the validity of the instrument, the two high school cohorts that graduate before and after the university opening have no significant differences in observable characteristics at high school graduation. To check whether other macroeconomic factors may have affected the two high school cohorts differently, we use the corresponding high school cohorts from another county as a control group. The control group is not affected by the university opening, which corroborates the validity of our instrument.

5.4 CAUSALITY AND IDENTIFICATION

The finding that economists are more likely to hold stocks is independent of the identifying assumption. The identifying assumption in the IV analysis is that the university opening only affects stock market participation through the effect it has on an individual's choice of an economics education. The subpopulation affected by the instrument consists of individuals who finish high school in the early 1970s. These individuals are older, better educated and wealthier than the average. On the other hand, the identifying assumption in the parameterized random effects probit model is that the unobserved individual effects are random, but have a time-invariant mean (which depends on observed

individual fixed effects). The effect is identified by individuals who have just completed their education. For these individuals, who are younger and less wealthy than the average, we also report a positive significant effect—although smaller in magnitude than for the older and wealthier individuals. In the difference-in-differences analysis in Section 3 the identifying assumption is that an individual does not choose a spouse on the basis of the individual's proneness to participate in the stock market. We find that interacting closely with an economist spouse increases stock market participation significantly.

The results we present from different kinds of analyses that use different identifying assumptions all hint at a causal effect of an economics education on stock market participation. Since we believe that it is more likely that an economics education increases investors' knowledge, rather than changes other unobserved characteristics (such as investor risk aversion), we interpret the results as indicating that more economists hold stocks because they know more about economics, stock markets, and investment opportunities in general.

6. Robustness Tests

The results from the robustness tests are not tabulated, but are available upon request.

6.1 HIGHLY EDUCATED INVESTORS

Above, we control for the level of education by including years of schooling as a control variable. In order to make a comparison between investors with the same length of education, we estimate the individual effects probit model (4) on a subsample of investors with at least 18 years of schooling, that is, the roughly 5% of the investors with a master's or PhD degree. Since there is evidence of ability sorting across levels of education, but not across fields of education within a given level, this analysis is presumably free of unobserved ability bias (such evidence is for instance found by Berger, 1988 and Arcidiacono, 2004). There are 19,233 investors with an education of at least 18 years. The economics education still has the highest marginal effect on the stock market participation probability compared to other educations.

6.2 ECONOMISTS' INFORMATION ACQUISITION

Our presumption is that the longer an economics education is, the more information the investor has about economics and thereby about stock market investments. There are 5,148 investors with economics educations of 2, 4,

and 6 years beyond high school, that is, totaling 14, 16, and 18 years of schooling.[20] We estimate the individual effects probit model (4) on the subsample of economists and exclude years of schooling from the set of explanatory variables. We use separate indicators for the medium and high level economics education. We find that both medium and long economics educations significantly increase the stock market participation probability compared to having a short economics education. The marginal effects from medium and long economics educations are not significantly different.

6.3 DYNAMIC PROBIT MODEL

If the investor participated in the stock market last period, the investor has already paid part of the participation costs, and probably has more knowledge about investment opportunities than current nonparticipants. Thus, we expect that participation in the previous period has a positive effect on the probability of participating this period. This is indeed what we find in the random effects probit model extended with the one-period lagged stock market participation indicator as explanatory variable.[21] We deal with the initial conditions problem using Wooldridge's method (2005). The largest marginal effect is now from the lagged stock market participation indicator and equals 0.81, which reveals that stock market participation is highly persistent over time. Still, the marginal effect from being an economist amounts to 0.08 and it is significant and much larger than for any other educational group. These results corroborate our presumption that there are fixed stock market participation costs, and that these costs are lower for economists.

7. Do Economists Also Hold More Stocks?

Since investors first decide whether or not to participate, and then subsequently determine the amount to invest in stocks if they participate, it is interesting to evaluate whether information about economics also changes the proportion of investors' financial wealth invested in stocks.

We investigate what determines the fraction of stock holdings out of the total value of the assets, where the total value of assets is the sum of an investor's holdings of stocks, bonds, cash, and real estate. Economists who

[20] We exclude the apprenticeship educated economists as well as the very few economists with a PhD degree.

[21] We use the random effects dynamic probit model where the individual effects are not parametrized. We do not parametrize the individual effects due to identification problems, which is the reason this is not our reference model throughout.

hold stocks, hold on average the same fraction of their total assets in stocks as other investors (19.29% for economists versus 19.27% for other investors). We do not observe what the nonparticipants would have held, had they chosen to participate. We use Heckman (1979) two-step selection model to investigate how investors' stock holdings relative to total assets vary with the observable explanatory variables (results available upon request).[22] The first step is a standard probit model for stock market participation, which is sufficient to produce consistent estimates in the second step. The second step is a regression of stocks to total asset on explanatory variables. In the second step, the coefficient to the economist indicator is the largest of the educational variables, implying that economists have the highest propensity to hold relatively more stocks in their portfolio, controlling for other factors.

We also investigate the individuals' holdings of stocks relative to their holdings of bonds. Unconditionally, we find that the economists who hold *both* bonds and stocks, hold a much higher fraction of their wealth in stocks; on average, they hold 7.6 times more of their wealth in stocks than in bonds—the comparable number for the noneconomist investor is 3.8. Interestingly, the finding that economists appear to hold relatively more stocks than bonds compared to other investors disappears when we account for selection into the group of active investors and condition on observable characteristics.

We conclude that our finding that economists participate more in the stock market and hold more stocks than other investors, even if not a higher stock-to-bond ratio, is comparable to the finding of Calvet et al. (2006), who show (using Swedish data) that more sophisticated investors invest more efficiently but also more aggressively.

8. Conclusion

It is puzzling that so few individuals hold stocks. In our data, only 23% of the investors have decided to actively participate in the stock market, even though standard portfolio theory predicts that all investors should hold some fraction of risky assets in their wealth portfolio.

A promising explanation of the stock market participation puzzle is that there are costs associated with stock market participation that deter individuals from entering the stock market. Such costs include both the monetary costs

[22] Vissing-Jørgensen (2002) pursues the same kind of portfolio choice analysis. However, she does not have access to financial and educational variables as detailed as ours. Furthermore, she estimates the Lee (1981) simultaneous equation selection model, which is essentially the same as Heckman's two-step selection model, though, slightly more general and asymptotically more efficient. We find almost identical results from estimating the simultaneous and the two-step selection models. This is not surprising given the huge size of our dataset.

associated with stock investments and costs that reflect the time spent on understanding risk-return trade-offs and general information about stock markets. Thus, if some agents are better able to gather and understand information about investment opportunities and stock markets, their effective costs of stock market participation will be lower and consequently they will have a higher probability of participating in the stock market. Previous studies have shown that income, wealth, and length of education are important factors in determining stock market participation, but our study is the first to apply detailed educational information. In particular, we test the hypothesis that economists have a higher probability of investing in stocks due to informational advantages. We use a unique register-based panel data set covering the period 1997-2001, comprising more than 1.87 million observations on individual investor choices at year end, as well as a wide range of other background characteristics assumed to affect investment decisions.

We confirm the hypothesis that economists have a higher probability of holding stocks. This result is robust across a wide range of specifications and estimation strategies.

Having established that economists have a higher tendency to hold stocks, it would be interesting to evaluate whether economists also perform better on the stock market, that is, whether their risk-adjusted returns are higher than those that otherwise comparable investors obtain. Such an investigation, however, would require access to trades in individual assets. Another issue that would be interesting to investigate is whether economists' different stock market behavior also has consequences for their welfare, as measured through their consumption patterns. For instance, it could be interesting to follow up on the findings of Mankiw and Zeldes (1991) to see whether economists also choose other consumption patterns as a result of their different behavior on the stock market. These, and other related questions, require use of additional data beyond those we have access to in the present paper. Nevertheless, we hope to find answers to these types of questions in future work.

References

Arcidiacono, P. (2004) Ability sorting and the returns to college major, *Journal of Econometrics* **121**, 343–375.

Basak, S. and Cuoco, D. (1998) An equilibrium model with restricted stock market participation, *Review of Financial Studies* **11**, 309–341.

Berger, M. (1988) Predicted future earnings and choice of college major, *Industrial & Labor Relations Review* **41**, 418–429.

Bernheim, B. D. and Garrett, D. M. (2003) The effects of financial education in the workplace: Evidence from a survey of households, *Journal of Public Economics* **87**, 1487–1519.

Bernheim, B. D., Garrett, D. M. and Maki, D. (2001) Education and saving: The long-term effects of high-school financial curriculum mandates, *Journal of Public Economics* **80**, 435–465.
Bertaut, C. C. (1998) Stockholding behavior of U.S. households: Evidence from the 1983–1989 survey of consumer finances, *Review of Economics and Statistics* **80**, 263–275.
Calvet, L. E., Campbell, J. Y. and Sodini, P. (2006) Down or out: Assessing the welfare costs of household investment mistakes, *NBER Working Paper* No. 12030.
Carneiro, P., Hansen, K. T. and Heckman, J. J. (2003) Estimating distributions of treatment effects with an application to the returns to schooling and measurement of the effects of uncertainty on college choice, *International Economic Review* **44**, 361–422.
Chamberlain, G. (1980) Analysis of the covariance with qualitative data, *Review of Economic Studies* **47**, 225–238.
Cocco, J. F., Gomes, F. J., and Maenhout, P. J. (2005) Consumption and portfolio choice over the life cycle, *Review of Financial Studies* **18**, 491–533.
Coval, J. and Moskowitz, T. J. (1999) Home bias at home: local equity preference in domestic portfolios, *Journal of Finance* **54**, 2045–2074.
Coval, J. and Moskowitz, T. J. (2001) The geography of investment: Informed trading and asset prices, *Journal of Political Economy* **109**, 811–841.
Duflo, E. and Saez, E. (2002) Participation and investment decisions in a retirement plan: The influence of colleagues' choices, *Journal of Public Economics* **85**, 121–148.
Grinblatt, M. and Keloharju, M. (2000) The investment behavior and performance of various investor types: A study of Finland's unique data set, *Journal of Financial Economics* **55**, 43–67.
Guiso, L. and Jappelli, T. (2005) Awareness and stock market participation, *Review of Finance* **9**, 537–567.
Guiso, L., Haliassos, M., and Jappelli, T. (2003) Household stockholding in Europe: Where do we stand and where do we go? *Economic Policy* **18**, 123–170.
Guvenen, F. (2005) A parsimonious macroeconomic model for asset pricing: Habit formation or cross-sectional heterogeneity, Manuscript, University of Rochester.
Guvenen, F. and Kuruscu, B. (2006) Does market incompleteness matter for asset prices? *Journal of European Economics Association*, forthcoming.
Haliassos, M. and Bertaut, C. C. (1995) Why do so few hold stocks? *Economic Journal* **105**, 1110–1129.
Heckman, J. J. (1979) Sample selection bias as a specification error, *Econometrica* **47**, 153–161.
Heckman, J. J. (1981) The incidental parameters problem and the problem of initial conditions in estimating a discrete time discrete data stochastic process, In Manski, C.F. and McFadden, D. (eds.) *Structural Analysis of Discrete Data with Econometric Applications*, MIT Press: Cambridge, MA.
Heckman, J. J., LaLonde, R. and Smith, J. (1999) The economics and econometrics of active labor market programs, In Ashenfelter, O. and Card, D. (eds.) *Handbook of Labor Economics*, Elsevier, Amsterdam Vol. IV, 1865–2073.
Hong, H., Kubik, J. D. and Stein, J. C. (2004) Social interaction and stock-market participation, *Journal of Finance* **59**, 137–164.
Lee, L. F. (1981) Simultaneous equations models with discrete and censored variables, In Manski, C.F. and McFadden, D. (eds). *Structural Analysis of Discrete Data with Econometric Applications*, MIT Press: Cambridge, MA.
Malloy, C. J., Moskowitz, T. J. and Vissing-Jørgensen, A. (2005) Long-run stockholder consumption risk and asset returns, Manuscript, GSB, University of Chicago.
Mankiw, G. N., and Zeldes, S. (1991) The consumption of stockholders and nonstockholders, *Journal of Financial Economics* **29**, 97–112.

Massa, M. and Simonov, A. (2006) Hedging, familiarity and portfolio choice, *Review of Financial Studies* **19**, 633–685.
Mundlak, Y. (1978) On the pooling of time series and cross section data, *Econometrica* **46**, 69–85.
Pagano, M. and Volpin, P. (2006) Shareholder protection, stock market development, and politics, *Journal of the European Economic Association* **4**, 315–341.
Palacios-Huerta, I. (2001) The human capital of stockholders and the international diversification puzzle, *Journal of International Economics* **54**, 309–331.
Parker, J. (2001) The consumption risk of the stock market, *Brookings Papers on Economic Activity* **2**, 279–348.
Peress, J. (2004) Wealth, information acquisition, and portfolio choice, *Review of Financial Studies* **17**, 879–914.
Viceira, L. M. (2001) Optimal portfolio choice for long-horizon investors with nontradeable labor income, *Journal of Finance* **56**, 433–470.
Vissing-Jørgensen, A. (2002) Towards an explanation of household portfolio choice heterogeneity: Nonfinancial income and participation cost structures, *NBER Working Paper* No. 8884.
Vissing-Jørgensen, A. (2004) Perspectives on behavioral finance: Does irrationality disappear with wealth? Evidence from expectations and actions, In Gertler, M. and Rogoff K. (eds.) *NBER Macroeconomics Annual*, MIT Press: Cambridge, MA, 139–206.
Willis, R. J. and Rosen, S. (1979) Education and self-selection, *Journal of Political Economy* **87**, 7–36.
Wooldridge, J. M. (2001) *Econometric Analysis of Cross Section and Panel Data*, The MIT Press: Cambridge, MA.