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Ownership versus on-campus use of mobile IT devices by university students

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ABSTRACT

This study investigated ownership and on-campus use of laptops, tablets, and smartphones, using survey information on Dutch university students. We show that 96% of students own at least one of these mobile IT devices (i.e., a laptop, tablet, or smartphone). Using econometric modelling, we also show that student income, parental income, gender, immigrant parents, and household type (e.g., living with parents) have a statistically significant but small effect on mobile IT device ownership. The demand for tablets is relatively income inelastic, and the demand for laptops and smartphones extremely so. Therefore ownership rates are high for all student groups, including lower income students. However, students leave their laptops (and tablets) at home most of the time, mainly because they find it cumbersome to carry a laptop, and the vast majority of students hold the opinion that abolishing computer labs while facilitating laptop use is a bad idea, despite the didactical advantages this may have during lectures. Thus, it appears that the current high ownership rates of mobile IT devices by no means imply students' preference or support for university Bring Your Own Device (BYOD) strategies.

1. Introduction

Integration of Information Technologies (ITs) in higher education is not only important for individuals who enjoy a higher quality of education (Peeraer and Van Pategem, 2010); it can even be argued that integration of ITs in (higher) education is beneficial for societies at large. For example, Bloom, Sadun, & Van Reenen (2012) show that a good use of ITs is associated with higher national productivity growth. As a result, for most (if not all) disciplines in higher education, computers play an important role. Several studies exist on students' use of university-provided computer labs (e.g. Burke et al., 2008; Spennemann, Atkinson, & Cornforth, 2007; Spennemann, Cornforth, & Atkinson, 2007) and wireless internet use on campuses (Henderson, Kotz, & Abyzov, 2008; Sevtsuk, Huang, Calabrese, & Ratti, 2009). We are, however, aware of only a very limited literature on student ownership and use of mobile IT devices. This is surprising, as students' use of university-provided computers comprises only a very small part of their total study-related computer use.[1]

The quick and recent upsurge of mobile IT devices is a relevant development for education. On the downside, these devices can distract students during lectures (Fried, 2008; Lauricella and Kay, 2010; Wurst, Smarkola, & Gaffney, 2008). Mobile IT devices can also positively influence the quality of education in several ways. For example, mobile IT devices enable students to work on assignments and access information (including podcasts, see Evans, 2008) in a manner that is not restricted by time and space (similarly, see Sarkar, 2012). Mobile IT devices can also foster student peer-to-peer collaboration (Lauricella and Kay, 2010).

Ubiquitous mobile IT devices allow universities to adopt Bring Your Own Device (BYOD) strategies, which are in a way opposed to more traditional IT policies that rely on university-provided desktops on campuses. One example of a BYOD strategy is abolishing university computer labs and urging (or obliging) students to bring their own device. Student computer labs are expensive to facilitate due to strong fluctuations in demand (Atkinson, Spenneman, & Cornforth, 2005). So, when (almost) all students own a mobile IT device, universities may abolish computer labs in favour of student-owned device use (e.g., Lennon, 2012; Li and Newby, 2002).

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[1] For example, our survey information indicates that only 14% of study related computer use takes place on university provided computers. See Section 4 for information on the survey data.

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Another example of a university BYOD strategy is further integrating student-owned mobile IT devices during lectures. Teachers can incorporate mobile IT devices during lectures in several ways. First, by means of an online application (app), student-owned IT devices can be used for electronic voting, which can make lectures more engaging.[2] Second, laptops and tablets can be used to add practical elements to lectures, for example, when students conduct computations on their own IT devices.[3] Third, educational apps can be designed that suit a wide array of educational purposes (e.g., Dickens and Churches, 2011; Peluso, 2012). Despite these potential advantages, integration of student-owned devices during lectures is still rather limited in most universities. It seems that the current generation of students use mobile IT devices for virtually everything, but nonetheless, these devices are rarely incorporated during lectures.

When making decisions on BYOD policies, IT practitioners and teaching staff face uncertainty on how this would affect the 'socio-economically weak segment of students' (e.g., Atkinson et al., 2005; Kirkwood and Price, 2005; Margaryan, Littlejohn, & Vojt, 2011). BYOD strategies may in principle be unfavourable to groups of students who do not have access to these technologies, but according to our knowledge, the literature only provides limited evidence on this. Importantly, when educational attainment is divided among socio-economic lines, BYOD strategies may, in principle, exacerbate these educational attainment differences when access to mobile IT devices is also divided among the same socio-economic lines. For example, when children with lower income parents have lower educational attainment (e.g., Chevalier, Harmon, O'Sullivan, & Walker, 2005), then BYOD strategies could even enlarge this gap when students with lower income parents also have less access to mobile IT technologies.

The purpose of our current paper is to study to what extent different groups of students are affected by university BYOD strategies. There are, in general terms, three main reasons why a student may be negatively affected by university BYOD strategies: (i) the student has no access to mobile IT technologies; (ii) the student finds it cumbersome to bring a laptop or tablet to the university; and (iii) the student has a preference for using university-provided computers. In our current paper, in order to study students' *access* to mobile IT technologies, we will apply econometric modelling to test to what extent student income, parental income, age, study-type, education type (e.g., law, economics), and origin of the student and parents (i.e., Dutch, non-Dutch) affect ownership of laptops, tablets, and smartphones.[4] In our empirical procedure, we will first model ownership of each device separately, and then model device ownership as bundled decisions (e.g., the student owns *no* mobile IT device, the student owns *all three* of these mobile IT devices, etc.). In order to gain insight into the students' preference for bringing mobile IT devices to the university, we provide descriptive statistics on the students' current propensity for bringing mobile IT devices to the university. In addition, we provide information on the reasons for bringing mobile IT devices to the university, or rather leaving these devices at home. In order to study to students' preference for university-provided computers, we will provide descriptive statistics on the extent to which students feel that they would be affected by the BYOD strategy of making laptop use mandatory (and abolishing university computers). By focusing on both ownership and use of mobile IT devices, we are able to show that ownership rates of mobile IT devices are very high for all groups of students, but at the same time, students usually leave laptops (arguably the best substitute for university computers) at home. So, although until now the focus of the literature has been mainly on *ownership* of mobile IT devices, our results strongly suggest that the willingness of students to bring these devices to the university (and use them as a substitute for university computers) is at present an equally, if not more important issue for the implementation of university BYOD strategies.

We apply survey information on ownership and use of mobile IT devices by 3132 students of a Dutch university in November 2011. In this university, computer labs are available to all students, but the university also provides all facilities required by students who prefer to use their own IT devices (e.g., wireless internet connection, sockets). Ownership of mobile IT devices is not mandatory and the university does not push students to purchase mobile IT devices. We find that different groups of students (e.g., with high or low student income, high or low *parental* income, immigrant parents, sexes, etc.) differ in the ownership of mobile IT devices, but the ownership rates are nonetheless high for all these groups. We also find that students leave their laptops at home most of the time because they find it cumbersome to carry a laptop. A large majority of students are opposed to the BYOD policy of making laptop use mandatory and abolishing computer labs.

The structure of the remainder of the current paper is as follows. Section 2 provides a literature review. Subsequently, Section 3 discusses the empirical approach. Section 4 discusses the survey data and provides descriptive statistics. In Section 5, we model mobile IT device ownership econometrically. Section 6 describes the propensity for bringing mobile IT devices to the university. In addition, Section 6 also discusses the reasons why students bring a laptop or a tablet to the university, and the reasons for *not* bringing a laptop to the university. Section 7 describes the students' attitudes towards the BYOD strategy of making laptop use mandatory, and Section 8 concludes.

2. Literature review

Our current paper correlates with several branches of literature. First, our paper is related to literature on IT use and educational attainment. This literature is ambiguous about the effect of ITs on educational attainment in primary and secondary education. For example, Angrist and Lavy (2002) find a negative effect of classroom computer use on student math scores of 4th grade students in Israel. Leuven, Lindahl, Oosterbeek and Webbink (2007) use a regression discontinuity design and find a negative effect of computer subsidies on

[2] In addition, electronic voting can be a helpful tool for providing teachers and students with feedback on whether students have understood the content of lectures. One advantage of electronic voting, compared to voting by raising hands, is that students are not influenced by each others' answers. Particularly for large groups of students, electronic voting is also faster because votes do not have to be counted manually. See, for example, King and Robinson (2009) for a more elaborate discussion on electronic voting during lectures.

[3] When students do not own mobile IT devices, theoretical lectures and practical computer classes are usually strictly separated for practical reasons, with practical lectures taking place exclusively in computer labs. So, one potential advantage of ubiquitous IT device ownership is that teachers can more easily combine theoretical explanations and practical exercises in one lecture.

[4] All these devices can access the internet and have much potential for integration in higher education, although applications vary. For example, all three devices can be used for teacher–student communication and electronic voting (which can be used to add an interactive element to teaching), tablets and laptops may be handy for doing individual computations during (practical) classes, but laptops in particular seem suitable for writing papers.

primary-school achievement (language, arithmetic, and information processing). Goolsbee and Guryan (2006) study the effect of a US subsidy for Internet and communication investments in schools, and find no significant effect on students' performance. Vigdor and Ladd (2010) find a negative effect of computer ownership on secondary school performance in North Carolina on math and reading scores, which can be attributed to displacement of social activities. However, other studies suggest the contrary. For example, the findings of Haelermans and Blank (2012) suggest that IT innovations have a *positive* effect on secondary school achievements. This result is in line with Banerjee, Cole, Duflo and Linden (2005) for India, and Machin, McNally, and Silva (2007) for England, who also argue that these mixed findings can be attributed to differences in 'fertile background' for making efficient use of IT in education.[5] Yet, according to our knowledge, the importance of ITs for *higher* education is not (or hardly) disputed. In *higher* education, students learn essential computer skills that are employed throughout their professional career (Lortie, 2002; So, Choi, Lim and Xiong, 2012). Also the importance of computers for, for example, communication, (scientific) information access, and working on assignments (e.g., theses) in higher education is enormous. Examples of studies that emphasise the importance of ITs for higher education include Nadira Banu Kamal and Thahira Banu (2010), Sarkar (2012), and Tamim, Lowerison, Schmid, Bernard, and Abrami (2011). Evans (2008) emphasises the importance of ITs for mobile- and e-learning. Furthermore, Fairlie (2012), based on a randomised experiment, finds that computers positively influence (minority) students' performance.

Second, our current paper is related to the digital divide literature, which studies how computer (e.g., Chinn and Fairlie, 2007; Fong, 2009; Padmanabhan and Wise, 2012; Vekiri, 2010), internet (e.g., Chinn and Fairlie, 2007; Fong, 2009; Sautter, Tippett, & Morgan, 2010; Talukdar and Gauri, 2011; Vekiri, 2010), and cell phone access (e.g., Buys, Dasgupta, Thomas, & Wheeler, 2009; Fong, 2009) are divided among socio-economic indicators such as income, race (US), immigrants (Europe), and education level. As education is considered a crucial determinant for intergenerational mobility in societies (Schütz, Ursprung, & Wößmann, 2008; Summers and Wolfe, 1977), the importance of the digital divide for educational equality in developing countries has also come to the fore in the literature (e.g., Padmanabhan and Wise, 2012; Were, Rubagiza, & Sutherland, 2009).

Third, our paper is related to two papers on student mobile IT device ownership and how these devices are used for learning. Jones, Ramanau, Cross and Healing (2010) find considerable age differences in new technology use for study and leisure, but they caution that also for the younger generation of students, considerable differences in technology use persist. Margaryan et al. (2011) study UK university students' mobile IT device ownership and the way in which digital technologies are employed for learning and socialising. The study finds high adoption rates of laptops and cell phones, but their dataset dates from 2007 so smartphones and tablets were left beyond their scope (smartphones were not common at this time, and tablets were nonexistent). As variables that influence mobile IT technology adoption, the latter study focuses on age and study-type, and it recommends further research on the effect of the socio-economic background of students on the use of digital technologies, which is the aim of our current paper. The present research will also focus on gender differences, which are considered potentially important in the literature (e.g. Jones et al., 2010; Kirkwood and Price, 2005).

3. Empirical approach

Our current paper relies on quantitative and qualitative research techniques. We include information on (log) student income, gender, and age as explanatory variables.[6] We include information on immigrant status by including a foreign-born parent dummy and a non-Dutch student dummy. We also include information on *parental* income for two reasons. First, parental income is interesting in its own right when one considers parental income as an indicator of student socio-economic status. Second, not including information on parental income may bias our estimates on the effect of *student* income on device ownership, because higher income parents are more likely to buy mobile IT devices for their children, so neglecting parental income may, in principle, result in an omitted variable bias. A methodological difficulty here is that students are unlikely to be able to provide reliable information on the incomes of their parents. Therefore, we use parental income dependent scholarships as a proxy for parental income. These scholarships are discussed more elaborately later. We control for household type (e.g., living with parents), number of years studied, and study type (e.g., law, economics).

First, we will use *binary* probability models on laptop, tablet, and smartphone ownership. We will then expand on these results by estimating *multinomial* models on the probability that an individual owns a certain *bundle* (i.e., combination) of devices (e.g., no mobile IT device; laptop, tablet, *and* smartphone, etc.).[7] The advantages of this multinomial approach are twofold. First, it allows for measuring the income elasticity for *not* owning any of these mobile IT devices, which is a particularly relevant category because these students are excluded from all BYOD activities. Second, it allows for distinguishing between students' inferior and more preferred bundles of mobile IT devices.

We use logistic regression (logit) models in our application. Logit models have the attractive feature that they enforce the predicted probabilities to be between 0 and 1 (linear probability models, for example, do not have this feature). Another reason why researchers

[5] See Kirkpatrick and Cuban (1998) for a meta analysis on computer use and underage student performance.

[6] We assume that all covariates are exogenous (so there is no reversed causality of device ownership on income, for example). Two reasons make this reversed causality possible. First, mobile IT devices (in particular laptop computers) may be used as a tool to make money. This effect is likely ignorable, because in the Netherlands employers typically provide employees with all the ICT tools that are required to perform the tasks at hand. Another reason why this effect is unlikely to be large is that only 1% of students do not own a computer (so computer ownership can hardly be a competitive advantage in the labour market). Second, income could, in principle, be endogenous when students work more hours for the purpose of buying mobile IT devices, for example. This bias is also unlikely to be large, given the only very small share of income that students spend on mobile IT devices. Suppose, for example, that the purchase costs of one of these devices is €350 for 4 years. The costs of purchasing this device are then only 1.2% of mean student income. Hence, our assumption on exogenous income, which is commonplace in the economics literature, seems reasonable. Notice, however, that if reversed causality exists, this would lead to an *overestimate* of the income effect. So, we are on the conservative side when we conclude that income has a rather weak effect on mobile IT device ownership, as we will do later.

[7] We have used multinomial logit models (rather than probit models) because it is not possible to estimate multinomial probit models for this many alternatives. It appears that for the binary estimates, logit and probit models give (almost) identical results. As an additional test, we have compared the outcomes of logit and probit models for a three alternative multinomial specification (i.e., owning no mobile IT device, owning a laptop, tablet, *and* smartphone, or owning any other combination of mobile IT devices.). Again, it appears that the outcomes of logit and probit models are (almost) identical. It also appears that the probabilities of not owning a mobile IT device (or owning all three of the devices) are the same for the three and seven bundles estimates. The latter results indicate that the outcomes of our study are rather robust to the employment of logit rather than probit models.

typically prefer logit models is that the standard assumptions on the distribution of errors are unlikely to hold for linear probability models (e.g., Verbeek, 2008). As the coefficients of logit estimates are not straightforward to interpret, we will particularly emphasise the predicted probabilities and mean marginal effects in the main text.

We will then provide information of a qualitative nature on students' propensity for bringing mobile IT devices to the university. We will also provide statistics on the reasons why students decide to bring mobile IT devices to the university, or rather leave them at home. In addition, we provide questionnaire information on students' attitudes towards making laptop use mandatory.

4. The data and descriptive statistics

In November 2011, 3132 students from a Dutch university participated in an online survey about ownership and use of laptops, tablets, and smartphones. The questionnaire also involves questions about student characteristics (e.g., income, gender, study type, etc.). A methodological difficulty with student income is that parents may help their children with the expenses of books, tuition, rent for a student room, etc. In order to make as fair a comparison as possible, students were asked to perceive these parental allowances as part of their income.[8] Later, we will show that the reported student incomes, as well as the income differences between student groups (i.e., sexes, age categories, housing situation), very closely match the statistics by the National Institute for Family Finance Information. Therefore, we find no evidence for systematic misreporting of income.[9] Questions on income, scholarship, and origin (i.e., Dutch or non-Dutch) were non-compulsory as these could be considered sensitive by some. Fortunately, the share of students that chose not to answer these questions is only negligible.

Table A1, located in the Appendix, provides information on the survey participant characteristics.[10] As the table shows, 96.3% of students reported information on their scholarship: 17.3% of students receive a complementary scholarship for lower income parents, and 44.6% receive a standard scholarship, so the share of lower income parents is 27% (i.e., $0.17/(0.17 + 0.45)$).[11] Only 1.1% of students receive a different scholarship (mainly international students).[12] Furthermore, 13.7% receive only a loan by the Dutch government, and 23.3% of students receive no scholarship.[13]

In addition, 92.0% of students have reported information on their net monthly income (categorical variable) from scholarships, parental allowances, and jobs. As expected for students, incomes tend to be comparatively low: 87.3% reported an income lower than €1000. The average income is €587. Apart from these incomes, study loans are common. Average incomes strongly vary over household types: €397 for living with parents, €655 for a student house, and €784 for own house/apartment. Mean monthly income is €78 higher for males than for females, and incomes strongly increase with age. The mean monthly incomes, as well as the income differences between sexes and household types, strongly coincide with the statistics of the National Institute for Family Finance Information (Van der Burg, Kreetz, & Van der Schors, 2012).[14] Tuition fees are the same for all students (except for non-Dutch students who pay a slightly higher fee).[15]

Table 1 provides information on student income and mobile IT device ownership. As illustrated, 83.8% of students have a laptop fully at their disposal and 3.7% share a laptop with another person.[16,17] Tablet ownership is less common: 7.2% of students own a tablet device fully

[8] The exact phrasing of the income question was as follows: "What is your net monthly income from scholarships, job income, parental contribution, etc? In case your family helps pay for your studies (e.g. via books, tuition, rent), please add an estimate of this amount to your income". The questionnaire was pre-tested by 14 students, and the students who pre-tested the questionnaire found this question easy to understand and answer.

[9] As an additional test, we have regressed income on all other explanatory variables (only the scholarship dummies were not included due to potential endogeneity). Again, the results are very much as expected, that is, student with parents born abroad are associated with somewhat lower income, international students have much lower incomes, students living away from home have much higher incomes, and incomes increase strongly (and significantly) with age. Law and economics students have higher incomes than students from other faculties, ceteris paribus.

[10] Participation in the survey was voluntary. Although self-selection would not (or hardly) affect our econometric modelling (where we control for a variety of student characteristics), self-selection could potentially bias our *descriptive* results. However, we have several reasons to believe that self-selection is not very important here. First, the shares of the faculties in the survey seem to be very representative: none of the 13 faculties' shares in the questionnaire deviates more than 3 percent points from the real student share of this faculty. Second, the higher share of female students coincides with the government statistics. Third, as we will explain later, the income statistics strongly coincide with the statistics by the National Institute for Family Finance Information. All in all, Table A1 strongly suggests that the group of students that participated in the survey is rather balanced.

[11] It is not possible to give a clear income threshold for complementary scholarships, as the parents' capacity to pay for their children's studies is also assessed based on, for example, the number of siblings. Although students can also apply for complementary scholarships in case of a family dispute, this is very rare, so complementary scholarships must be a good proxy for parental income.

[12] In the empirical estimates, the categories 'other scholarship' and 'no scholarship' have been merged (that is, these students receive no regular scholarship from the Dutch government), because including the estimates separately would result in very large standard errors. In the sensitivity analysis, we show that including these categories separately hardly influences our point estimates.

[13] Students may be non-eligible for scholarships when they are aged above a certain threshold, when they are non-Dutch, or when they incur study delay, for example. In many cases these students are still eligible for a study loan. Also, students may not want to apply for these scholarships because they have to be repaid with interest if the study is not finished successfully.

[14] The National Institute for Family Finance Information (NIBUD) reports a mean university student income of €841, including study loans and parental allowances (Van der Burg et al., 2012, p. 18). The latter study also indicates that students borrow on average €218 per month (i.e., 55% of students borrows €396 on average, p. 41). So, the non-loan mean income reported by NIBUD is equal to €623, which is much in line with the mean income reported in our survey. Note, however, that other studies of the same institute report slightly higher average study loans (Nibud, 2010), in which case the mean income reported in our survey is slightly *higher* than the NIBUD statistics. All in all, the incomes reported in our survey match the NIBUD statistics very closely.

[15] The higher fees will not bias our estimated income coefficient, because any systematic difference in the way income is reported should be captured by the non-Dutch student dummy.

[16] This high laptop ownership rate is in line with previous studies (e.g. Jones et al., 2010; Kennedy, Judd, Churchward, & Gray, 2008; Margaryan et al., 2011; Nagler and Ebner, 2009).

[17] As an aside, it appears from the survey information that 91% of students who do not have a laptop computer have a desktop computer, so the share of students that do not dispose of their own computer (i.e., laptop, desktop, or tablet) is only 1%. This is important because it appears that only a very marginal share of students is fully dependent on university-provided computers for working on assignments (although some students may still be dependent on university computer labs due to software requirements, for example). This high computer (i.e., laptop *or* desktop) ownership rate is consistent with earlier studies (e.g., Jones and Madden, 2002; Jones et al., 2010). We have asked students about the reasons for owning neither a laptop nor a desktop computer. Of the 29 students who do not own a computer, 12 reported that they have no need for one, 11 did not want to spend the money, and 6 used to have a computer which got broken.

Table 1
Descriptive statistics on income and ownership of mobile IT devices among students.

Devices	Ownership	Freq	(%)	Mean income
Laptop	None	390	12.5	533
	Shared	117	3.7	539
	Full	2625	83.8	597
Tablet	None	2789	89.0	577
	Shared	117	3.7	593
	Full	226	7.2	707
Smartphone	No	1006	32.1	536
	Yes	2126	67.9	611

Note: net monthly income in Euros.

and 3.7% share this device with another person. As well, 67.9% of students own a smartphone.[18] For all three devices, Table 1 suggests a positive correlation between income and ownership rates.

Table 2 provides descriptive statistics on income and ownership of IT device bundles, which are exploited later in the multinomial logit estimate. Table 2 shows that 52.7% of students own a laptop and a smartphone (but no tablet), while 25.4% own only a laptop (but neither a smartphone nor a tablet). As well, 3.1% of students own a device bundle other than the ones listed in Table 2, that is, these students own a tablet but no laptop and/or smartphone. Again, income and the number of devices owned are positively correlated.

5. Econometric modelling of device ownership

5.1. Binary models

Table A2 in the Appendix reports binary logit coefficients and marginal effects for mobile IT device ownership. Here, ownership of each device is estimated in a separate model (rather than as device bundles, as we will see later). It appears that the tablet ownership probability is lower for students with lower-income parents (marginal effect −0.056, standard error 0.019),[19] and the lower-income parents dummy is non-significant for laptops and smartphones. It also appears that students with immigrant parents have a lower probability of owning a laptop computer (m.e. −0.053, s.e. 0.015), but a *higher* probability of owning a smartphone (m.e. 0.090, s.e. 0.025). The coefficient of migrant parents is almost equal to zero (i.e. 0.001) for tablet ownership, and hence non-significant.

Non-Dutch students less often own a smartphone (m.e. −0.110, s.e. 0.037). The latter rather strong effect is likely because smartphone contracts usually have requirements on country of residence, so the conditions of smartphone contracts may be less favourable to foreign exchange students who do not intend to stay in the Netherlands for long. Students who live in a student house have a lower probability of owning a tablet relative to the reference group of living with their parents (m.e. −0.078, s.e. 0.017), but a *higher* probability of owning a laptop computer (m.e. 0.063, s.e. 0.017). This is also likely because using a laptop computer gives them more flexibility, for instance, to work on assignments when they visit their parents over weekends. Females have a much higher probability of owning a laptop computer (m.e. 0.096, s.e. 0.013), but a *lower* probability of owning a tablet (m.e. −0.029, s.e. 0.013) and smartphone (m.e. −0.038, s.e. 0.019).[20] In addition, Table A2 also suggests lower ownership rates with age, conditional on log incomes.[21]

We are also particularly interested in the effect of income on mobile IT device ownership, because mobile IT device ownership may, *in principle,* be strongly divided among income lines when many students cannot afford to buy mobile IT devices. To illustrate the effect of income on the probability of owning mobile IT devices, Fig. 1 illustrates this ownership probability, conditional on student income. All other covariates are kept at their mean values in Fig. 1. It appears from Fig. 1 that the laptop ownership probability is high for all incomes, and that the differences between income levels are small. For example, the probability of owning a laptop is 0.873 given a net monthly income of €300, and 0.896 given an income of €1500, so the probability difference is rather small even when income increases fivefold.[22] The smartphone ownership probability increases slightly more steeply with income. The smartphone ownership probability is equal to 0.661 given an income of €300, and 0.742 given an income of €1500. The tablet ownership probability is relatively low for all income levels, but its relative increase is steeper: the probability of tablet ownership is 0.099 given an income of €300, but 0.146 given an income of €1500 (an increase of 48%).

Table A4 reports income elasticities of the demand for the mobile IT devices. At a mean income of €587, the probability of owning a laptop is equal to 0.878, and the marginal effect of a 10% income increase is equal to 0.0014.[23] So at mean income, the income elasticity for laptops is equal to 0.016 (i.e., 0.0014/0.878/0.1). This implies that the demand for laptops is very income *inelastic*. Likewise, the income

[18] This result is much in line with Jones et al. (2010).
[19] The marginal effect is the predicted change in probability given a one-unit change in the explanatory variable. So, this particular marginal effect signifies that the probability of owning a tablet is about 5.6 percent points lower for students with lower-income parents.
[20] In line with Margaryan et al. (2011), we also find strong differences between study types in terms of mobile IT adoption.
[21] Although the age dummies are non-significant in Table A2, we have also experimented with including age as a linear variable, in which case the effect of age is significant at the 1% level for laptop and smartphone ownership (and still non-significant for tablet ownership).
[22] Table A1 shows that these rather large income differences are not uncommon for students.
[23] The marginal effect of a 10% income increase is equal to ln(1.1), multiplied by the marginal effect.

Table 2
Descriptive statistics on income and ownership of mobile IT device bundles among students.

	Freq	(%)	Mean income
No mobile IT device	138	4.4	507
Other bundle	98	3.1	519
Only laptop	796	25.4	541
Only smartphone	204	6.5	562
Smartphone and laptop	1651	52.7	602
Smartphone, laptop, and tablet	245	7.8	727
Total	3132	100	587

Notes:
1) Net monthly income in Euros.
2) Ownership shares include shared devices.

elasticity for smartphones is 0.073, which is also very low. The income elasticity for tablets is somewhat higher, although not extremely so: the income elasticity for tablets is equal to 0.235.

5.2. Multinomial estimate (device bundles)

The current subsection extends on the results of the previous subsection by estimating a *multinomial* logit model on the probability that the individual owns a certain combination of devices. The results are given in Table A3. The reference category is owning a laptop and smartphone, but no tablet (this is the most frequently occurring combination of devices).

The alternative of owning none of the mobile IT devices is, in our opinion, a particularly interesting alternative; these students would be affected by all BYOD strategies because they have no IT device that can be brought to the university. The corresponding coefficients are reported in Column [1] of Table A3. It appears that students living in a student house and females both have a 0.032 lower probability of owning none of the mobile IT devices (both significant at $p < 0.01$). Scholarship type, immigrant parents, and study-phase have no significant effect on the probability of owning no mobile IT device.[24]

Another interesting result in column [4] is that lower-income parents decrease the probability of owning all three devices by 0.054 compared to the reference category of owning only a laptop and a smartphone ($p < 0.01$). So, the result of Table A2, that parental income also influences tablet ownership, is maintained in the multinomial estimate. The coefficients for other bundles (only laptop, only smartphone, other combination of mobile IT devices) are also presented in Table A3.

Fig. 2 reports the probabilities of ownership of different device bundles, conditional on student income. It appears that the probabilities of owning the 'laptop and smartphone' bundle and the 'smartphone' bundle are roughly invariant for different income levels. This roughly invariant effect of income can partly be explained by competing effects of income.[25] The probability of owning the 'laptop' bundle and 'laptop and smartphone' bundle decrease non-ambiguously with income. The probability of owning all three mobile IT devices (i.e., a laptop, tablet, *and* smartphone) increases from 0.067 to 0.119 when income increases from €300 to €1,500, which is also a likely result. As expected, the probability of owning none of the mobile IT devices decreases with income, but not exceptionally. That is, the probability of owning no laptop, tablet, or smartphone decreases from 0.047 to 0.030 when income increases from €300 to €1500.

5.3. Sensitivity analysis

As explained in Section 4, it appears that the reported student incomes very strongly coincide with Van der Burg et al. (2012), which strongly suggests that student incomes are not systematically misreported. We have nonetheless conducted a sensitivity test on the misreporting of study loans as income. Students who have only a study loan should certainly borrow much more than students with other types of scholarships, in which case the overestimate of the reported income should, to a certain degree, also be captured by the 'only a loan' scholarship dummy. Therefore, we have re-estimated the models without scholarship dummies and the income coefficient remained essentially unchanged,[26] which strongly suggests that study loans were not systematically misreported as income. In our main estimates, we have merged the 'different scholarship' with the 'none of the above scholarships' category, because of the only very few observations of the former. So, we have also re-estimated the model while including the 'none of the above scholarships' as a separate category. This also hardly changed our results. Moreover, we have re-estimated our model separately for students who live with their parents and students who live away from home. Again, the results hardly differ (the probabilities of owning no mobile IT device are (almost) identical, for example).[27] Thus, our results are rather robust.[28]

[24] It appears that age also has a significant effect on the probability that a student does not own mobile IT devices. In particular, it appears that students aged over 27 have a 4.6% higher probability of owning none of the mobile IT devices than the reference category of 17–20 years. The probability of owning no mobile IT devices also varies rather strongly over study types.

[25] For example, higher incomes may induce some students to switch from 'no device' to the 'smartphone' bundle, whereas it may also induce other students with a smartphone to buy a laptop or tablet, in which case they would switch to the 'smartphone and laptop' or 'other' bundles.

[26] I.e., point estimates for the (log) income coefficient of 0.123 (s.e. 0.079), 0.276 (s.e. 0.090), and 0.253 (s.e. 0.058) rather than 0.145 (laptops), 0.290 (tablets), and 0.256 (smartphones) for the binary estimates.

[27] The marginal effects of log income on the probability that a student owns none of the IT devices are −0.0112 (s.e. 0.0092) for students who live with their parents, and −0.0114 (s.e. 0.0052) for students who live away from home.

[28] More detailed results of our sensitivity tests are available upon request.

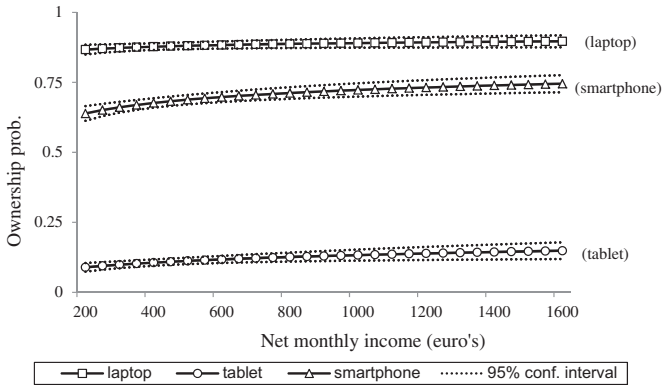

Fig. 1. Income and device ownership probabilities.

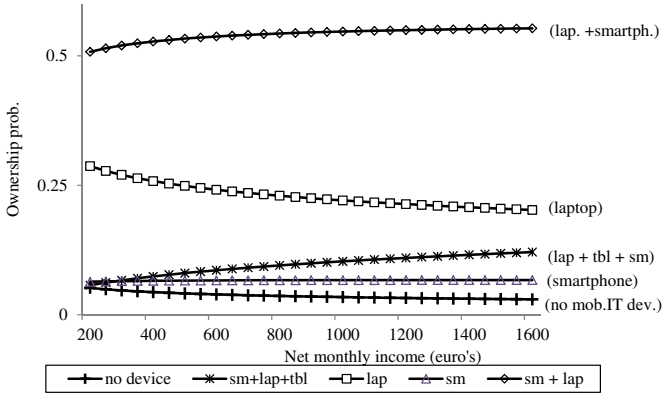

Fig. 2. Income and device bundle ownership probabilities.

6. Propensity for bringing devices to the university

In the preceding sections, we have shown that nowadays almost all students own mobile IT devices. To further study the implications of this finding for higher education, the current section provides descriptive statistics on how often these devices are brought to the university, and for what reason. As mobile IT device ownership does not necessarily imply student support for BYOD strategies, the next section will provide information on students' attitudes towards the BYOD strategy of abolishing computer labs in favour of facilitating laptop use.

In the survey, we asked students how often they visited the university in the preceding week (November 7–11, 2011), and how often they took a laptop or tablet with them. Based on this information, we calculated the propensity of bringing these devices to the university. The results are given in Table 3. It appears that laptop owners who share this device with another person bring the laptop to the university 8% of the time (column [1]). Laptop owners who do *not* share this device with another person (i.e., 'full' owners) bring the laptop to the university much more often, namely 28% of the time. The mean propensity for bringing a laptop is equal to 0.24 (including students who do not own laptops).

Column [2] shows that shared *tablet* owners bring the device to the university about 6% of the time, which is comparable to laptop owners. *Full* tablet owners bring this device to the university exactly half of the time, but the mean propensity for bringing a tablet is equal to 0.04 (as only few students own tablets). Assuming that all smartphone owners bring a smartphone to the university, the propensity for bringing at least one mobile IT device to the university is equal to 0.75 (column [4]).[29]

Students who indicated that they often bring a laptop or tablet to the university were asked about the most important reasons for doing so. The results are given in Table 4. The most important reason for bringing a *laptop* (column [1]) is comfort in use (72%), for example, when students prefer to work on group assignments in the canteen (or similar venues) rather than in computer labs. Also a better functionality (as compared to the university-provided computers) (58%), convenience for short use (e.g., browsing the web for information) (51%), and avoiding overcrowded university computer labs (39%) are important reasons. As well, 33% of students gave an answer other than the forced choice options provided in the questionnaire.[30]

Column [2] in Table 4 provides the most important reasons for bringing a *tablet* device to the university, which are similar to the reasons for bringing a laptop, but some differences are notable. In particular, it appears that the most important reason for bringing a tablet to the

[29] The survey does not contain information about bringing smartphones to the university, because it was assumed that students carry their mobile phones with them about all the time.

[30] The most important reason for bringing a laptop not included in the forced choice options is taking notes during lectures (66%). Also access to own files and programs (19%) and preference for a Macintosh operating system (4%) are important.

Table 3
Propensity for bringing mobile IT devices to university.

	[1] Laptop	[2] Tablet	[3] Smartphone	[4] Laptop, tablet, *or* smartphone
Shared owners	0.08	0.06	–	–
Full owners	0.28	0.50	–	–
All students	0.24	0.04	0.68	0.75

Notes:
1) 'Full' owners are owners who do not share this device with another person.
2) In columns [3] and [4], it is assumed that all smartphone owners bring this device to university.
3) Table based on the week of November 7–11, 2011.

Table 4
Most important reasons for bringing device to the university.

	[1] Laptop (%)	[2] Tablet (%)
Comfort in use (e.g., easy to use for group work)	72	61
Functionality better than university computers (e.g., applications, speed)	58	38
Wieldy for short use (e.g., quick search for information on web)	51	81
University computers often overcrowded	39	26
Reasons other than use at university (e.g., for use in train or elsewhere)	19	31
Fun-activities (e.g., games, music)	17	39
Insufficient information on availability of university computers	7	5
Other, namely… *(open question)*	33	30

Notes:
1) Only applicable to students who regularly bring device to the university.
2) The laptop question (column [1]) was answered by 659 students.
3) The tablet question (column [2]) was answered by 115 students.

university is that these devices are wieldy for short use. This is likely because students often have to look up information on the internet (e.g., e-mail, Blackboard learning environment). Fun-activities are also notably important for bringing a tablet to the university (39%).[31]

Table 5 reports the most important reasons for *not* bringing a laptop to the university. By far the most important reason for not bringing a laptop is that it is cumbersome to carry (87%). Other important reasons for leaving laptops at home are that students fear that their laptop may get stolen (27%) or broken (18%). Other students leave laptops at home because they find the university-provided desktop computers more comfortable/ergonomic (18%). Also practical reasons are important for leaving laptops at home (e.g., printing or WiFi connectivity problems).

It appears that males bring laptops to the university much more often than females. The propensity for bringing a laptop to the university is 0.34 for male and 0.24 for female laptop owners. We cannot say with certainty why females bring their laptops less often, but females more often reported 'cumbersome to carry' as an important reason for not bringing a laptop to the university (89% of females vs. 83% of males who rarely bring the device).[32]

Students who brought a *laptop* to the university on a certain day used it on average 1.3 h during lectures and 1.8 h outside lectures at student workplaces. Students who brought a *tablet* to the university used it 1.2 h during lectures and 1.0 h outside lectures, on average.

7. Attitudes towards making laptop use mandatory

In the survey, we also asked the students about their opinion on making laptop use mandatory.[33] In order to make the BYOD trade-off clearer to students, we included three examples of advantages (e.g., didactical advantages) and three disadvantages (e.g., costs involved for students) of making laptop use mandatory in the phrasing of our question. Students were also asked to indicate on a five-point Likert scale how large they thought the consequences of making laptop use mandatory would be for them. For convenience, we will interpret the first three categories in the Likert scale as 'limited consequences', that is, these students contemplate small or 'regular' consequences of making laptop use mandatory, but no 'large' consequences. The outcomes of the questions about making laptop use mandatory are presented in Table 6. Column [2] shows that 22.8% of students have a negative opinion on making laptop use mandatory and envisage large consequences for them if this would be the case. Column [3] shows that 39.5% of students think that making laptop use mandatory would be a bad idea, but at the same time they contemplate 'limited consequences' for themselves if this would be the case. Furthermore, column [4] shows that 17.8% of students are 'neutral' about making laptop use mandatory, and 20% hold the opinion that making laptop use mandatory is a 'good

[31] The most important reasons for bringing a tablet not included in the forced choice options are taking notes during lectures and reading course material on the tablet (this way, students save on printing costs).

[32] We have also regressed the propensity of bringing a laptop to the university on a series of control variables, including study type and income. Also, this specification indicates that females have a 0.1 lower propensity for bringing a laptop to the university, everything else being equal. So, it appears that this gender difference is not driven by differences in study type (or other confounding factors that we can control for).

[33] In particular, we asked about half of the students to react on the statement "making laptop use mandatory is a *good* idea", whereas the other half of students reacted on the statement "making laptop use mandatory is a *bad* idea". In the results presented later, we have reversed the Likert scale of the 'bad idea' group.

Table 5
Most important reasons for *not* bringing laptop to the university.

	(%)
Cumbersome to carry a laptop	87
Afraid that laptop may get stolen	27
No access to printers at university	22
Desktop use more comfortable/ergonomic	18
Afraid that laptop may get broken	18
No access to campus WiFi	15
Insufficient laptop facilities at university (e.g., sockets, specially equipped desks)	11
Required software not on laptop	7
Technical specifications of laptop insufficient	6
Forgotten to bring laptop to university	2
Other, namely… *(open question)*	18

Notes:
1) Based on responses of students who own a laptop, but rarely bring it to the university.
2) The question was answered by 1510 students; this is 55% of students owning a laptop.

Table 6
Opinion on making laptop use mandatory.

Student group	[1] Nr. obs.	[2] Bad idea, large consequences	[3] Bad idea, limited consequences	[4] Neutral	[5] Good idea
All students	3132	22.8	39.5	17.8	20.0
Females	1889	24.1	39.8	18.2	18.0
Income < €600	1716	23.8	38.5	17.3	20.4
Lower income parents scholarship	522	24.3	39.9	15.5	20.3
Immigrant parents	573	26.5	34.4	19.9	19.2
Living away from home	1833	22.4	40.6	17.4	19.7

Note: Columns [2]–[5] are percentages.

idea' (column [5]).[34] Furthermore, Table 6 shows that the differences in attitudes towards making laptop use mandatory are very comparable for different groups of students. However, we observe that students with immigrant parents reported large and negative expected consequences slightly more often. This could, for example, be explained by their lower propensity for owning laptop computers. As an alternative explanation, it may also be the case that students with immigrant parents are more dependent on university computer labs because their housing situation is different (immigrants more often live in the larger cities, for example).

8. Conclusion

In our current paper, we have tested for the probability of owning laptops, tablets, and smartphones for different groups of students. In addition, we have provided descriptive statistics on the propensity for bringing these devices to the university and on the students' opinion about making laptop use mandatory (and abolishing university computer labs). All of these research topics are highly relevant for university Bring Your Own Device (BYOD) strategies.

Ownership rates of laptops, tablets, and smartphones appear to be high. For example, for a female student with a net monthly income of only €300 and whose parents are immigrants with also a low income, the probability that she owns at least one of the mobile IT devices is as high as 0.98. We have also shown that laptop ownership is extremely income *inelastic* (i.e., elasticity equal to 0.016). The income elasticity for smartphones is also very low (i.e., 0.073), but the income elasticity for tablets is somewhat higher (i.e., 0.235). These findings suggest that, even though the literature has previously expressed the concern that BYOD strategies may affect the socio-economically weak segment of students disproportionally (e.g., Atkinson et al., 2005; Kirkwood and Price, 2005; Margaryan et al., 2011), all students nowadays have a high probability of owning mobile IT devices, including lower income students.

Another concern with university BYOD strategies is that it requires students to bring mobile IT devices to the university. At present, students do not seem very enthusiastic about bringing their mobile IT devices and thus they usually leave their laptops and tablets at home. They only bring a laptop to the university one in four days because they find it cumbersome to carry. As a consequence, students are rather lukewarm about the BYOD strategy of making laptop use mandatory, despite the didactical advantages this may have for their education. It thus appears that the need to bring devices to the university is a main disadvantage of BYOD strategies for students.

Acknowledgements

We thank two anonymous referees for valuable comments.

[34] Of the students who believe that making laptop use mandatory is a good idea, 83% believe that doing so would have 'limited' consequences for them. This may indicate that students do not believe that the educational benefits of making laptop use mandatory will be very large.

Appendices

Table A1
Descriptive statistics on student characteristics.

		Freq.	Valid percent (%)	Cum. (%)
Net monthly income	<€200	418	14.5	14.5
	€200–400	685	23.8	38.3
	€400–600	613	21.3	59.5
	€600–800	451	15.6	75.2
	€800–1000	349	12.1	87.3
	€1000–1200	146	5.1	92.3
	€1200–1400	74	2.6	94.9
	€1400–1600	45	1.6	96.5
	>€1600	102	3.5	100
	Missing	*249*	*8.0*	–
Scholarship type	Standard scholarship	1346	44.6	44.6
	Complementary scholarship (lower income parents)	522	17.3	61.9
	Only a loan (no other scholarship)	413	13.7	75.6
	Different scholarship	32	1.1	76.7
	None of the above	704	23.3	100.0
	Missing	*115*	*3.7*	–
Origin	Dutch student, with both parents born in Netherlands	2324	74.8	74.8
	Dutch student, with at least one parent born abroad	573	18.4	93.3
	International (non-Dutch) student	209	6.7	100.0
	Missing	*26*	*0.83*	–
Living sit.	Living with parents/guardians	1213	38.7	38.7
	Student house	944	30.1	68.9
	Own house/apartment (rented or bought)	889	28.4	97.3
	Other	86	2.8	100.0
Sex	Female	1889	60.3	60.3
	Male	1243	39.7	100.0
Study year	1st year bachelor	717	22.9	22.9
	2nd year bachelor	457	14.6	37.5
	3rd year bachelor	537	17.2	54.6
	Master	1097	35.0	89.7
	Other (e.g., pre-Master)	324	10.3	100.0

Table A2
Binary logit estimate on device ownership of students.

Device	[1] Laptop		[2] Tablet		[3] Smartphone	
	coef.	m.e.	coef.	m.e.	coef.	m.e.
Log net monthly income, €	0.145* (0.080)	0.015* (0.008)	0.290*** (0.091)	0.027*** (0.009)	0.256*** (0.059)	0.052*** (0.012)
Scholarship type dummies ('standard' scholarship omitted)						
Lower-income parents	0.181 (0.175)	0.018 (0.018)	−0.594*** (0.197)	−0.056*** (0.019)	0.187 (0.127)	0.038 (0.025)
Loan	−0.328 (0.227)	−0.033 (0.0230)	−0.468* (0.257)	−0.044* (0.024)	0.061 (0.162)	0.012 (0.033)
No scholarship/other	−0.038 (0.222)	−0.004 (0.022)	−0.104 (0.225)	−0.010 (0.021)	−0.267* (0.154)	−0.054* (0.031)
Origin dummies (Dutch with both parents born in NL omitted)						
Dutch with foreign-born parent(s)	−0.520*** (0.145)	−0.053*** (0.015)	0.008 (0.165)	0.001 (0.016)	0.442*** (0.122)	0.090*** (0.025)
Non-Dutch	0.351 (0.338)	0.035 (0.034)	−0.508 (0.348)	−0.048 (0.033)	−0.541*** (0.184)	−0.110*** (0.037)
Household dummies (lives with parents/other omitted)						
Student house	0.621*** (0.168)	0.063*** (0.017)	−0.835*** (0.185)	−0.078*** (0.017)	−0.151 (0.114)	−0.031 (0.023)
Own house/apartment	0.541*** (0.174)	0.055*** (0.018)	−0.213 (0.174)	−0.020 (0.016)	−0.034 (0.123)	−0.007 (0.025)
Female dummy	0.947*** (0.131)	0.096*** (0.013)	−0.314** (0.136)	−0.029** (0.013)	−0.189** (0.095)	−0.038** (0.019)
Age dummies (<20 years omitted)						
20–22 years	0.099 (0.200)	0.010 (0.020)	−0.246 (0.209)	−0.023 (0.020)	0.124 (0.148)	0.025 (0.030)
23–26 years	0.013 (0.255)	0.001 (0.026)	−0.283 (0.269)	−0.027 (0.025)	0.253 (0.184)	0.051 (0.037)
27–34 years	−0.444 (0.319)	−0.045 (0.032)	−0.063 (0.332)	−0.006 (0.031)	−0.187 (0.235)	−0.038 (0.048)
Study-phase dummies (1st year of bachelor omitted)						
Bachelor (2nd year)	−0.308 (0.197)	−0.031 (0.020)	0.067 (0.207)	0.006 (0.019)	−0.151 (0.149)	−0.031 (0.030)
Bachelor (3rd year)	−0.297 (0.231)	−0.030 (0.023)	0.084 (0.244)	0.008 (0.023)	−0.321* (0.168)	−0.065* (0.034)
Master	0.184 (0.233)	0.019 (0.024)	0.025 (0.241)	0.002 (0.023)	−0.217 (0.166)	−0.044 (0.034)
Other (e.g., pre-Master)	0.096 (0.291)	0.010 (0.029)	0.158 (0.295)	0.015 (0.028)	0.107 (0.208)	0.022 (0.042)
Education type dummies (10)	Yes		Yes		Yes	
Observations	2825		2825		2825	

Note: column 'm.e.' reports mean marginal effects; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table A3
Multinomial logit estimate on ownership of device bundles among university students.

Device	[1] No device		[2] Smartphone		[3] Laptop		[4] Laptop, smartphone, tablet		[5] Other	
	coef.	m.e.	coef.	m.e.	coef.	m.e.	coef.	m.e.	coef.	m.e.
Log net monthly income, €	−0.313** (0.122)	−0.011** (0.005)	−0.007 (0.113)	0.002 (0.006)	−0.224*** (0.066)	−0.041*** (0.011)	0.335*** (0.112)	0.029*** (0.008)	−0.133 (0.160)	−0.003 (0.004)
Scholarship type dummies ('standard' scholarship omitted)										
Lower-income parents	−0.659** (0.329)	−0.019 (0.013)	−0.242 (0.224)	−0.003 (0.013)	−0.221 (0.137)	−0.011 (0.023)	−0.889*** (0.253)	−0.054*** (0.017)	−0.393 (0.311)	−0.006 (0.009)
Loan	0.399 (0.361)	0.020 (0.014)	0.171 (0.295)	0.016 (0.017)	−0.185 (0.181)	−0.027 (0.031)	−0.418 (0.296)	−0.027 (0.020)	−0.756 (0.545)	−0.020 (0.016)
No scholarship/other	0.292 (0.350)	0.010 (0.014)	−0.156 (0.304)	−0.012 (0.017)	0.207 (0.172)	0.037 (0.029)	−0.106 (0.267)	−0.011 (0.018)	0.062 (0.424)	0.000 (0.012)
Origin dummies (Dutch with both parents born in NL omitted)										
Dutch with foreign-born parent(s)	0.096 (0.247)	0.009 (0.010)	0.498*** (0.189)	0.037*** (0.011)	−0.580*** (0.144)	−0.109*** (0.024)	−0.195 (0.204)	−0.008 (0.014)	0.234 (0.279)	0.010 (0.008)
Non-Dutch	0.276 (0.458)	0.010 (0.018)	−0.590 (0.555)	−0.039 (0.032)	0.461** (0.199)	0.095*** (0.033)	−0.494 (0.433)	−0.040 (0.030)	0.045 (0.596)	0.000 (0.017)
Living situation dummies (lives with parents/other omitted)										
Student house	−0.901*** (0.292)	−0.032*** (0.012)	−0.493** (0.217)	−0.021* (0.012)	0.185 (0.127)	0.070*** (0.021)	−0.949*** (0.223)	−0.062*** (0.015)	−0.649** (0.329)	−0.015 (0.009)
Own house/apartment	−0.363 (0.268)	−0.011 (0.011)	−0.668*** (0.239)	−0.036** (0.014)	0.001 (0.139)	0.020 (0.023)	−0.309 (0.205)	−0.016 (0.014)	−0.255 (0.329)	−0.004 (0.009)
Female dummy	−0.861*** (0.208)	−0.032*** (0.008)	−0.966*** (0.176)	−0.054*** (0.010)	0.254** (0.109)	0.076*** (0.018)	−0.348** (0.162)	−0.019* (0.011)	−0.432* (0.253)	−0.010 (0.007)
Study-phase dummies (1st year of bachelor omitted)										
Bachelor (2nd year)	0.184 (0.328)	0.003 (0.013)	0.584** (0.264)	0.031** (0.015)	0.112 (0.171)	0.006 (0.029)	0.055 (0.248)	−0.003 (0.017)	0.421 (0.369)	0.009 (0.010)
Bachelor (3rd year)	0.031 (0.371)	−0.006 (0.015)	0.570* (0.315)	0.027 (0.018)	0.345* (0.189)	0.046 (0.032)	−0.043 (0.287)	−0.015 (0.019)	0.998** (0.465)	0.025* (0.013)
Master	−0.406 (0.364)	−0.019 (0.014)	0.072 (0.320)	0.002 (0.018)	0.225 (0.187)	0.040 (0.032)	−0.200 (0.280)	−0.019 (0.019)	0.848* (0.477)	0.024* (0.014)
Other (e.g., pre-Master)	−0.712 (0.474)	−0.028 (0.019)	0.217 (0.388)	0.016 (0.022)	−0.150 (0.235)	−0.026 (0.040)	−0.256 (0.342)	−0.017 (0.023)	1.190** (0.585)	0.037** (0.017)
Education type dummies (10)	Yes									
Age dummies (4)	Yes									
Observations	2825									

Note: 'laptop and smartphone' baseline category; column 'm.e.' reports mean marginal effects; ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table A4
Income elasticities (separate models).

	Laptop	Tablet	Smartphone
Ownership probability	0.8782 (0.0060)	0.1097 (0.0058)	0.6818 (0.0085)
m.e. 10% income increase	0.0014 (0.0008)	0.0026 (0.0008)	0.0050 (0.0011)
Income elasticity	0.0158	0.2354	0.0727

Note: standard errors between parentheses; probabilities and marginal effects calculated for mean of covariates.

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