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Selling company shares to reluctant employees: France Telecom's experience
APPENDICES B AND C

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Abstract

In 1997, France Telecom went through a partial privatization. Using a database that tracks over 200,000 eligible participants, we analyze employees' decisions whether to participate; how much to invest; and what stock alternatives to select. The results are broadly consistent with our neoclassical model. We report four anomalous findings: (1) The firm specificity of human capital has a negligible effect on employees' investment decisions; (2) the amount invested seems driven by different forces than the decision to participate, and we attempt to measure this "threshold effect"; (3) employees "left on the table" one to two months' salary by failing to participate; and (4) most participants underweighted the most valuable asset.

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NOTE: Appendices B and C will be made available from the authors

Appendix B
Setup of a simple model of portfolio selection

Our stylized three-period model provides intuition and testable predictions of the determinants of portfolio choice in a setting with risky labor income, incomplete markets and a binding choice of holding period. Markets are incomplete along three dimensions: Firstly, there is no borrowing at either the risky or riskless rate. This extends the liquidity constraints that have gained prominence in the literature on precautionary savings (Deaton (1991), Browning and Lusardi (1996)). Second, idiosyncratic labor income risk is not insurable (Bodie, Merton and Samuelson (1992), Bertaut and Haliassos (1997), Viceira (2001)). Since labor income is exogenous in our model, the associated risk is related to the concept of unavoidable background risk (Gollier and Pratt (1996)). Finally, there are no markets in the long-lived assets between the date of purchase and the maturity date.

There are two distinguishing characteristics of our model. First are the state-dependent period two budget constraints: An investor cannot sell any of the long-lived assets purchased in period one to finance consumption or new investments in period two. Thus the period two consumption and investment decision depends on three factors: The amount of consumable financial wealth, realized period-two labor income, and the value of and composition of the non-consumable portion of financial wealth. Second are the numerous discounts, matching bonuses and free shares as well as the constraints on the amounts that can be invested. It is not clear whether the general predictions from the portfolio selection literature continue to hold with this unusual investment opportunity set, which we therefore model explicitly.

Worker-investors choose their investment and consumption in three periods, subject to shocks to both risky financial assets and risky labor income. The investment choice set -modeled to closely reflect the choices facing the France Telecom workers- includes the assets from the France Telecom offering and the standard risk-free asset and a risky asset unrelated to France Telecom (e.g. an investment in equities unrelated to France Telecom).

In the first two periods, the investor decides about his current consumption and about the composition of his financial portfolio. In period one, the investor has the choice between five different assets. The first asset is the standard risk-free bond. The second asset is a slightly discounted share in France Telecom. The share can be traded in period 2, and is meant to represent a simplified version of the *Disponix* and *Simplix* products, which have short holding periods in exchange for reduced purchase discounts.[1] To capture the discounts, the investors receive free shares as a function of the number of shares purchased based on the actual terms of the *Disponix* offering.

Additionally, there are two illiquid, long-lived assets based on the France Telecom stock. These assets cannot be sold in the intermediate period, such that any investment has to be held until period three. The first illiquid asset, *Abondix*, is nothing more than the standard France Telecom stock, sold at a 20% reduced price. *Abondix* also comes with a matching bonus and delivers a number of free shares as a function of the number of units purchased. The second long-lived asset, *Multiplix*, is downside protected: Investors have to pay the same price as for *Abondix* and are guaranteed a return of 25% on their personal investment in period three. On top of the guaranteed repayment, investors receive a matching bonus in period one and ten times the positive difference between the period three share price and the period one share price as final payoff. *Multiplix* thus delivers the upside on ten shares for each share purchased, and the guaranteed personal investment is augmented by an additional matching bonus.[2]

The model takes into account the rules applied to the granting of bonuses and free shares in the offering, and incorporates the constraints put on the amounts that can be invested into the long-lived assets.[3]

Finally, the period one investment opportunity set contains a risky asset unrelated to France Telecom. This captures the possibility to invest into the stock market or other risky assets independently from the France Telecom offering. Realistically, one would have to take into account that the French stock market, and probably most risky assets available to French retail investors, are correlated with the return on the France Telecom

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1. In reality, *Disponix* and *Simplix* have different number of free shares, purchase discounts, and holding period tradeoffs, that we do not adequately capture in our simple model. We make this simplification in order to concentrate on the longer-lived assets and to make the model more tractable.
2. For simplicity, we ignore tax considerations and subsidized financing.
3. The rules under which the discounts, bonuses and free shares are granted as well as the relevant constraints are described in detail in the body of the paper.

stock. Instead we make the simplifying assumption that the return on the unrelated risky asset is orthogonal to the return on the France Telecom stock.

In period two, the investor has to hold onto any illiquid assets *Abondix* and *Multiplix* bought in period one. The investor then faces the standard consumption-savings decision, and has to allocate any additional savings between the two short-term risky and the riskless asset. The only assets available for investment in period two are risk-free bonds, standard France Telecom shares and the independent risky asset. We assume that the investor receives no utility from bequests and consumes all his wealth in period three. The uncertainty in our model unfolds as follows. The one-period return on the France Telecom share is given by:

(B1) $$R_{FT,t} = R_f + premium + \varepsilon_{FT,t} \text{ for } t = 1,2$$

where R_f is the gross risk-free rate, premium is the equity premium and $\varepsilon_{FT,t}$ is a mean-zero shock to the stock return between period t and period $t+1$. Similarly, the return on the unrelated risky asset is given by:

(B2) $$R_t = R_f + premium + \varepsilon_t \text{ for } t = 1,2$$

The investor in our model receives labor income in each period. Period one labor income L_1 is known with certainty, but second and third period labor income is risky. It is subject to two random shocks, one of which corresponds to the shock to the France Telecom stock. This formalizes the notion that human capital is a risky asset, and related to the performance of the employing firm. The second shock represents idiosyncratic labor income risk, such as illness, layoffs, or unexpected income windfalls. Shocks to labor income are persistent, such that a shock at t=2 affects income at t=3. Formally, period-two labor income is given by:

(B3) $$L_2 = L_1(1 + \rho \cdot \varepsilon_{FT,1}) \cdot (1 + \varepsilon_{L,1})$$

where $\varepsilon_{FT,1}$ is the shock to the France Telecom stock return and $\varepsilon_{L,1}$ is a mean-zero idiosyncratic labor income shock. The covariation between labor income and stock returns is strictly increasing in the parameter ρ. Labor income in period 3 continues to be subject to shocks to the France Telecom stock:

(B4) $$L_3 = L_2(1 + \rho \cdot \varepsilon_{FT,2})$$

For simplicity, we set the idiosyncratic labor income shock in period three to zero. To prevent our investor from simply hedging the positions in the illiquid assets at t=2, we assume that short sales of both risky and riskless assets are prohibited.[4] All three sources of risk -$\varepsilon_{FT,t}$, ε_t and $\varepsilon_{L,t}$ - are mutually independent.

The preferences of our investor are described by a constant-relative-risk-aversion utility function, a formulation that is common in the neoclassical portfolio selection literature, and we assume the standard Von Neumann-Morgenstern time-separability conditions. Thus the investor's objective function is to maximize utility of consumption over the three periods, which is given by[5]

$$U(c_1, c_2, c_3) = u(c_1) + \delta u(c_2) + \delta^2 u(c_3)$$

(B5) and

$$u(c_t) = \frac{c_t^{1-\gamma}}{1-\gamma}$$

where δ represents the time discount factor, and γ is the coefficient of relative risk aversion.

In order to solve the model, we assume that each of the three sources of risk -the France Telecom shock, the shock to the unrelated asset and the labor income shock- can take on only one of two values in each period. We represent the underlying uncertainty in the form of a binomial tree and solve the model numerically by backward induction. Assuming binomial shocks and three sources of uncertainty results in nine decision nodes in the intermediate period. We apply a grid search to the investor's decision problem at each of the intermediate nodes, and to his decision problem in the first period. The standard calibration of the model uses the following parameter values: Initial wealth equals FF 200,000 and initial labor income equals FF 180,000 p.a. before taxes. The relative risk aversion (RRA) parameter is set to 5 and varied between 2 and 20. This range is arbitrary, but relates to previous empirical work.[6] The individual time preference rate is equal to the risk-free interest rate at 5%, while the equity premium equals 6%.

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4. Were employees able to sell stock short, they would have immediately purchased infinite amounts of the discounted asset, shorted them and earned arbitrage profits by “monetizing” the discount.
5. Because we are trying to model the tradeoff between liquidity and return, we cannot assume that the investor is maximizing over final wealth, since in that case the portfolio weight on the liquid, low return asset would be zero.
6. See footnote 11 in the body of the text for a discussion of the relevant literature.

The risk parameters in the baseline calibration are a 30% annual volatility for the France Telecom stock return, a 25% volatility for the unrelated risky asset and a 5% volatility for the independent labor income shock. The outside risky asset has a more attractive Sharpe ratio than the France Telecom stock, capturing the idea that holding (for example) an indexed fund offers in general a more favorable risk-return tradeoff than holding a single stock. The parameter controlling the covariation between stock returns and labor income, ρ, is set to 0.1.

Figure B1 illustrates the model predictions: **Panel A** shows personal contributions in French Franc as a function of relative risk aversion, firm-specificity of labor income, and labor income. **Panel B** illustrates the portfolio allocations among the available France Telecom assets, and **Panel C** shows the predicted average holding period and the fraction of the portfolio that is downside protected, again as a function of the same variables.

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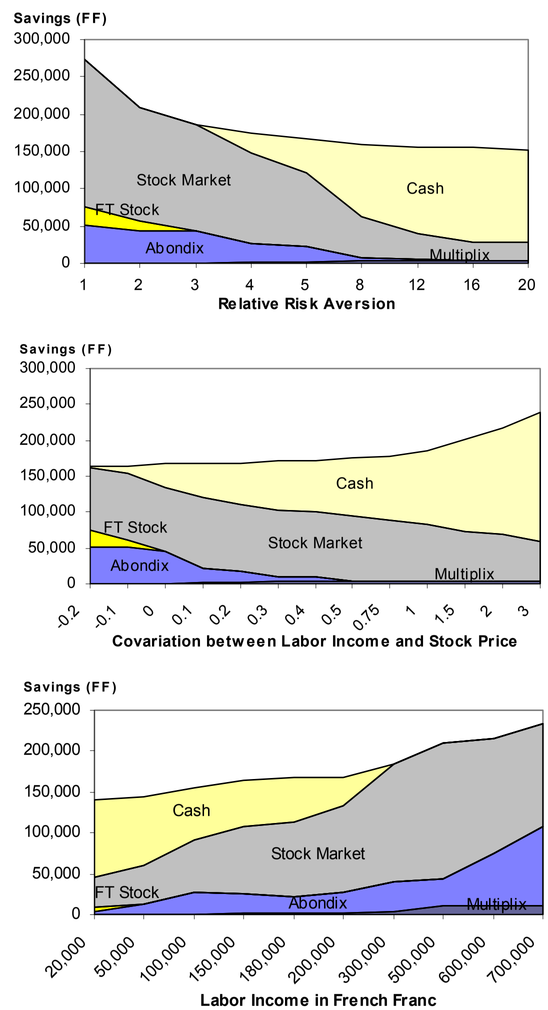
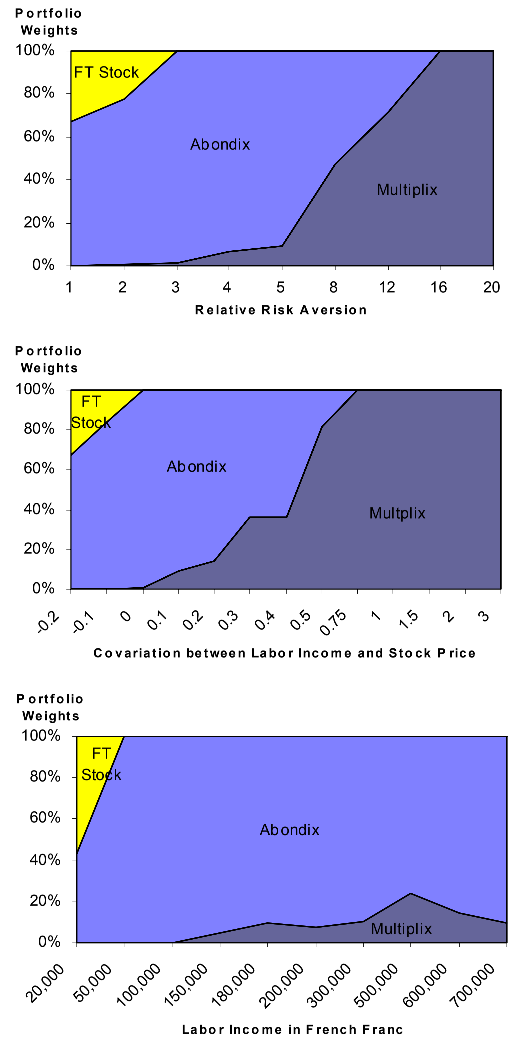
Panel A



Panel B



Panel C

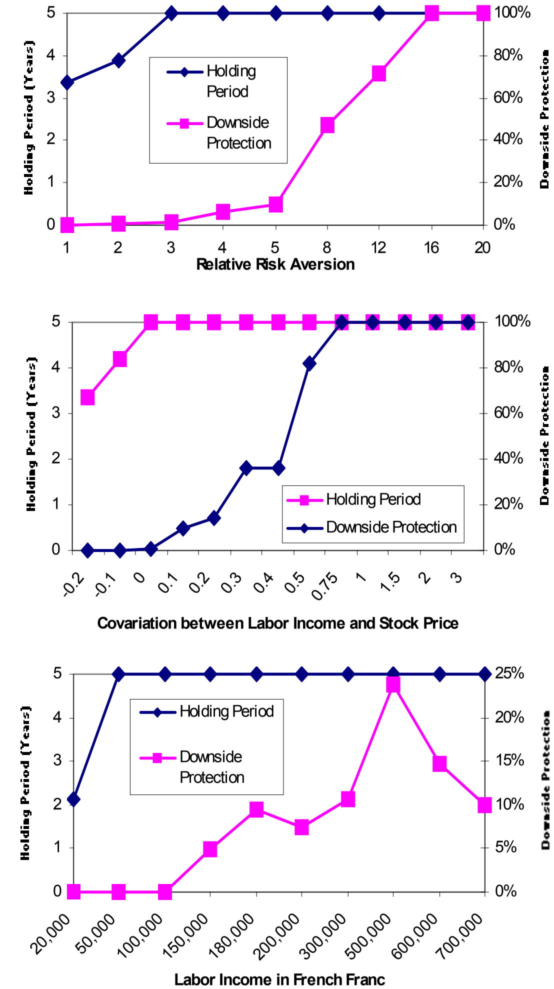


Figure B1
Model-predicted portfolio allocations

Illustration of the model predictions for savings and portfolio selection decisions as a function of relative risk aversion, firm-specificity of labor income (represented by the covariation parameter ρ), and labor income in French Franc. **Panel A** shows the savings (given by financial wealth plus labor income minus consumption), **Panel B** shows the portfolio allocations for participants in the France Telecom offering, and **Panel C** shows the average holding period (in years) of the chosen portfolio, and the fraction of the portfolio that is downside protected through *Multiplix*. All the model variables are set to their baseline calibration, except for the variable being examined.

Appendix C
Estimating the threshold levels

This section describes the methodology for estimating the threshold levels below which latent individual investments would not be observable. The double-hurdle specification is closely related to the censored regression model first proposed by Tobin (1958) and the sample-selection models described by Heckman (1976). It follows the model of Cragg (1971), in which the first hurdle is a probit model for participation, and the second hurdle is a censored regression for the contribution level similar to Tobin's model.[1]

We illustrate the methodology for the simple case when there is only one threshold applicable to all individuals. The underlying latent variable model is given by:

$$\text{(C1)}\qquad \begin{aligned} & y_i^* = \alpha + x_i^{'}\beta + \varepsilon_i \qquad\qquad \varepsilon_i \sim N(0,\sigma^2) \\ & y_i = y_i^* \ \mathit{iff}\ y_i^* \geq K \\ & y_i = 0 \ \mathit{otherwise.} \end{aligned}$$

where y_i* is the latent personal investment, which will be observed if and only if y_i* is larger than some threshold level *K*. The likelihood function of the standard Tobit model augmented by the threshold effect *K* is given by:

$$\text{(C2)}\qquad \begin{aligned} L(\alpha,\beta,K,\sigma) &= \prod_{y_i^*\geq K} \Pr(y_i^* \geq K) * f(y_i \mid y_i^* \geq K) \ * \prod_{y_i^*<K} \Pr(y_i^* < K) \\ &= \prod_{y_i^*\geq K} \frac{1}{\sigma}\phi\left(\frac{y_i - \alpha - x_i^{'}\beta}{\sigma}\right) \ * \prod_{y_i^*<K} 1 - \Phi\left(\frac{(\alpha - K) + x_i^{'}\beta}{\sigma}\right) \end{aligned}$$

Here $\phi(\cdot)$ and $\Phi(\cdot)$ correspond to the standard normal pdf and cdf respectively. The two parts in (C2) correspond to a classical regression model for the non-censored observations and to a probit-type probability term for the censored observations. The only non-standard feature of this formulation is the appearance of the threshold level as part of the constant term for the censored observations. Note that estimating the model in (C1) as a standard Tobit model amounts to forcing the constants in the censored and the non-censored part to be equal, whereas the correct specification (C2) allows the constant term in the probit part to be reduced by the

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1. For an in-depth treatment of limited dependent variable models with selectivity, see Lee (1983). A recent application of the techniques employed in this section can be found in Maki and Nishiyama (1996).

threshold level.

Heckman (1976) estimates the standard Tobit model in two steps, using the well known result that the expected value of a non-censored observation can be written as:

$$\text{(C3)} \qquad E(y_i \mid y_i^* \geq K) = \alpha + x_i'\beta + \sigma\lambda\left(\frac{K - \alpha - x_i'\beta}{\sigma}\right)$$

Here $\lambda(\cdot)$ stands for the inverse Mills ratio. An estimate of $\lambda(\cdot)$ can be obtained by defining a dummy variable which takes the value one for participants and zero for non-participants, and running a probit regression for the participation decision. This provides us with consistent estimates of $(K - \alpha - x_i'\beta)/\sigma$ and hence consistent estimates of $\lambda(\cdot)$. Substituting these into (C3), we can estimate the contribution regression by OLS. This in turn gives us consistent estimates of α and σ. Finally, combining the consistent estimates of α and σ from the contribution regression with the consistent estimate of $(K - \alpha)/\sigma$ from the participation regression, we get a consistent estimate of the threshold level *K*.

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