

The Effect of Wealth on Individual and Household Labor Supply: Evidence from Swedish Lotteries

By DAVID CESARINI, ERIK LINDQVIST, MATTHEW J. NOTOWIDIGDO AND ROBERT ÖSTLING*

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We study the effect of wealth on individual and household labor supply using the randomized assignment of monetary prizes in a large sample of Swedish lottery players. We find that winning a lottery prize leads to a modest, but long-lasting reduction of labor earnings. The earnings response is stronger for winners than their spouses, which is hard to reconcile with standard unitary household labor supply models. A calibrated dynamic model of individual labor supply implies a lifetime income effect in the range 0.1-0.2 and labor-supply elasticities in the lower end of the range reported in earlier research.

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Understanding how labor supply responds to wealth changes is critical when evaluating economic policies that explicitly or implicitly involve transfers of wealth, such as changes to retirement systems, property taxes or lump-sum components of welfare pay-

* Cesarini: Center for Experimental Social Science, Department of Economics, New York University, NBER and Research Institute of Industrial Economics (IFN), Stockholm, Sweden. E-mail: david.cesarini@nyu.edu. Lindqvist: Department of Economics, Stockholm School of Economics and Research Institute of Industrial Economics (IFN), Stockholm, Sweden. E-mail: erik.lindqvist@hhs.se. Notowidigdo: Northwestern University and NBER. E-mail: noto@northwestern.edu. Östling: Institute for International Economic Studies, Stockholm University, Stockholm, Sweden. E-mail: robert.ostling@iies.su.se. We thank Erik Hurst, Che-Yuan Liang, Jesse Shapiro, Johanna Wallenius, and seminar audiences at the AEA Annual Meeting, Bocconi, Chicago Booth, Cornell University, LSE, CREI-UPF, NBER Summer Institute, Northwestern University, the Rady School of Management, Stockholm University, and Uppsala University for helpful comments. André Chiappori, David Domeij and Alessandra Voena provided especially valuable guidance and feedback. We also thank Richard Foltyn, Renjie Jiang, Kristzian Kovacs, Odd Lyssarides, Svante Midander, and Erik Tengbjörk for excellent research assistance. This paper is part of a project hosted by the Research Institute of Industrial Economics (IFN). We are grateful to IFN Director Magnus Henrekson for his strong commitment to the project and to Marta Benkestock for superb administrative assistance. The project is financially supported by two large grants from the Swedish Research Council (B0213903) and Handelsbanken's Research Foundations (P2011:0032:1). We also gratefully acknowledge financial support from the NBER Household Finance working group (22-2382-13-1-33-003), the NSF (1326635), and the Swedish Council for Working Life and Social Research (2011-1437).

ments. Since the income effect provides the link between uncompensated and compensated wage elasticities via the Slutsky equation, accurate estimates of how labor supply responds to wealth shocks are also valuable for obtaining credible estimates of compensated wage elasticities (Keane, 2011). Such elasticities, in turn, are critical inputs in the theory of taxation (Mirrlees, 1971; Saez, 2001) and studies of business cycle fluctuations (Prescott, 1986; Rebelo, 2005).

Despite a large empirical literature, there is limited consensus on the magnitude of the effect of wealth on labor supply (Pencavel, 1987; Blundell and MaCurdy, 2000; Keane, 2011; Saez et al., 2012). While there is arguably some agreement among labor economists that large, permanent changes in real wages induce relatively modest differences in labor supply, Kimball and Shapiro (2008) write that “there is much less agreement about whether the income and substitution effects are both large or both small.” The lack of consensus likely stems in part from the substantial practical challenges associated with isolating plausibly exogenous variation in unearned income or wealth, which is necessary to produce credible wealth effect estimates. In this paper, we confront these challenges by exploiting the randomized assignment of lottery prizes to estimate the causal impact of wealth on individual- and household-level labor supply. Our work is most closely related to Imbens, Rubin & Sacerdote’s (2001) survey of Massachusetts Lottery players.¹ Comparing winners of large and small prizes who gave consent to release their post-lottery earnings data from tax records, they estimate that around 5-10 percent of an exogenous increase in unearned income is spent on reducing labor earnings.

Our study has three key methodological features that enable us to make stronger inferences about the causal impact of wealth than previous lottery studies evaluating the effect of wealth on labor supply (Arvey and Liao, 2004; Furåker and Hedenus, 2009; Hedenus, 2009; Imbens et al., 2001; Kaplan, 1985; Larsson, 2011; Picchio et al., 2015). First, we observe the factors conditional on which the lottery wealth is randomly assigned, allowing us to leverage only the portion of lottery-induced variation in wealth that is ex-

¹Our work is also related to previous research that uses natural experiments such as policy changes or bequests to estimate the causal effect of wealth on labor supply (Bodkin, 1959; Holtz-Eakin et al., 1993; Joulfaian and Wilhelm, 1994; Krueger and Pischke, 1992).

ogenous. Second, the size of the prize pool is very large (approximately \$650 million), allowing us to obtain precise estimates of treatment effects in many subsamples.² Prizes also vary in magnitude, which allow us to test for nonlinear effects.³ Third, Sweden's high-quality administrative data allow us to observe a rich set of labor market outcomes, some of which are realized over 20 years after the event, in a virtually attrition-free sample. Additionally, our data also allow us to address many (but not all) concerns that are often voiced about the external validity of studies of lottery players.

In our reduced-form analyses of individual-level labor supply, we find that winning a lottery prize immediately reduces labor earnings, with effects roughly constant over time and lasting more than 10 years. In our main specification, a windfall gain of 1 million Swedish krona (1M SEK, about \$140,000), reduces the pre-tax labor earnings of the winner over the first 10 years by roughly 80,000 SEK, or approximately one-half of the average annual income. A majority of the overall earnings response is accounted for by a reduction in hours worked. There is little evidence of heterogeneous or nonlinear effects, and winners are not more likely to change employers or become self-employed.

Our main reduced-form results can be qualitatively and quantitatively accounted for by a dynamic labor supply model with a binding retirement age.⁴ Models without retirement predict labor-earnings responses that vary strongly with age (see, e.g., Imbens et al., 2001), a prediction not borne out empirically by our reduced-form estimates. Including a binding retirement age attenuates the relationship between the lottery-induced labor earnings reduction and age, which allows our simulated model to more closely match our reduced-form empirical results.

We use the calibrated model to extend the results well beyond the first 10 years following the prize event in order to estimate lifetime marginal propensities to earn income (MPE) out of lottery wealth. The simulation results indicate that the lifetime wealth

²We use the Federal Reserve Bank of St Louis EXSDUS foreign exchange rate for January 2010 of \$7.1534 per SEK whenever converting monetary amounts into USD.

³The estimated effects in Imbens et al. (2001) are highly non-linear and also somewhat sensitive to both the small number of individuals in the sample who won prizes exceeding \$2 million USD, as well as specifications which account for non-random survey non-response (Hirano and Imbens, 2004).

⁴In calibrating the model, we account for the role of taxes since individual labor supply respond to the after-tax wage.

effect would be understated substantially if only the first 10 years were included. We also show that the best-fit parameters imply that the lifetime MPE varies with age and is strongest in the very youngest winners, where our estimates suggest a lifetime MPE in the range -0.15 to -0.20 . We also use the full structure of the model to calculate key labor-supply elasticities. We estimate average uncompensated labor supply elasticities to be close to zero and intensive-margin, individual-level compensated (Hicksian) and intertemporal (Frisch) elasticities of around 0.1 to 0.2. These estimates are in the lower range of previously reported estimates (Keane, 2011).

In our household-level analyses, we find that taking into account the labor supply of non-winning spouses increases the estimated effect on earnings by 24%. Our estimates are precise enough to reject both a zero effect on the non-winning spouse's earnings and the null hypothesis that the earnings responses of the winning and non-winning spouses are identical; we systematically find that the winning spouse (male or female) reacts more strongly. The latter result is inconsistent with unitary household labor supply models, which have the strong prediction that the observed labor supply responses to household wealth shocks should not depend on the identity of the lottery winner (Kimball and Shapiro, 2008; Blundell et al., 2014).

The remainder of this paper is structured as follows. Section I describes the lottery data and our measures of labor supply. Section II discusses our empirical framework and reports the results from a randomization test. Section III reports our main individual-level empirical results. Section IV describes a dynamic life-cycle model, shows that this model can quantitatively account for our main results, and uses this model to estimate key labor supply elasticities. Section V reports household-level results and discusses how they inform household labor supply models. Section VI concludes the paper. In the interest of brevity, we refer the interested reader to our Online Appendix (hereafter, "OA") for details regarding our measures of labor supply, a description of the Swedish tax system and a number of robustness tests. Tables and figures prefaced by the letter "A" are included in the OA.

I. Data

Our estimation sample is constructed by matching three samples of lottery players, and their spouses, to population-based registers on labor market outcomes and demographic characteristics. We first describe the key variables obtained from population-based registers that will be used throughout our analyses.

A. Outcome Variables

All earnings measures are based on population-wide registers originally collected by the tax authorities. Throughout the paper, we convert monetary variables to year-2010 SEK.

Sweden underwent a major tax reform 1990-1991. Before 1991, capital and labor incomes were taxed jointly and taxes were strongly progressive, which complicates the analysis of wealth effects. We therefore restrict attention to labor supply in 1991-2010 when labor earnings and capital income are taxed separately.

Our main outcome variable is gross labor earnings. This income measure includes wage income, income from self-employment and income support during sickness absence and parental leave. Unemployment support and pension income are excluded. We also study the two key components of labor earnings separately; wage earnings and self-employment income.

Additionally, we analyse the effect of wealth shocks on after-tax income. We estimate after-tax income using detailed information about the Swedish tax system, see OA Section 4.2 for details. Since labor earnings, pension income and unemployment benefits are all taxed jointly, we calculate after-tax income using overall taxable income which includes both pension income and unemployment benefits. Employers pay social security contributions (SSC) on top of gross earnings. SSC is partly a tax on labor and partly tied to future benefits, and we adjust the earnings measures accordingly in some of our analyses below. In OA Section 10 we discuss the robustness to alternative after-tax income measures.

We supplement the register-based variables with information about wages and hours

worked obtained from Statistics Sweden’s annual wage survey. The survey has incomplete coverage, especially for the private sector, and in any given year it covers about 60% of the people in our sample who are working (see Figure A4.4). To increase coverage, we impute wages from adjacent years, but we do not use observations from the post-win period to impute wages from the pre-win period, or vice versa. The wage data allow us to calculate hours worked as the ratio of wage earnings and wages. We express hours worked in percent of full-time work. In order to reduce the problem of outliers due to division bias (downward bias in wages causing an upward bias in hours worked), we censor hours worked at 125% of full-time.⁵ The wage survey also includes data on occupation, which we use to estimate the effect on occupation switching.

Finally, we use Statistics Sweden’s registry of employers to examine whether wealth affects the choice of employer, workplace, industry, and the geographical location of work. Further details about variable definitions are relegated to Section 4 in the OA.

B. Lottery Samples

We use data from three different lotteries. For each lottery, we use available data and knowledge about the institutional details to define “cells” within which the lottery wealth is randomly assigned. Controlling for cell-fixed effects in our analyses ensures that all identifying variation comes from players in the same cell. Because the exact construction of the cells varies across lotteries, we describe each lottery separately.⁶ The lottery cell construction is summarized in Table A3.1. Throughout the paper, we restrict attention to players who were between age 21 and 64 at the time of the win.

Prize-Linked Savings Accounts. The first sample we use is a panel of Swedish individuals who held “prize-linked savings” (PLS) accounts between 1986 and 2003. PLS accounts incorporate a lottery element by randomly awarding prizes to some accounts rather than paying interest (Kearney et al., 2011). PLS accounts have existed in Sweden since 1949 and were originally subsidized by the government. When the subsidies ceased

⁵The wage survey also includes a direct measure of hours worked. In OA Section 11 we show that the results are similar if we use this alternative measure of hours worked.

⁶A detailed account of the institutional features of our three lottery samples, the processing of our primary sources of lottery data, data quality, and how cells were constructed is provided in the Online Appendix to Cesarini et al. (2015).

in 1985, the government authorized banks to continue to offer prize-linked-savings products. Two systems were put into place, one operated by savings banks and one by the major commercial banks and the state bank. Each system had over 2 million accounts in the late 1980's, implying that one in two Swedes held a PLS account.

We combine two sources of information from the PLS program run by the commercial banks, *Vinnarkontot* ("The Winner Account"). Our first source is a set of printed lists with information about all prizes won in the draws between 1986 and 2003. The prize lists have been manually entered and contains information about prize amount, prize type (described below), the winning account number, but not the identity of the winner. The second source is a large number of microfiche images with information about account number, the account owner's personal identification number (PIN), and the account balance of all eligible accounts participating in the draws between December 1986 and December 1994 (the "fiche period"). The Online Appendix to Cesarini et al. (2015) provides a detailed account of how the micro fiche data were digitized and processed to construct a monthly panel for the years 1986 to 1994. By matching the prize list data with the micro fiche data, we are able to identify PLS winners between 1986 and 2003 who held an account during the fiche period (1986 to 1994).

PLS account holders could win two types of prizes: odds prizes and fixed prizes. The probability of winning either type of prize was proportional to the number of tickets associated with an account: account holders assigned one lottery ticket per 100 SEK in account balance. Fixed prizes were prizes whose magnitude did not depend on the balance of the winning account. Odds prizes, on the other hand, paid a multiple of 1, 10, or 100 times the account balance to the winner (with the prize capped at one million SEK).

For fixed-prize winners, our identification strategy exploits the fact that in the population of players who won the same number of fixed prizes in a particular month, the actual prize amount is independent of account balances (and therefore potential outcomes). For each draw, we define cells comprising all individuals who won the exact same number of prizes in the draw.

To construct odds-prize cells, we match individuals who won exactly one odds prize in a draw to individuals who also won exactly one prize (odds or fixed) in the same draw and whose account balance is nearly identical to the winner. This matching procedure ensures that within a cell, the prize amount is independent of potential outcomes. To avoid double-counting, a fixed-prize winner who is successfully matched to an odds-prize winner is assigned to the new odds-prize cell instead of the original fixed-prize cell. After the fiche period, we do not observe account balances and we therefore restrict attention to odds prizes won during the fiche period. To keep the number of cells manageable, we exclude all odds prizes below 100,000 SEK.

The Kombi Lottery. Our second sample is an unbalanced panel of about half a million individuals who participated in a monthly ticket-subscription lottery called *Kombilotteriet* (“Kombi”). The proceeds from Kombi go to the Swedish Social Democratic Party, Sweden’s main political party during the post-war era. Subscribers choose their desired number of subscription tickets and are billed monthly. Our dataset contains information about all draws conducted between 1998 and 2010 and information the players who won prizes exceeding 1M SEK. For each draw, our panel therefore contains one entry per lottery participant, with information about the number of tickets held in the draw and any large prizes won. The Kombi rules are simple: two individuals who purchased the same number of tickets in a given draw face the exact same probability of winning a large prize. To construct the cells, we match each winning player to (up to) 100 non-winning players with an identical number of tickets in the month of the draw. To improve the precision of our estimates, we choose controls of the same sex and similar age whenever more than 100 matches are available.

The Triss Lottery. Triss is a scratch-ticket lottery run since 1986 by Svenska Spel, the Swedish government-owned gaming operator. Triss lottery tickets can be bought in virtually any Swedish store. The sample we have access to consists of two categories of scratch-ticket winners: Triss-Lumpsum and Triss-Monthly. Winners of either type of prize are invited to participate in a morning TV show. At the show, Triss-Lumpsum winners draw a new scratch-off ticket from a stack of tickets with a known prize plan

that is subject to occasional revision. Triss-Lumpsum prizes vary in size from 50,000 to 5 million SEK (net of taxes). Triss-Monthly winners participate in the same TV show, but draw one ticket that determines the size of a monthly installment and a second that determines its duration. The tickets are drawn independently. The durations range from 10 to 50 years, and the monthly installments range from 10,000 to 50,000 SEK. To make the monthly installments in Triss-Monthly comparable to the lump-sum prizes in the other lotteries, we convert them to present value using a 2% annual discount rate.⁷ We exclude about 10% of the lottery prizes for which there are indications in the data that the player shared ownership of the ticket.

Our identification strategy makes use of the fact that, conditional on the prize plan and winning exactly one prize, the nominal prize amount is random. Two players are assigned to the same cell if they won exactly one prize in the same year and under the same prize plan.

C. Prize Distribution

Table 1 shows the distribution of prizes in the pooled sample and for each lottery separately. All prizes are net of taxes and measured in year-2010 SEK. In total, there are more than 5,500 prizes in excess of 100,000 SEK (\$14,000) and almost 1,500 prizes of 1 million SEK (\$140,000). To put these numbers in perspective, the median disposable income among a representative sample of Swedes in 2000 was 170,000 SEK. The total prize amount in our pooled sample is 4,662 million SEK (about \$650 million). Although the number of winners is much larger in PLS, PLS prizes only constitute 36% of the total prize amount.⁸

[TABLE 1 HERE]

⁷We set the discount rate to match the real interest rate in Sweden which, according to Lagerwall (2008), was 1.9 percent during 1958-2008.

⁸Triss-Monthly make up for 36% of the total prize amount, Triss-Lumpsum 21% and Kombi 7%.

D. Representativeness

A natural concern about lottery studies is that they lack external validity because lottery players are not representative of the general population. While this concern would appear to be valid in the United States (as discussed in Imbens et al., 2001), it does not seem to apply to our sample of lottery players. Table A3.2 provides information on the demographic characteristics for each lottery sample. To evaluate the representativeness of the lottery samples, we also report descriptive statistics for random population samples drawn in 1990 and 2000. We reweight the representative samples so as to match the age and sex distribution of the lottery winners.

Overall, the results from this comparison suggest that, at least in terms of observable characteristics, there are no large differences between the players we study and a representative sample of the Swedish population. Lottery winners are slightly wealthier, have slightly higher labor earnings and capital income than the general population. Table A3.2 also shows that there is some heterogeneity across lotteries. For example, PLS winners have somewhat higher educational attainment compared to a representative sample, while the opposite is true for winners in Triss and Kombi.

A related concern is that, even though *lottery players* may be similar to the population at large, *lottery prizes* constitute a very specific type of wealth shock that cannot be generalized to other types of wealth. Although we cannot completely rule out this concern, the evidence presented below shows that lottery winners do not squander their wealth and that their labor supply response fit the predictions of standard life-cycle models quite well irrespective of the type of lottery (PLS, Kombi or Triss) or mode of payment (Triss-Lumpsum or Triss-Monthly).

II. Identification Strategy

Controlling for cell-fixed effects in our analyses ensures that all identifying variation comes from players in the same cell. If the identifying assumptions underlying the lottery cell construction are correct, then characteristics determined before the lottery should not predict amount won once we condition on cell fixed effects. To test for violation of

conditional random assignment, we therefore run the regression

$$(1) \quad L_{i,0} = \mathbf{X}_{i,0}\boldsymbol{\eta} + \mathbf{Z}_{i,-1}\boldsymbol{\theta} + \epsilon_{i,0},$$

where $L_{i,0}$ is prize money at the time of the event, $\mathbf{X}_{i,0}$ is the matrix of cell fixed effects, and \mathbf{Z}_{-1} is a vector baseline controls that includes indicator variables for sex, region of birth, college completion as well as a third-order polynomial in age and labor earnings in the year before the lottery. The time-varying baseline covariates are measured in the year prior to the lottery. Table A3.3 reports the p -values for the individual and joint significance of the baseline controls in the pooled sample and for each lottery separately. For the pooled sample, we also estimate the equation without cell fixed effects. Overall, the results are consistent with the null hypothesis that wealth is randomly assigned once we condition on the cell fixed effects.

Normalizing the time of the lottery to $t = 0$, our basic estimating equation is:

$$(2) \quad y_{i,t} = \beta_t L_{i,0} + \mathbf{X}_i \boldsymbol{\delta}_t + \mathbf{Z}_{i,-1} \boldsymbol{\gamma}_t + \epsilon_{i,t} \quad (t = 0, 1, \dots, T),$$

where $y_{i,t}$ is individual i 's outcome of interest at time t and $L_{i,0}$ and \mathbf{X}_i are defined exactly as in the previous section. The controls for pre-lottery characteristics, $\mathbf{Z}_{i,-1}$, are included only to increase the precision of our estimated treatment effects. In our preferred specification, $\mathbf{Z}_{i,-1}$ includes the same controls as in the randomization tests in Table A3.3 as well as the lagged value of the dependent variable measured in year $t = -1$ whenever it is available. We use OLS to estimate Equation (2) and cluster standard errors at the level of the individual.

The key coefficients of interest are the estimated coefficients $\hat{\beta}_0, \hat{\beta}_1, \dots, \hat{\beta}_{10}$. These coefficients flexibly capture the dynamic effect of a wealth shock at time $t = 0$.⁹ We also consider an event study framework and impose the restriction that $\beta_t = \beta$ for all $t =$

⁹Because $y_{i,t}$ in most of our analyses are measured in 1991-2010 and the sample consists of individuals who won the lottery in 1986-2010, the composition of the pooled sample changes somewhat with t . For example, an individual who won the lottery in 1986 will not enter the data until $t = 5$. Conversely, an individual who won in, say, 2010 will exit the data at $t = 1$. In OA Section 8, we therefore also estimate the Equation (2) for different time horizons holding the sample fixed.

1, ..., 5.¹⁰ The event-study estimates increase statistical power and allow us to present our findings in a more parsimonious way. Because we restrict the sample to individuals aged 21-64 at the time of winning, some of our winners reach retirement age over the time horizon we consider. Rather than restricting the basic estimation sample, we incorporate a binding retirement age in the dynamic labor supply model used to interpret the reduced-form results. We also show reduced-form results stratified by age.

Since small average effects could mask large effects in certain subpopulations, we also estimate heterogeneous effects. In these analyses, we interact both the lottery prize $L_{i,0}$, the vector of cell fixed effects, \mathbf{X}_i , and the controls, $\mathbf{Z}_{i,-1}$, with a subpopulation indicator variable, thereby leveraging only within-cell variation.

III. Individual-Level Analyses

We first analyze how lottery wealth affects individual labor supply. Unless otherwise stated, the outcome variable is gross labor earnings. Table 2 reports the estimated effect of wealth on gross labor earnings one and two years after the lottery, as well as the 3-, 5- and 10-year totals. Table 2 also shows the event-study estimate for the $t = 1, \dots, 5$ horizon. Figure 1 graphically depicts the coefficient estimates, along with 95% confidence intervals, for the first ten years after the lottery event, and the five years prior to the lottery.¹¹ Reassuringly, Figure 1 confirms that there is no statistically significant difference in the pre-event trends of winners and non-winners. In the year of the lottery event, labor earnings decline immediately and stabilize at a level roughly 1,150 SEK lower for each 100,000 SEK won.¹² There is a slight tendency of a smaller effect with time from the lottery and the 10-year reduction in earnings is 8,033 SEK per 100,000 SEK won. As

¹⁰Since the average winner will receive the prize by approximately end of June in $t = 0$, the labor supply response in $t = 0$ will be about half as large as the response in $t = 1$, even if individuals face no obstacle to adjusting their labor supply. We therefore exclude $t = 0$ from the event study estimates.

¹¹Since Figure 1 also estimates the "effect" of a future lottery prize on earnings, these regressions do not include controls for time-varying characteristics (lagged labor earnings and educational attainment).

¹²The slight discrepancy between the estimates in Table 2 and Figure 1 is due to us conditioning on labor earnings in $t = -1$ in Table 2 but not in Figure 1. In OA Section 8, we also report and discuss results for up to 20 years after the lottery. While the overall response is reasonably stable over time, the response is larger for younger winners. The estimated effect for winners below age 45 at $t = 20$ (-2,500 SEK per 100,000 SEK won) implies a stronger response than we estimate in the sample at large. Due to the limited statistical power, we chose not to emphasize the long-run results, but instead rely on the model to extrapolate the long run effect. However, the strong long-run response of young winners is a caveat to the general conclusion of modest wealth effects.

shown in our heterogeneity analyzes below, the attenuation of the response is largely due to more lottery winners reaching retirement age with time from the lottery.

[FIGURE 1 HERE]

[TABLE 2 HERE]

To give a more detailed picture of the labor supply response, Table 3 shows the event-study estimates for different earnings measures, with the event-study estimate for gross labor earnings (-1.068) reported in column 1 as a benchmark. First, columns 3 and 4 show that the bulk of the reduction in gross labor earnings is due to a fall in wage earnings (-0.967), but the drop in self-employment income (-0.142) is also statistically significant.

Second, Table 3 shows how lottery wealth affects earnings before and after taxes. As shown in columns 5 and 6, both unemployment benefits (0.035) and earnings from the pension system (0.157) increase following a lottery win, even though only the latter effect is statistically significant. Winners are thus able to compensate part of the reduction in labor earnings by increased benefits. Since both unemployment benefits and pensions are included in taxable earnings, the effect on taxable earnings in column 7 (-0.900) is smaller than the effect on labor earnings in column 1. Column 8 shows that the effect on earnings after taxes is quite small (-0.580), reflecting both the relatively high taxes in Sweden and the increase in received benefits. When we include the value of future benefits (notably pensions) implicit in social security contributions (SSC) in our after-tax earnings measure (shown in column 9), the estimated effect is only somewhat larger (-0.624).

Finally, column 2 in Table 3 shows that adding the full amount of SSC to labor earnings significantly increases the negative effect of wealth shocks (-1.412). Since labor earnings plus SSC represent employers' total cost of labor, the estimate in column 2 can be thought of as the effect of wealth shocks on production value. The difference between the estimates in column 2 and 8 thus reflect the wedge induced by the tax- and transfer system: A net wealth shock of 100,000 SEK reduces the yearly post-win production

value by approximately 1,400 SEK, while winners' net earnings only go down by about 600 SEK.

[TABLE 3 HERE]

In order to assess how important the detailed lottery data underlying the cell construction is for our identification, we also provide “naïve panel study” estimates that only exploit the size and timing of lottery prizes by summing all lottery prizes by year and individual. The results are presented in detail in OA Section 12 and show that the naïve estimates are approximately 50% larger than the estimates shown in Figure 1.

A. Margins of Adjustment

Table 4 shows the event-study estimates for several extensive-margin earnings measures. Winning 1M SEK reduces the probability of participation, defined as having labor earnings in excess of 25,000 SEK, the years after the win by 2.07 percentage points. Panel A of Figure 2 shows that the extensive-margin effect is strongest two years after the win, and then weakens with time. We see a similar response on the extensive margin for wage earnings (-2.24) and also a reduction on the extensive margin of self-employment (-0.62). The negative extensive-margin effect on self-employment together with the negative effect on self-employment income in Table 3, contrasts with previous findings that wealth shocks increase transition into self-employment (Lindh and Ohlsson, 1996; Taylor, 2003; Holtz-Eakin et al., 1994a,b).

[TABLE 4 HERE]

The estimated effects for the extensive margin implies that much of the labor-supply response occurs on the intensive margin, in the form of lower wages or fewer hours. Under the assumption that the average earnings of the workers who leave the labor force equals the sample average, the extensive margin accounts for about 50% of the labor supply response immediately after winning the lottery and about 25% six years after the lottery (see Panel B in Figure 2).

For the subsample for which we observe wages, we can also study the effect on wages and hours worked. Column 5 and 6 in Table 4 report the event-study estimates for monthly wages and hours worked. Wages fall by 0.16 SEK per 1000 SEK won, suggesting that the intensive-margin response partly reflects a decline in wages. Panel C in Figure 2 shows that the effect of wealth on wages appears to be stronger with time from the lottery. The hours response is also negative: a 1M SEK prize reduces hours worked by 3.11% of full-time, corresponding to 1.3 hours per week, or 60 hours per year. As shown by Panel D in Figure 2, the hours response is stable over time. Panel E in Figure 2 decomposes the total wage earnings response into hours worked and wages (see OA Section 11 for details). There is a tendency for the wage effect to grow over time, but the hours response always dominates. Finally, Panel F in Figure 2 shows that more than half of the hours response is accounted for by intensive-margin adjustments.

[FIGURE 2 HERE]

In sum, adjustment takes place both along the extensive and intensive margin, with the intensive margin becoming more important with time from the lottery. The intensive-margin response is due both to lower wages and fewer hours worked.

Finally, we also analyze whether lottery winners adjust their labor supply by changing employers, workplaces, occupations, industries or the location of work. Figure A2.1 shows that there are no effects with respect to any of these outcomes.

B. Robustness and Heterogenous Effects

We conduct a number of analyses to explore the robustness of the estimated effect on labor earnings and whether the effect differs across subgroups. We first explore whether the wealth effect is non-linear, as would be the case if workers that wish to reduce their labor supply face fixed adjustment costs. Table A3.4 reports the estimates from a quadratic model and a spline model with a knot at 1M SEK. The point estimates suggests that the marginal effect of lottery wealth is smaller for larger prizes, but the difference is not statistically significant. Table A3.4 also shows that the estimated effect is slightly larger when very large (> 5M SEK), large (> 2M) or moderate (> 1M SEK) prizes are excluded.

Figure 3 reports the labor supply trajectories for different subsamples. The corresponding five-year event-study estimates are available in Table A3.5, where we also test for equal effects in different samples. Panel A in Figure 3 shows that the effect is similar across lotteries, and Table A3.5 shows that we cannot reject the null hypothesis of equal effects. In particular, lump-sum prizes and (appropriately discounted) monthly installment prizes have similar effects on labor earnings, suggesting that it is appropriate to confront the data with a forward-looking dynamic labor supply model as we do in the following section.

[FIGURE 3 HERE]

Standard life-cycle models predict that older workers, who have fewer years to spend the lottery prize, should exhibit a larger labor supply response. We therefore estimate Equation (2) separately for three different age groups (21-34, 35-54, and 55-64). Panel B in Figure 3 shows that the effect is surprisingly similar in the years immediately following the lottery event (and Table A3.5 confirms that there is no statistically significant difference). There is a tendency of a smaller response for the oldest age group five to ten years after winning the lottery, but this is likely due to a large fraction in this age group reaching retirement age which mechanically attenuates the effect of the wealth shock.

A common finding in the literature is that female labor supply is more responsive to economic incentives. Panel C in Figure 3 shows that the tendency is the opposite in our data, although the difference between men and women is not significantly different from zero. Panel D in Figure 3 shows that the response is similar for individuals with and without a college degree. Finally, we analyze whether the response differs across income groups. Panel E in Figure 3 indicates that the pre-tax earnings response is higher for winners with high pre-lottery earnings. The event-study estimate reported in Table A3.5 is about twice as large for high earners compared to those with low or medium earnings, but the difference is not statistically significant. However, high-income earners face higher marginal tax rates, and as a consequence the difference in the after-tax earnings response is much smaller (see Panel F in Figure 3 and Table A3.5).

IV. Dynamic Labor Supply Model

In this section, we develop and estimate a simple dynamic life-cycle labor supply model using a simulated minimum distance procedure. We use the simulated model for two purposes. The first is to recover a model-based estimate of the long-run, lifetime effect of a lump-sum lottery prize on after-tax labor earnings. The second purpose of the model is to recover estimates of key labor supply elasticities, such as the uncompensated (Marshallian), compensated (Hicksian), and intertemporal (Frisch) labor supply elasticities. These elasticity estimates are identified by a combination of the reduced-form income effect estimates and functional form assumptions.

A. Model Setup

The baseline model is a discrete-time, dynamic labor supply model with perfect foresight, no uncertainty, and no liquidity constraints. Individuals live for T periods ($t = 0, 1, \dots, T - 1$) and receive unearned income a_t in period t . Each period, individuals choose consumption c_t , annual work hours h_t , and next period's assets (A_{t+1}). Annual earnings (y_t) are the product of the after-tax wage w_t and annual hours. Assets earn interest rate r between periods. Individuals in the model will choose to save for retirement, which must occur at $t = R^*$ or earlier; at this time, individuals can no longer choose $h_t > 0$. The per-period utility function is Stone-Geary, as in Imbens et al. (2001).¹³ Individuals make consumption, labor supply, and savings/borrowing decisions to maximize lifetime present discounted utility (using a discount rate δ), according to

$$\begin{aligned} U &= \sum_{t=0}^{T-1} \frac{1}{(1+\delta)^t} (\beta \log(c_t - \gamma_c) + (1-\beta) \log(\gamma_h - h_t)), \\ A_{t+1} &= (1+r)(A_t - c_t + w_t h_t + a_t), \\ A_T &\geq 0, \\ h_t &= 0 \quad \forall t \geq R^*. \end{aligned}$$

¹³The per-period utility function is $\beta \log(c_t - \gamma_c) + (1-\beta) \log(\gamma_h - h_t)$. The parameter β is the relative weight on consumption in utility, γ_c is subsistence term for consumption, and γ_h is the maximum annual hours of work available.

A lump-sum lottery prize is represented as a one-time shock to A_0 . The empirical results provide individual-level estimates of $d(y_t)/dA_0$ for each time period following the prize. Before describing the simulation strategy, we discuss the role of three important model assumptions.

No Barriers to Saving and Borrowing. We assume that agents can save and borrow at interest rate r . Since there are no liquidity constraints, a lump-sum prize and an equal-sized “installment” prize (of the same present discounted value) will have the same dynamic effects on labor earnings. This is consistent with our reduced-form results which find similar results for Triss-Lumpsum and Triss-Monthly prizes.

Stone-Geary Functional Form. Stone-Geary preferences simplifies the simulation since the per-period problem can be solved in closed form. Additionally, in a static model, this functional form delivers an income effect that does not vary with the wage, which is consistent with the finding that the after-tax earnings response is similar in different income groups.

Binding Retirement Age. Individuals in Sweden have flexibility in choosing exactly when to retire, but as we discuss further in Section 6 in the OA, a binding retirement age at 65 is a reasonable simplifying assumption. There is clear evidence of “bunching” of retirement ages around age 65, with some retirement before age 65, but very little retirement after age 65. As shown by Table 3, we find a small positive effect on pension income, but there is no statistically significant effect on the extensive margin for individuals who win prizes in their 50s and 60s (see Table 4). This fact is consistent with the model since individuals prefer to smooth leisure and consumption over the life cycle and there is consequently no incentive to retire early.

The binding retirement age allows the simulated model to more closely fit the reduced-form empirical results. Models without a binding retirement age will generally predict much stronger variation in annual earnings responses by age (i.e., T), as discussed in Imbens et al. (2001). Intuitively, this is because in models without retirement, individuals will smooth their annual reductions in labor earnings over the remaining years of working life, so there will be larger annual earnings declines for older winners with fewer

remaining years of life left. Moreover, in standard models without retirement, the time pattern of the dynamic effect of lottery will not vary with age. For example, in the model above with $\delta = r$ and $T = R^*$, the overall lifetime earnings reduction is independent of age. As discussed in the previous section, both of these features of a standard model contrast with our main results. The immediate labor supply response is fairly similar for all age groups, and while younger workers exhibit roughly constant effects over time, the earnings effect declines over time for older workers. The binding retirement age can account for both of these features. First, with a binding retirement age, individuals will save some of their lottery winnings into retirement, which attenuates the relationship between the immediate earnings reduction and age. Second, the annual earnings response mechanically goes towards zero for older winners, as these older workers reach the binding retirement age.

B. Model Simulation

We simulate the model repeatedly to find the combination of parameters which produces simulated results that are closest to matching the main individual-level results.¹⁴ The years of life remaining depend on the age of the winner when the prize is awarded. When simulating the model, we match the empirical distribution of the age of winners in the data, and we calibrate several parameters at outset. We assume the binding retirement age is at age 65 and all individuals die at age 80, so a 25 year old winner would face $T = 60$ and $R^* = 45$. We choose $r = 0.02$ to match the average real risk-free rate in Sweden during the time period spanned by the data. We assume that the subsistence

¹⁴In simulating the model, it is useful to re-cast the model above as a discrete-time dynamic program, with period length in years. In each period t , the individual chooses consumption, work hours, and next period's assets in order to maximize the following expression:

$$\begin{aligned} U_t(A_t) &= \max_{c_t, h_t, A_{t+1}} \left\{ \beta \log(c_t - \gamma_c) + (1 - \beta) \log(\gamma_H - h_t) + \frac{1}{1 + \delta} U_{t+1}(A_{t+1}) \right\} \\ A_{t+1} &= (1 + r)(A_t + w_t h_t - c_t) \\ A_T &\geq 0 \end{aligned}$$

In the simulations, we exploit the dynamic programming property that holding constant the choice of A_{t+1} (given A_t), one can solve for optimal choices of c_t and h_t in closed-form. To see this, treat A_t and A_{t+1} as constant. Then, the continuation utility is a constant and is not affected by choice of consumption and hours. To solve the model computationally, we start with the discrete-time transversality condition $A_T = 0$ and solve the model backwards.

consumption term is $\gamma_c = 20,000$ SEK, which is about 12 percent of the median annual disposable income.

This leaves three parameters to estimate via simulation: the discount rate (δ), the maximum annual hours limit (γ_h), and the relative weight on consumption in utility (β). For a given value of r , the time path of labor earnings following the lottery helps pin down δ . If $\delta > r$, then short-run reductions in earnings should be larger than long-run reductions.¹⁵ The lifetime earnings reduction to winning lottery is primarily determined by the value of β , since this parameter governs the strength of the income effect. Given the other two parameters, the value of γ_h determines the optimal choice of hours worked. The parameter γ_h is therefore primarily identified by the average actual hours worked in our data.¹⁶

We estimate the three parameters using a standard simulated minimum distance procedure. For each set of parameters, we simulate the model and estimate the effect of a lottery win in simulated data. We then find parameters which give model-based estimates that come closest to the reduced-form effect of the lottery win. To do this, we compute $d(y_1)/dA_0, \dots, d(y_{10})/dA_0$ numerically and also calculate average annual hours $\bar{H} = \frac{1}{T} \sum_{t=1}^{t=10} h_t$. We calculate these statistics for each simulated individual and then average across individuals (weighting individuals so that the age distribution in simulated sample matches the empirical distribution). The estimates from the simulated model are defined as $\pi(\theta)$, where θ corresponds to the vector of parameters to be estimated (i.e., $\theta = (\delta, \beta, \gamma_h)$); the corresponding reduced-form empirical estimates of each of these moments are defined as $\hat{\pi}$. The simulation procedure is repeated a large number of times to find the combination of parameters that comes closest to matching the main results

¹⁵This identification discussion is meant to convey intuition, but the actual identification of δ is more subtle. The binding retirement range will also cause the earnings reductions to decline over time mechanically as winners reach the binding retirement age. Therefore, the full structure of the model is needed to separate the mechanical effect of retirement from the effect of $\delta > r$. Another way to think about the identification of δ would be to focus on younger winners who would not face binding retirement age during the 10 years following lottery win. For these winners, the time path of earnings response can be used to directly identify δ , given r .

¹⁶To gain intuition for this identification argument, consider a static, one-period problem with no unearned income and Stone-Geary preferences. In this case, the optimal hours choice is given by $h = \beta\gamma_h + (1 - \beta)\gamma_c/w$. With no subsistence consumption ($\gamma_c = 0$), then $h = \beta\gamma_h$. Therefore, observed hours worked will directly inform γ_h , given β . In the data, the average annual hours worked is 1,566 hours, which corresponds to workers in our sample working 82.8% of full-time on average (which corresponds to 1,880 annual hours). This estimate comes from the analysis sample used to estimate the effect of the lottery on wages, restricting to individuals with annual earnings greater than 25,000 SEK.

across all of these groups. We define “closeness” using the weighted minimum distance criterion

$$m = (\hat{\pi} - \pi(\boldsymbol{\theta}))' \hat{W}^{-1} (\hat{\pi} - \pi(\boldsymbol{\theta})),$$

where \hat{W}^{-1} is a diagonal matrix of the inverse of the estimated sampling variance for each reduced-form parameter estimate. The parameter vector which minimizes the criterion above is given by $\hat{\boldsymbol{\theta}}$, which gives the model-based estimates. The standard errors for this estimated parameter vector (which incorporate the sampling error in the reduced-form estimates) can be computed from the estimated variance-covariance matrix

$$\hat{V} = (\hat{G}' \hat{W}^{-1} \hat{G})^{-1},$$

where $G = \partial \pi(\boldsymbol{\theta}) / \partial \boldsymbol{\theta}$. Since 11 reduced-form empirical moments are used to estimate three model parameters, we can implement a specification test using the test statistic $(\hat{\pi} - \pi(\hat{\boldsymbol{\theta}}))' \hat{W}^{-1} (\hat{\pi} - \pi(\hat{\boldsymbol{\theta}}))'$, which is distributed as $\chi^2(11 - 3) = \chi^2(8)$.

C. Simulation Results and Implied Labor Supply Elasticities

Table 5 summarizes the simulation results. The χ^2 test statistic is not large ($\chi^2(8) = 3.43$, $p = 0.095$), suggesting that the model provides a reasonably good fit to the reduced-form results. The estimate of β is 0.845 (s.e. 0.010). This suggests that holding marginal utility of wealth constant, roughly 15 percent of unearned income is spent reducing after-tax labor earnings, with the rest spent increasing consumption. The estimate of δ is 0.010 (s.e. 0.005). The somewhat large standard error (as a percent of the parameter estimate) is primarily due to the fact that the differences between the short-run and longer-run responses are not estimated very precisely, and this comparison is what is used by the model to pin down the value of δ (given the assumed risk-free rate r and the distribution of the ages of winners in the sample). Lastly, the estimate of γ_h (which can be interpreted as the maximum annual hours of work available) is 1,870.0 (s.e. 39.7). This is very close to the 1880 hours that characterizes full-time work in Sweden.

[TABLE 5 HERE]

Figure 4 compares the simulated model to the earnings effects over time; consistent with the relatively low χ^2 test statistic, the model-based estimates track the empirical estimates fairly closely. Panel B of Table 5 compare simulated results to empirical results that were not directly “targeted” in estimation, focusing on differences by age of winner, size of prize amount, and wage of winner. Our reduced-form results show limited variation across each of these sources of individual heterogeneity, and our simulation results are broadly in line with these empirical results. Overall, it appears that the estimated model matches our main empirical results fairly closely and can therefore be used for exploratory counterfactual simulations. We therefore conclude by using the estimated model for two purposes: (1) estimating the lifetime income effect and (2) estimating key labor supply elasticities.

[FIGURE 4 HERE]

Estimating the Lifetime Marginal Propensity to Earn. Using the estimates of the model, we can compute the lifetime marginal propensity to earn (after-tax) income out of unearned income, where the calculation extrapolates beyond the first 10 years following the lottery win to the entire remaining years of life. The model estimates imply lifetime MPEs that vary with age at the time of win, from -0.20 for twenty-year old winners to -0.05 for winners aged 60 (see column 1 in Panel A of Table 6). This is primarily a consequence of the binding retirement age. The second and third columns show the cumulative wealth effect over the first 10 years (following prize) and the share of lifetime effect that is accounted for by the 10-year effect. For older lottery winners near (binding) retirement, the lifetime effect and the 10-year effect are identical, since these winners all retire within 10 years. For younger winners, the lifetime wealth effect and 10-year effect diverge substantially. For winners between ages 20 and 45, most of the lifetime earnings reduction occurs after the first 10 years, implying that the cumulative 10-year effects significantly understate lifetime wealth effects.

[TABLE 6 HERE]

Recovering Key Labor Supply Elasticities. In Panel B of Table 6, the model-based parameter estimates are used to recover estimates of key labor supply elasticities that feature prominently in much previous research: the uncompensated (Marshallian) elasticity, the compensated (Hicksian) elasticity, and the intertemporal (Frisch) elasticity. Using the model parameters from Table 5, it is straightforward to simulate these elasticities. The simulated elasticities are shown in Panel B of Table 6 for an individual who wins at age 50. The uncompensated elasticity is very small in magnitude, which is a direct consequence of the Stone-Geary functional form assumption (since the income and substitution effects are similar by assumption). The Hicksian elasticity is estimated to be around 0.1, which is somewhat smaller than the average Hicksian elasticity estimates reported in the meta-analysis in Keane (2011). The Frisch elasticity is estimated to be close to 0.2, which smaller than the consensus estimates used by the Congressional Budget Office (Reichling and Whalen, 2012). Although these specific elasticities are recovered from the reduced-form income effect estimates and the functional form assumptions of the dynamic model, we emphasize that these results are not driven primarily by the specific Stone-Geary functional form. As we describe in more detail in OA Section 5, in a wide range of time-separable utility models, the Frisch elasticity and the Hicksian elasticity are related by the intertemporal elasticity of substitution (IES) and the estimated income effect (Ziliak and Kniesner, 1999; Browning, 2005). Therefore, modest estimates of the income effect necessarily constrain the Frisch elasticity to be similar in magnitude to the Hicksian elasticity, as long as the IES is not large.

Overall, we conclude that a simple dynamic life-cycle model can account for the estimated pattern of results across ages, prize amounts, and pre-win earnings levels. The model can also provide a reasonable fit for asset accumulation over the life-cycle in a Swedish representative sample.¹⁷ However, there are several important caveats. First, the reduced form result showed that winners partly adjust labor supply along the extensive margin, which the model has no ability to capture since there is no extensive

¹⁷Panel A in Figure A2.2 shows the simulated asset path for a 25-year-old non-winner, whereas Panel B shows the median and mean net wealth by age in a Swedish representative sample in year 2000. The simulated model assumes that lifespan ends at 80 and there is no bequest motive; either a bequest motive or uncertain lifespan would allow the model to better fit the wealth data after age 65.

margin decision in the model. Second, we assume that individuals have the ability to save and borrow to smooth consumption and labor supply choices. This is consistent with the lack of evidence of differences in earnings responses to lump-sum and PDV-equivalent monthly installment prizes; however, some of the estimated labor earnings response may be accounted for by liquidity effects rather than “pure” wealth effects, as discussed in Chetty (2008). Lastly, the model assumes that there is perfect foresight and no uncertainty, and the estimated structural parameters may be sensitive to alternative assumptions regarding the role of uncertainty in determining labor supply.

V. Household-Level Analyses

Our household-level analyses are guided by two questions. First, due to spillovers between spouses or sharing of lottery prizes, restricting attention to winners may underestimate the total effect of lottery wealth on labor supply. Second, the lottery wealth shocks allow us to test the unitary model of the household, according to which the identity of the lottery winner should not affect how households adjust their labor supply. To see why the unitary model has this prediction, consider the following simplified, static version of the unitary model of household labor supply that is estimated in Blundell et al. (2014). Households consist of two adults that jointly solve the following static labor supply problem:

$$\begin{aligned} \max_{C, H^1, H^2} & U(C, H^1, H^2) \\ \text{s.t. } & C = A^1 + A^2 + H^1 w^1 + H^2 w^2, \end{aligned}$$

where C is total household consumption, H^i is labor supply of individual i , w^i is the wage of individual i , and A^i is unearned income (assets) owned by individual i . A straightforward implication of this model is “exogenous income pooling”, i.e. $dH^i/dA^1 = dH^i/dA^2$ for $i = 1, 2$. In the context of lotteries, income pooling implies that the household labor supply response to a lottery win is independent of who owned the lottery ticket.

Before addressing the two questions, we begin with a short discussion of how lottery wealth is allocated between spouses. In both the PLS and the Kombi lottery, there is a clearly defined owner of the lottery ticket since the winning account (PLS) or lottery ticket subscription (Kombi) pertains to a specific individual. The division of ownership of Triss lottery tickets within a married couple is less clear, because spouses may sometimes buy the lottery ticket that qualify them to the TV show together.¹⁸ In order to analyze how lottery wealth is allocated within couples, we regress net wealth in the years following the lottery draw on lottery prize. Net wealth is based on annual data from the Wealth Registry, which includes detailed information on individuals' year-end net wealth holdings between 1999 and 2007.¹⁹ Given the limited time span of the Wealth Registry, there are very few winners in PLS for which we observe wealth. We therefore restrict attention to the Triss-Lumpsum and Kombi lotteries. Panel A in Figure A2.3 shows the wealth trajectories for Triss-Lumpsum winners, Triss-Lumpsum winners' spouses, and the household as a whole. By the end of the year of the lottery event, net wealth increases by 56 SEK for winners and 27 SEK for their non-winning spouses. Panel B in Figure A2.3 shows that the corresponding numbers for Kombi are 39 SEK for winners compared to 8 SEK for their spouses. As shown in Table A3.6, winners keep significantly more for themselves in both lotteries; spouses in Triss-Lumpsum receive 32% of the increase in registered net wealth, whereas Kombi spouses receive 18%. As a rough benchmark for PLS, Panel C in Table A3.6 shows the effect of lottery prizes on capital income for the PLS sample. We find that non-winning spouses in PLS receive 12% of the increase in household capital income, suggesting that PLS winners retain most of the

¹⁸As described in detail in the Online Appendix accompanying Cesarini et al. (2015), the Triss data contain information about shared ownership of lottery tickets between friends, relatives and colleagues. We exclude the approximately 10% of Triss prizes where there was information that ownership was shared. The Triss data rarely indicates shared ownership between married spouses, probably because "contracts" regarding ownership are less explicit between spouses than, say, between friends, and because, as discussed above, wealth is split equally in the event of a divorce. Consequently, there are likely to be cases when married couples have bought a winning ticket together, but only one of the spouses appear on the show.

¹⁹The wealth measure does not include cash, cars, or other durables, merchandise, assets transferred to other family members, or money that has been concealed from the tax authority. The purchase of a car (or some other consumer durable) worth 100K will thus typically reduce measured wealth by 100K, even though actual net wealth has only declined by 100K minus the resale value of the car. For all of these above reasons, the estimated effect of lottery wealth on year-end wealth at $t = 0$ (on average 6 months after the lottery) only gives an upper bound on the fraction of the wealth shock that is consumed in the year of the lottery.

lottery wealth. These results thus suggests that winners retain control of a larger share of the lottery prize wealth than spouses in all lotteries, but less so in Triss-Lumpsum.

Table 7 shows the five-year event-study estimates for married and unmarried winners, and the whole sample. For married winners, we report winner, spousal and household labor supply, as well as the difference between winner and spousal labor supply. In the full sample, we include the labor supply of non-winning spouses when calculating household labor supply. The individual-level labor supply response in the full sample is identical to the specification reported in column (1) of Table 2. Figure 5 shows the corresponding dynamic effects.

[TABLE 7 HERE]

Table 7 shows that the labor supply of married winners' drops by 0.98 SEK for each 100 SEK won, compared to 0.46 for their spouses. The labor supply of the household is hence reduced by 1.44 SEK per 100 SEK. The labor supply of unmarried winners goes down by 1.26 SEK per 100 SEK won. While married winners reduce their labor supply less than unmarried winners, the total response of married couples is larger than for singles. In the full sample, including the response of non-winning spouses increases the labor supply response by about 24%, from -1.07 to -1.32 . Focusing only on winners thus lead to an underestimation of the labor supply response.

[FIGURE 5 HERE]

The results in Panel A in Table 7 also shows that winners tend to respond more strongly than spouses, which contradicts income pooling. To more carefully assess the unitary model, we restrict attention to PLS and Kombi since Triss-Lumpsum lottery tickets may be jointly owned. We also restrict the sample to couples where both spouses (not just the winner) was between age 21 and 64 at the time of winning. As shown in Panel A in Table A3.7, the difference between the labor supply response of the winner (-1.14) and the spouse (-0.36) in this subsample is 0.79 SEK per 100 SEK won. The difference is marginally statistically significant ($p = 0.057$). The difference is larger than the differential effect report in Table 7, which is consistent with the conjecture that Triss lottery

tickets are more likely to be jointly owned. Panel B in Table A3.7 shows that the estimated difference is similar when we further restrict the sample to couples where both spouses were below age 59 at the time of winning so that no spouse reaches retirement age during the five-year period (-0.88 , $p = 0.049$). As shown in Panel C, winners react more strongly than their spouses also in terms of after-tax income (-0.35 , $p = 0.048$). It is noteworthy that the relative reduction in labor supply of winners and their spouses is in line with non-winning spouses' share of lottery wealth documented in Figure A2.3. In additional analyses reported in Table A3.8, we find no clear evidence that the effect of lottery wealth on winner and spousal earnings depends on winner's sex, or whether it is the primary or secondary earner that wins the lottery.²⁰

Our identification strategy only allows us to leverage variation in wealth that is random across, but not within, households. It is therefore conceivable that non-winning spouses are systematically different from winners in a way that is correlated with the labor supply response to a positive wealth shock. In an attempt to reduce the concern of non-random assignment of wealth between spouses, we restrict the sample to couples where the non-winning spouses participated in the lottery at some point in time prior to or in the winning draw. As a second robustness test, we go further and restrict the sample to couples where both spouses participated in the same lottery in the winning draw. While neither of these tests are perfect as winning spouses on average still hold more lottery tickets, imposing these restrictions implies that we move closer to random assignment of lottery wealth also within married couples.²¹ Perhaps surprisingly, the last two panels of Table A3.7 show that imposing these restrictions in fact strengthens the differential response between winning and non-winning spouses.

²⁰Because of the smaller size, standard errors are relatively large in these subsamples. When including the Triss sample, we obtain suggestive evidence that the differential response is stronger when the husband or the primary earner wins the lottery.

²¹Table A3.7 (Panel A) shows that winners in PLS held on average 170 tickets in the winning draw, compared to 48 for their spouses. The corresponding numbers for Kombi are 1.48 and 0.09. Restricting the sample to spouses that participated in the lottery (Panel D), PLS winners had 166 tickets compared to 75 for spouses; Kombi winners had 1.51 tickets and their spouses 0.90. Restricting the sample to spouses that participated in the winning draw (Panel E) causes very little change in the number of tickets held by the winners, but increases the average among spouses to 115 (PLS) and 1.26, respectively. Table A3.9 shows that the differences between winning and non-winning spouses in terms of demographic characteristics are always small in PLS whereas winners in Kombi earn more than their spouses and are more likely to be male. Restricting the sample to couples where both spouses participated in the lottery reduces (but does not eliminate) these differences in Kombi.

Another concern with our household-level results is that lottery wealth might affect household composition. As discussed in OA Section 9, our point estimates suggest that lottery wealth increase divorce risk, but the effect is not statistically significant. Moreover, restricting the sample to couples who remain married does not change our results appreciably.

A. *Alternative Models of Household Labor Supply*

The household-level results shows that the identity of the winner determines who in a married couple that reduces labor supply the most. This result is inconsistent with income pooling and complements a large empirical literature (see the review by Chiappori and Donni, 2009) that uses labor supply data to test the exogenous income pooling restriction of unitary models of household. Relative to this previous work, to our knowledge we are the first to use a random lottery that is distributed to each member of the household with positive probability. For example, Attanasio and Lechene (2002) also exploit exogenous variation in unearned income, but in their setting there is no randomization over which member of household received the transfer income. Specifically, they note that “it would have been more useful if the randomization was over who, within the beneficiaries’ households, would receive the transfer: the husband or the wife.” By testing exogenous income pooling in a setting whether either member of the household can receive lottery prize, we provide credible evidence against the income pooling prediction of the unitary model of household labor supply.

Although our results are inconsistent with the unitary model, they are potentially consistent with some household bargaining models. However, bargaining models that rely on divorce as the only threat point are also difficult to reconcile with our results since married couples face “community property” rules in the event of a divorce. Under Swedish marriage law, the default rule in the event of divorce is that all assets are divided equally between spouses. Unless there is prenuptial agreement, which is uncommon, any remaining lottery wealth will hence be split equally (see OA Section 7 for further details). As long as a couple is married, however, the winner owns and controls the prize money

unless he or she decides to transfer part of the prize to the non-winning spouse, or deposit the money in a joint account.

Alternative bargaining models that emphasize outside options other than divorce could be consistent with our results, but this would require specific assumptions about how exactly the lottery prize alters bargaining power within the household. Instead, our results seem most consistent with the “separate spheres” bargaining model of Lundberg and Pollak (1993), which uses threat points internal to the marriage and allow control of income within the marriage to affect family demands. Following Chiappori and Donni (2009), another alternative model that would be consistent with our results is one in which the weights on each household member’s individual utility function are endogenous to the distribution of wealth and unearned income within the household. In this model, the household collectively maximizes a utilitarian social welfare function with welfare weights that are affected by the lottery outcome, and the identity of lottery winner matters because individual lottery winnings change the relative welfare weights through a weighting function.

VI. Conclusion

We have shown that there is an immediate and permanent change in labor earnings in response to an exogenous wealth shock. The magnitude of the response is modest; pre-tax labor earnings decreases by about one percent of the wealth shock in each of the first ten years following the win. The response is about 40 percent smaller when we instead consider after-tax income, and about 40 percent larger when labor supply is measured in terms of production value (labor earnings included employer-paid SSC).

A large part of the adjustment takes place along the intensive margin, suggesting that individuals in our context do not face large, costly barriers to adjusting their labor supply. Another surprising finding is the absence of heterogeneity across many interesting demographic subgroups. Imbens et al. (2001) find no significant differences in the responses of men and women and notice that this is at odds with a large literature that finds that women are systematically more responsive to price and wealth changes. We

find a similar result in our data with substantially more power to detect important differences in labor supply responses by gender. Perhaps even more surprising is the lack of heterogeneity in wealth effects by age. A standard life-cycle labor supply model (as in Imbens et al., 2001) suggests larger wealth effects as retirement approaches. We reconcile this finding with the past literature by calibrating a dynamic labor supply model with a binding retirement age and show that this calibrated model can match our results.

Lastly, when we analyze household-level data, we find larger reductions in total household labor earnings, suggesting that spouses of winners reduce their labor earnings as well. However, we find evidence that lottery winners reduce their labor earnings more than their spouses, regardless of the gender of the winner. This provides unusually strong evidence against the testable prediction of unitary models of household labor supply that exogenous unearned income is “pooled” within the household. Overall, our analysis shows how lottery prizes can be used to inform many different aspects of individual and household labor supply.

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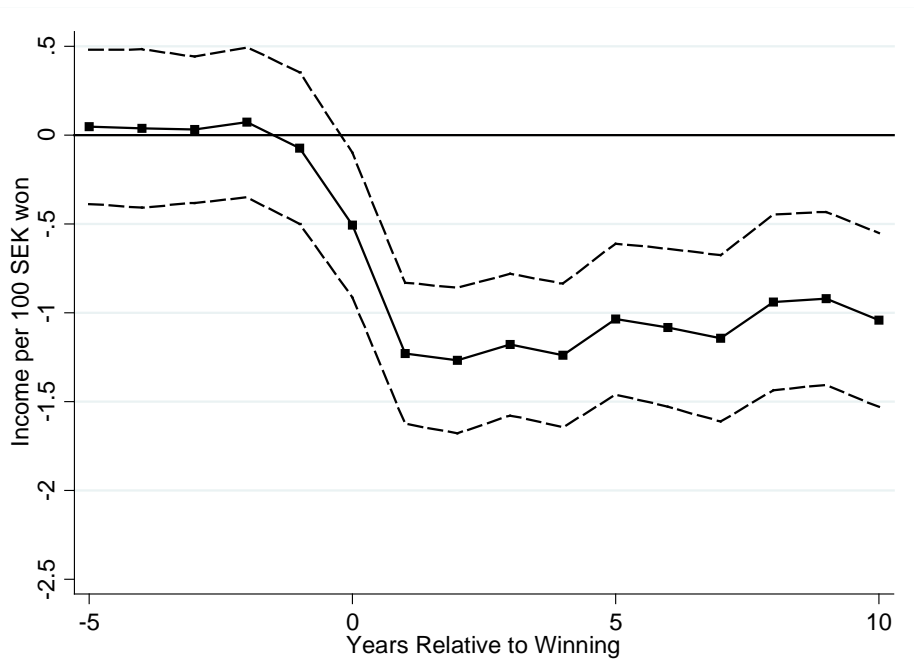
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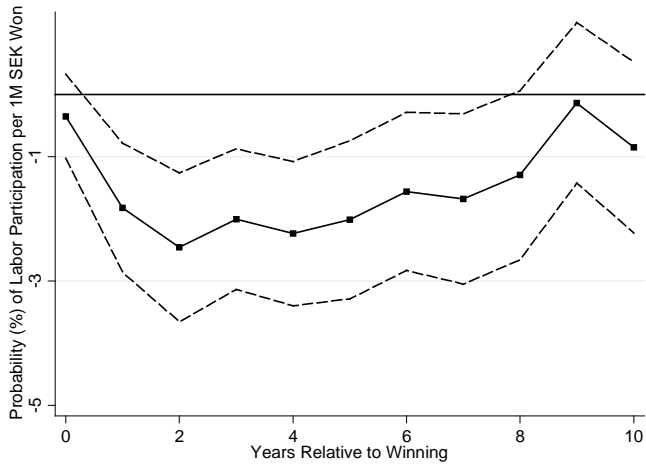
Figure 1: Effect of Lottery Prize on Gross Labor Earnings



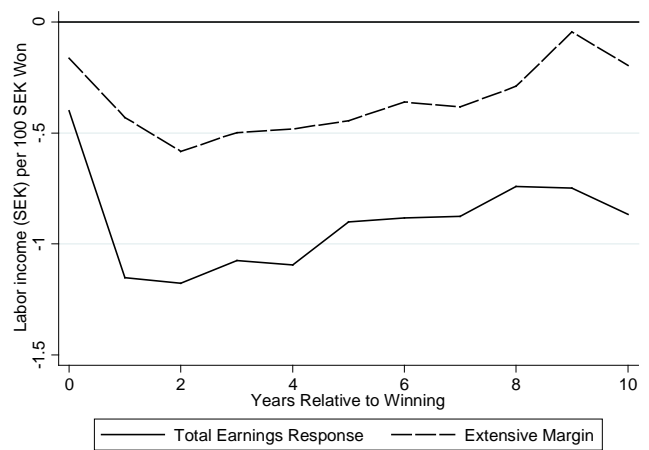
Notes: This figure reports estimates obtained from Equation (2) estimated in the pooled lottery sample with gross labor earnings as the dependent variable. A coefficient of 1.00 corresponds to an increase in annual labor earnings of 1 SEK for each 100 SEK won. Each year corresponds to a separate regression and the dashed lines show 95% confidence intervals.

Figure 2: Margins of Adjustment

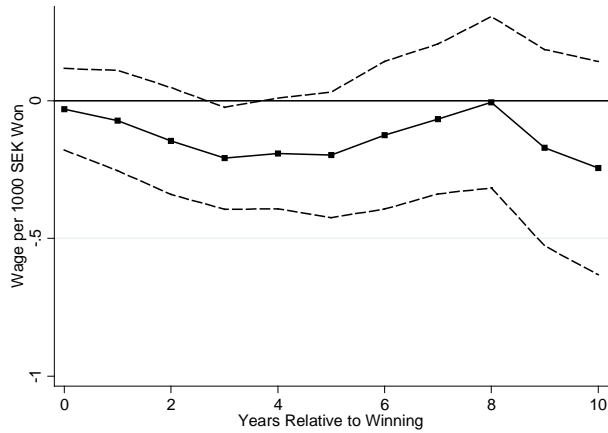
Panel A: Effect on Extensive Margin



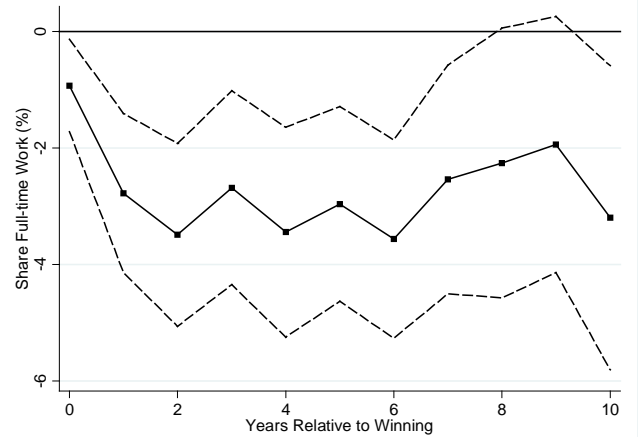
Panel B: Intensive vs Extensive Margin



Panel C: Effect on Wages



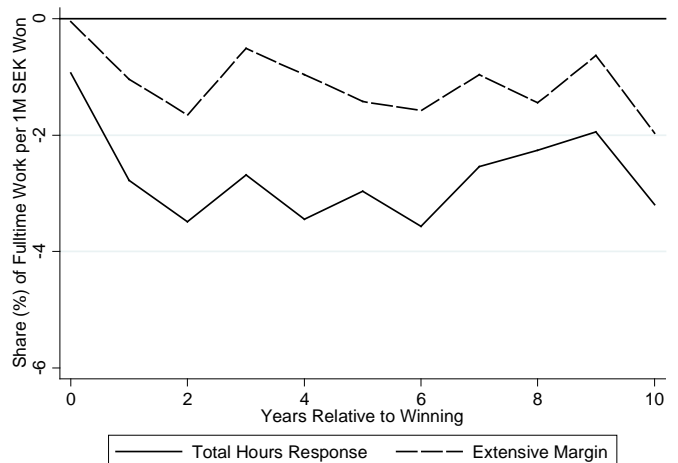
Panel D: Effect on Hours (Share of Full-Time)



Panel E: Wages and Hours Decomposition



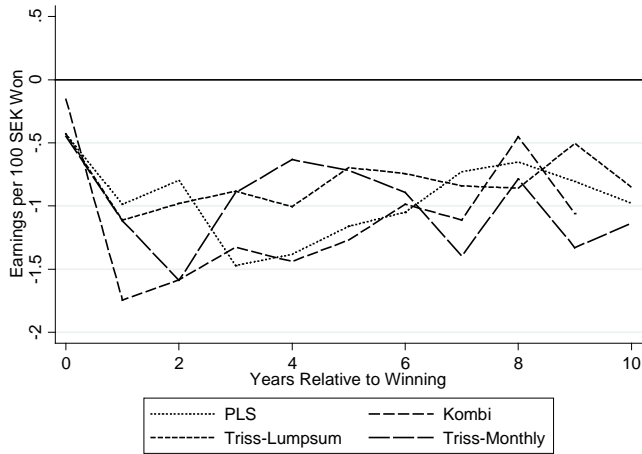
Panel F: Decomposition of Hours Worked



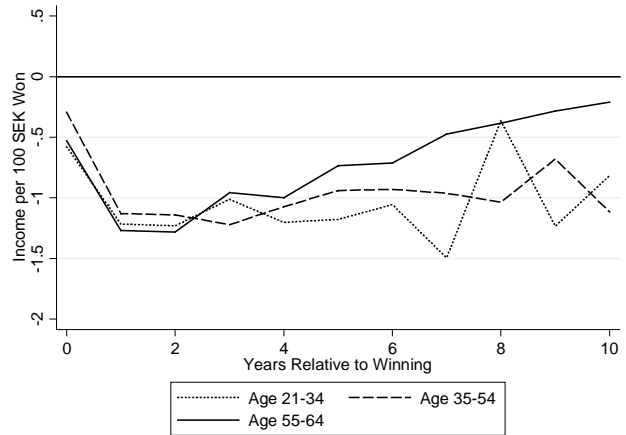
Notes: This figure reports estimates obtained from Equation (2) estimated for the different outcomes discussed in Section III.A. Each year corresponds to a separate regression. The dashed lines in Panel A, C and D display 95% confidence intervals.

Figure 3: Heterogeneous Effects of Lottery Prize on Labor Earnings

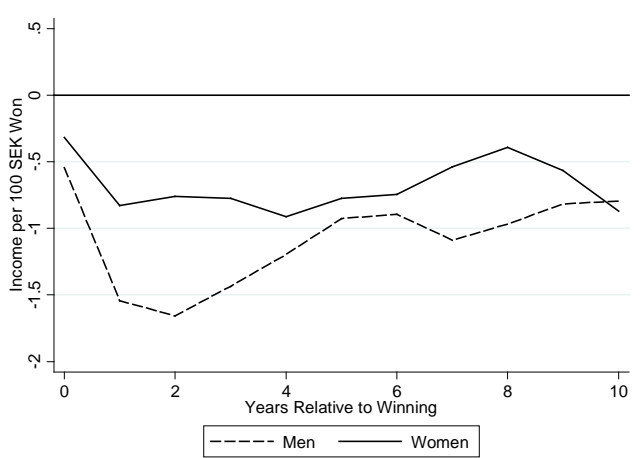
Panel A: Heterogeneity by Lottery



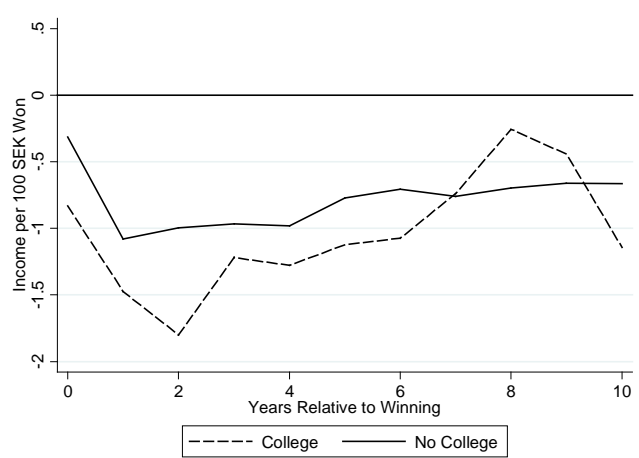
Panel B: Heterogeneity by Age



Panel C: Heterogeneity by Gender



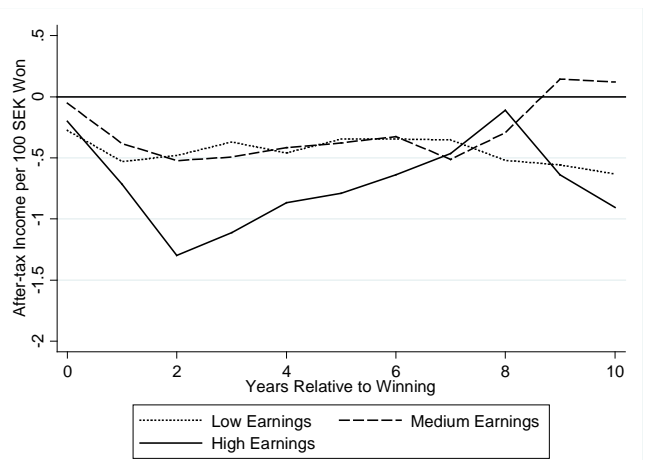
Panel D: Heterogeneity by Education



Panel E: Heterogeneity by Income Tercile (Pre-tax)

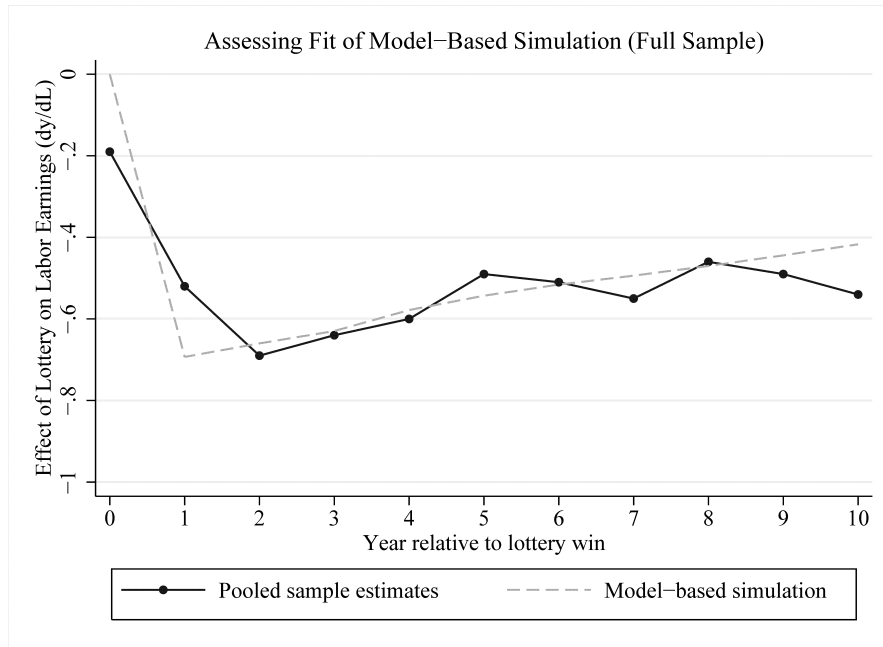


Panel F: Heterogeneity by Income Tercile (Post-tax)



Notes: This figure reports estimates obtained from Equation (2) estimated in different subpopulations. The dependent variable is gross labor earnings in Panel A to E and after-tax earnings in Panel F. A coefficient of 1.00 corresponds to an increase in annual earnings of 1 SEK for each 100 SEK won. Each year corresponds to a separate regression.

Figure 4: Comparing Model-Based Estimates to Empirical Results



Notes: This figure compares the estimates obtained from Equation (2) estimated in the pooled lottery sample with after-tax earnings as the dependent variable to the model-based estimates using the best-fit parameters reported in Table 5. Year 0 correspond to the year the lottery prize is awarded and in the simulation the prize is assumed to be awarded at end of the year, so dy/dL for that year is 0 by assumption.

Figure 5: Effect of Lottery Prize on Labor Earnings of Winners and Spouses



Notes: This figure reports estimates obtained from Equation (2) estimated separately for winners, their spouses and the household. The dependent variable is gross labor earnings. Each year corresponds to a separate regression.

Table 1. Distribution of Prizes

	Pooled Sample		Individual Lottery Samples							
			PLS		Kombi		Triss-Lumpsum		Triss-Monthly	
	Count	Share	Count	Share	Count	Share	Count	Share	Count	Share
0 to 1K SEK	25,172	10.0%	0	0.0%	25,172	99.0%	0	0.0%	0	0.0%
1K to 10K SEK	204,626	81.3%	204,626	92.0%	0	0.0%	0	0.0%	0	0.0%
10K to 100K SEK	16,429	6.5%	15,520	7.0%	0	0.0%	909	27.8%	0	0.0%
100K to 500K SEK	3,685	1.5%	1,654	0.7%	0	0.0%	2,031	62.1%	0	0.0%
500K to 1M SEK	355	0.1%	195	0.1%	0	0.0%	160	4.9%	0	0.0%
≥1M SEK	1,481	0.6%	481	0.2%	263	1.0%	168	5.1%	569	100.0%
TOTAL	251,748		222,476		25,435		3,268		569	

Notes: This table reports the distribution of lottery prizes for the pooled sample and separately for each lottery sample. The sample is restricted to those aged 21-64 at time of win, and the prize ranges reported in the rows is inclusive from below and exclusive from above.

Table 2. Lottery Prizes and Individual Labor Earnings

	Panel A: Pre-tax Labor Earnings					
	$t = 1$	$t = 2$	3-year total	5-year total	10-year total	Event study estimate $t = 1-5$
	(1)	(2)	(3)	(4)	(5)	(6)
Prize Amount (SEK/100)	-1.152	-1.177	-3.219	-4.681	-8.033	-1.068
SE	(0.153)	(0.191)	(0.517)	(0.917)	(1.961)	(0.149)
p	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]
N	199,168	211,555	193,312	186,819	173,129	249,278
	Panel B: Pre-tax Labor Earnings Including Social Security Contributions					
	$t = 1$	$t = 2$	3-year total	5-year total	10-year total	Event study estimate $t = 1-5$
	(7)	(8)	(9)	(10)	(11)	(12)
Prize Amount (SEK/100)	-1.530	-1.568	-4.292	-6.297	-10.808	-1.412
SE	(0.203)	(0.254)	(0.686)	(1.216)	(2.611)	(0.199)
p	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[<0.001]
N	199,168	211,555	193,312	186,819	173,129	247,847
	Panel C: Post-tax Earnings					
	$t = 1$	$t = 2$	3-year total	5-year total	10-year total	Event study estimate $t = 1-5$
	(13)	(14)	(15)	(16)	(17)	(18)
Prize Amount (SEK/100)	-0.548	-0.701	-1.739	-2.480	-3.367	-0.580
SE	(0.079)	(0.114)	(0.275)	(0.488)	(1.050)	(0.081)
p	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[0.001]	[<0.001]
N	199,168	211,555	193,312	186,819	173,129	247,847

Notes: This table reports results of estimating Equation (2) in the pooled lottery sample with three different earnings measures as the dependent variable. The prize amount is scaled so that a coefficient of 1.00 implies a 1 SEK increase in earnings per 100 SEK won.

Table 3. Lottery Prizes and Individual-Level Labor Earnings: Different Measures of Earnings and Income

Taxes	Labor Earnings		Wage Earnings	Self-employment Income	Unemployment Benefits	Pensions	Earnings		
	Pre-tax	Pre-tax incl. SSC	Pre-tax	Pre-tax	Pre-tax	Pre-tax	Pre-tax	Post-tax	Post-tax incl. SSC benefits
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Prize Amount (SEK/100)	-1.068	-1.412	-0.967	-0.142	0.035	0.157	-0.900	-0.580	-0.624
SE	(0.149)	(0.199)	(0.151)	(0.036)	-0.026	-0.085	-0.131	-0.081	-0.084
<i>p</i>	[<0.001]	[<0.001]	[<0.001]	[<0.001]	[0.177]	[0.064]	[<0.001]	[<0.001]	[<0.001]
<i>N</i>	249,278	247,847	247,915	248,058	248,058	248,058	249,278	247,847	247,847
	Includes (3) and (4)					Includes (1), (5) and (6)			

Notes: This table reports event-study estimates obtained by estimating Equation (2) in the pooled lottery sample with different earnings measures as the dependent variable. The earnings measure in column (2) include SSC paid by the employer and the column (9) earnings measure include the implicit employee benefit of SSC. The variables are scaled so that a coefficient of 1.00 implies a 1 SEK increase in earnings per 100 SEK won.

Table 4. Margins of Adjustment

	Extensive Margin (> 25K SEK)					
	Labor Earnings	Wage Earnings	Self-employment	Pension Income (≥ Age 50)	Hours (Percent of Full Time)	Monthly Wages
	(1)	(2)	(3)	(4)	(5)	(6)
Prize Amount	-2.067	-2.244	-0.623	0.458	-3.109	-0.158
SE	(0.449)	(0.475)	(0.253)	(0.507)	(0.616)	(0.085)
<i>p</i>	[<0.001]	[<0.001]	[0.014]	[0.366]	[<0.001]	[0.063]
Scaling	Percentage points per 1M SEK won				1M SEK	1000 SEK
<i>N</i>	249,278	247,915	248,058	130,848	110,080	110,080

Notes: This table reports event-study estimates obtained by estimating Equation (2) in the pooled lottery sample. The variables in columns (1) to (5) are scaled so that a coefficient of 1.00 implies a 1 percentage point increase in participation or fraction of full-time worked per million SEK won, whereas the prize amount is scaled by 1000 SEK in column (6).

Table 5. Simulation-Based Estimates of Model Parameters

<u>Panel A: Minimum Distance Estimates</u>		
Consumption Weight in Utility, β	0.845	
SE	(0.010)	
Annual Discount Rate, δ	0.010	
SE	(0.005)	
Hours Constraint, γ_h	1,870.0	
SE	(39.67)	
Goodness-of-fit, $\chi^2(8)$	3.428	
p -value	[0.095]	
<u>Panel B: Combination of Some of Moments Used in Model-Based Estimation</u>		
	<u>Reduced-Form Estimate</u>	<u>Model-Based Estimate</u>
$\Sigma_{t=1..5} dy_t/dL_0$ ($dL_0 = 100k$ SEK)	-3.12	-3.10
<u>Panel C: Moments Not Used in Model-Based Estimation</u>		
	<u>Reduced-Form Estimate</u>	<u>Model-Based Estimate</u>
$\Sigma_{t=1..5} dy_t/dL_0$ ($dL_0 = 100k$ SEK)	-3.12	-3.10
$\Sigma_{t=1..5} dy_t/dL_0$ ($dL_0 = 1M$ SEK)	-2.99	-3.09
$\Sigma_{t=1..5} dy_t/dL_0$ (low-wage)	-2.55	-3.18
$\Sigma_{t=1..5} dy_t/dL_0$ (high-wage)	-2.85	-3.04
$\Sigma_{t=1..5} dy_t/dL_0$ (21-34 winners)	-3.06	-1.81
$\Sigma_{t=1..5} dy_t/dL_0$ (35-54 winners)	-3.13	-3.25
$\Sigma_{t=1..5} dy_t/dL_0$ (55-64 winners)	-2.85	-2.66

Notes: This table reports results of estimating the dynamic model via indirect inference, with asymptotic standard errors in parentheses. The goodness-of-fit test uses the minimized value of weighted minimum distance procedure, based on 11 moments and 3 parameters.

Table 6. Implied Labor Supply Elasticities from Simulated Model

<u>Panel A: Implied Lifetime Wealth Effects at Various Ages</u>			
	Implied Lifetime Wealth Effect	Cumulative Wealth Effect Over First 10 Years	Effect Over First 10 Years as Share of Lifetime Effect
	(1)	(2)	(3)
Win at Age 20	-0.204	-0.035	17.1%
Win at Age 25	-0.189	-0.032	17.1%
Win at Age 30	-0.174	-0.040	22.7%
Win at Age 35	-0.158	-0.045	28.4%
Win at Age 40	-0.141	-0.052	37.0%
Win at Age 45	-0.126	-0.060	47.9%
Win at Age 50	-0.107	-0.067	63.1%
Win at Age 55	-0.082	-0.082	100.0%
Win at Age 60	-0.051	-0.051	100.0%

<u>Panel B: Implied Labor Supply Elasticities</u>		
(Win at Age 50, Retire at Age 65, Die at Age 80)		
(1)	Effect of lottery prize on total labor earnings over remaining working life (Implied Lifetime Wealth Effect)	-0.107
(2)	Effect of permanent change in wages on total hours worked (Uncompensated (Marshallian) Elasticity)	0.001
(3)	Effect of transitory change in wages on hours worked (Intertemporal Frisch Elasticity)	0.198
(4)	Implied Compensated (Hicksian) Labor Supply Elasticity (from (1) and (2) through Slutsky equation)	0.108

Notes: This table reports key labor supply elasticities implied from model using the parameters reported in Table 5. Panel A reports elasticities at different ages. Each row computes the lifetime wealth effect and the wealth effect over the first 10 years. Row (1) in Panel B reports the effect of lottery prize on total labor earnings (i.e., sum of dy/dL across all remaining working years, as implied by model), row (2) the the implied effect of permanent increase of wages on total hours worked (summed up across all remaining working years), row (3) reports the Frisch elasticity (i.e., effect of transitory change in wages on hours worked), and row (4) shows the implied Hicksian elasticity from the Slutsky equation.

Table 7. Lottery Prizes and Household Labor Earnings

<u>Panel A: Married Winners</u>				
	Household	Winner	Spouse	Difference
	(1)	(2)	(3)	(4)
Prize Amount (SEK/100)	-1.439	-0.981	-0.458	-0.522
SE	(0.298)	(0.200)	(0.206)	(0.276)
<i>p</i>	[<0.001]	[<0.001]	[0.026]	[0.059]
<i>N</i>	144,979	144,979	144,979	144,979
<u>Panel B: Unmarried Winners</u>				
	Household	Winner		
	(5)	(6)		
Prize Amount (SEK/100)	-1.259	-1.259		
SE	(0.229)	(0.229)		
<i>p</i>	[<0.001]	[<0.001]		
<i>N</i>	101,473	101,473		
<u>Panel C: Total Sample</u>				
	Household	Winner		
	(7)	(8)		
Prize Amount (SEK/100)	-1.324	-1.068		
SE	(0.193)	(0.149)		
<i>p</i>	[<0.001]	[<0.001]		
<i>N</i>	249,278	249,278		

Notes: This table reports event-study estimates obtained by estimating Equation (2) on winners, winner's spouses and at the household level for different subsamples. Panel A include all winners that were married the year before the lottery event, Panel B those that were unmarried and Panel C both married and unmarried winners. The prize amount is scaled so that a coefficient of 1.00 implies a 1 SEK increase in earnings per 100 SEK won. The estimates in Panel A includes baseline controls for the winner's spouse.