

Estate Taxation, Entrepreneurship, and Wealth

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This paper studies the estate tax in a quantitative framework with business investment, borrowing constraints, estate transmission, and wealth inequality. We find that the estate tax has little effect on the saving and investment decisions of small businesses, but does distort the decisions of larger firms, thereby reducing aggregate output and savings. Removing such distortions by eliminating the estate tax does not necessarily imply that everyone would be better off. If other taxes were raised to reestablish fiscal balance, those at the top of the wealth distribution would experience a large welfare gain, but most of the population would lose. (JEL D31, E21, H2)

Since its introduction in 1916, the estate tax has been one of the most controversial parts of the United States tax code.

Estate tax opponents dub it a “death tax,” claim that it hurts business activity and job creation, and assert that its negative effects are thus felt by all households, including those that never pay the tax. For these reasons, they call for abolishing it. In contrast, its supporters see the estate tax as an effective way to tax the richest (and dead) few and redistribute. They also point out that the abolition of the “death tax” on a small set of rich people implies a “birth tax” on all citizens.

This paper measures the burden of effective estate taxation, and how it is distributed across the population using a quantitative, general equilibrium economy that explicitly studies entrepreneurial entry, continuation decisions, investment and job creation, and transmission of estates across generations. While calibrated to match some other key aspects of the data, this framework matches the observed wealth inequality and wealth mobility for entrepreneurs and workers, and replicates the observed consumption inequality. The fact that such a simple model does that well along all of these dimensions helps us trust the policy implications that it generates.

This paper evaluates the effects of abolishing the estate tax under three alternative scenarios, starting with the one that casts abolishing it under the most favorable light, all the way to the least benign one. These scenarios differ because of the distortions introduced by the other policy instruments used to reestablish fiscal balance. The first tax policy raises no other tax, but cuts wasteful government spending as a fraction of output. Alternatively, under the second and third tax policies, the government keeps government spending as a fixed fraction of output and increases either the tax on consumption or the one on total income. We compute the steady states before and after abolishing estate taxes, the transition path of the economy between steady states, and the implied welfare costs and benefits of each reform.

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Our model implies a large gap between the headline-making statutory numbers and the effective estate taxation. We find a large effective exemption level (about \$5 million per household), and a fairly low effective marginal tax rate (16 percent). These findings are consistent with previous estimates (see William G. Gale, James R. Hines, and Joel Slemrod 2001 for an overview). Our effective exemption level reinforces previous arguments that the exemption level is high enough to imply that the impact of estate taxes on family farms and businesses is not a major concern for most estates (see, for example, Neil E. Harl 1995; Gale and Slemrod 2001).

We do find that the estate tax distorts the saving and investment decisions of the very rich, who also hold a large fraction of total wealth, thereby reducing aggregate output and savings.

These distortions do not necessarily imply that their abolition would increase welfare for everyone. The estate tax is highly progressive, and abolishing it does generate a large welfare gain for the super-rich. However, if another tax is raised to reestablish fiscal balance, most of the population experiences a welfare loss. Surprisingly, even when no other tax is raised, but wasteful government spending is cut as a fraction of output, someone experiences a welfare loss. In this case, the increased investment by the entrepreneurs drives down the interest rate, and the people who are not rich enough to benefit from the estate tax cut, but are rich enough to have the bulk of their income coming from capital rather than labor, are worse off.

Our results thus indicate that most households today would find it in their interest to oppose the more realistic reforms in which a consumption or income tax would be raised to compensate for decreased revenues from abolishing estate taxation. More generally, all of the policy experiments that we consider contradict the claim that most households would benefit from abolishing estate taxation.

We also find that the aggregate effects of eliminating estate taxation crucially depend on what other tax instrument is used at the same time to reestablish fiscal balance. In the case in which, perhaps more realistically, the tax on total income were raised, the distortions coming from this small increase for all of the population erase almost all of the aggregate increase in total output coming from increased investment of the very rich who benefit from the elimination of the estate tax. In the cases in which either wasteful government spending is cut as a fraction of output, or the consumption tax is raised, aggregate output does increase. This comes from the classic fact that a tax on total income also hits capital income and distorts savings.

In none of the policy experiments do wealth and consumption inequality go up significantly as a result of the abolition of estate taxes.

Section I places this paper in the context of the previous work on entrepreneurship and taxation, while Section II provides a brief overview of estate taxation in the United States. Section III describes our model. Section IV discusses our calibration procedure. Section V evaluates the fit of our model against a number of important features of the data that we do not match by construction. Section VI evaluates the effects of abolishing estate taxation while using various instruments to reestablish fiscal balance, and Section VII concludes.

I. Previous Literature on Entrepreneurship

To the best of our knowledge, this paper is the first work that evaluates estate taxation reforms by using a quantitative, general equilibrium model that takes into account the effects of the reforms on the key channels that most worry legislators: wealth inequality, business activity, aggregate activity at large, and estate transmission. Our model also quantitatively matches a number of important features of the data, including wealth inequality.

Despite the relevance of estate taxation reform and its major impact on policy circles, few papers study this reform in the context of quantitative models capable of replicating the extreme concentration of wealth observed in the data. This is because constructing such a model, computing

it, and calibrating it to the data are not easy tasks. (For discussions, see Vincenzo Quadrini and José Víctor Ríos Rull 1997a; Cagetti and De Nardi 2008; Jess Benhabib and Alberto Bisin 2007; Neng Wang 2007.)

Ana Castañeda, Javier Díaz-Giménez, and Ríos Rull (2003) and John Laitner (2001) are exceptions in that they study estate taxation in the context of quantitative models that are, to some extent, capable of replicating the extreme concentration of wealth observed in the data. Neither of these papers, however, models entrepreneurial business formation and the associated job creation and investment. Other academic contributions have shown that entrepreneurship and some kind of borrowing constraint are key determinants of investment, saving, wealth holdings, and wealth inequality (see Quadrini and Ríos Rull 1997b; Quadrini 1999, 2000; William Gentry and R. Glenn Hubbard 2004; and Cagetti and De Nardi 2006).

Previous literature has also argued that entrepreneurial capital accumulation is influenced by borrowing constraints both in developing economies (Francisco Buera 2008b; Hyeok Jeong and Robert M. Townsend, forthcoming; António Antunes, Tiago Cavalcanti, and Anne Villamil 2008) and in developed ones (Gentry and Hubbard 2004; Buera 2008a; David G. Blanchflower 2008; Alexander Monge-Naranjo 2008; Luis Carranza, José E. Galdón-Sánchez, and Jesús Fernández-Villaverde 2003).

Other works have studied the effect of income and capital taxation with explicit modeling of entrepreneurial decisions (e.g., Césaire Meh 2005; Sagiri Kitao 2008; Vasia Panousi 2008). Regarding other aspects of quantitative models of entrepreneurship and government policies, V. V. Chari, Mikhail Golosov, and Aleh Tsyvinsky (2003) focus on the lock-in effect of capital gains taxes on entrepreneurial start-ups, Wenli Li (2002) studies the effects of government subsidies, while Ahmet Akyol and Kartik Athreya (2008) and Meh and Yaz Terajima (2008) examine the effects of bankruptcy laws.

The framework developed in this paper builds on Cagetti and De Nardi (2006), enriching it by allowing the entrepreneurs to hire workers; by introducing progressive income and estate taxation, and proportional consumption taxation; and by computing the transition paths of the economy in response to tax changes.¹

II. A Brief Overview of Estate Taxation in the United States

The revenues from the estate and gift tax and the fraction of estates that pay estate taxes are small. Only 2 percent of the estates of adult decedents pay any estate taxes and their revenue is about 0.3 percent of US output (see, for example, Gale and Slemrod 2001).

At a first glance, these revenues might seem at odds with the statutory numbers that we read in the newspaper headlines. Looking at the tax code in greater detail, one quickly gets the sense that effective taxation and headline-making statutory estate taxation are very different.

Here, we focus only on the features of both statutory and effective estate taxation that are most important given our purposes. Among the most recent literature Gale, Hines, and Slemrod (2001), Henry J. Aaron and Gale (1996), and Gale and Maria Perozek (2001) provide overviews and discussions on estate and gift taxation.

Federal law imposes an integrated set of taxes on estates, gifts, and generation-skipping transfers. The gross estate includes all of the decedent's assets. In the process of going from the gross

¹ See Juan Carlos Conesa and Dirk Krueger (2006) for an earlier example of computing the economy's transition path in a Bewley model.

estate to the net, taxable estate, here are some of the important steps (the specific numbers that we use here are based on the year 2000 tax code²):

- (i) The allowed estate tax implied exemption level was \$675,000.
- (ii) Assets are typically evaluated at fair market value. Closely held businesses, however, are allowed to value real property assets at their “use value” rather than their highest alternative market-oriented value. The maximum allowed reduction in value is \$770,000.
- (iii) In addition, it is often possible to discount asset values substantially when such assets are not readily marketable or the taxpayers’ ownership does not correlate with control.
- (iv) Interests in certain qualified family businesses were also allowed an extra deduction of up to \$625,000 in 2000 for the value of the business being transferred.
- (v) One can apply unlimited deductions for transfers to a surviving spouse.

After determining the net estate, that is, the value of the gross estate less appropriate deductions, the statutory tax rate is applied. The “applicable credit amount” implied that in the year 2000, at least the first \$675,000 was not taxable. The marginal federal tax rate for a taxable return above that amount started at 37 percent and topped out at 55 percent.

Credit is given for state inheritance and estate taxes. Most states now levy “soak-up taxes” that shift revenues from the federal to the state treasuries without adding to the total tax burden on the estate.

By looking at the simple plan above, one can see that a rich couple could immediately double the standard exemption level just by leaving the children assets up to the deduction upon the death of the first decedent, and then applying the deduction a second time upon death of the other spouse. Gale and Slemrod (2001) argue that simply by using legal valuation techniques, exemptions, and various deductions, a couple with a \$4 million dollar business could pass it to their heir without paying any estate taxes, and without having to engage in any complicated tax avoidance plan. They also argue that this threshold can be increased even further using other legal strategies.

Judicious application of valuation plans and the extra deduction for the presence of a family business further increase the exemption level and bring down the effective estate tax rate above the exemption level. Richard Schmalbeck (2001) describes many (legal) estate tax avoidance schemes and provides some measures of effective estate taxes after such plans are implemented. Aaron and Alicia Munnell (1992) and Wojciech Kopczuk and Slemrod (2001) also argue that there are many ways to reduce effective estate taxation.

Eller, Brian Erard, and Chih-Chin Ho (2001) focus on tax noncompliance by using audit data. They find overall (illegal) estate tax evasion to be about 13 percent of the potential tax base.

Although many experts agree that effective estate taxation can be substantially lower than the statutory one, there is considerable uncertainty about how much people do reduce the effective estate tax burden (see Edward N. Wolff 1996; James M. Poterba 2000). Similarly, there is uncertainty about the effective progressivity of the estate tax and its exact exemption level. Some argue that it is easier to decrease the tax burden for smaller estates (which are also less likely to

² See Barry W. Johnson, Jakob Mikow, and Martha Britton Eller (2001) and W. Elliott Brownlee (2000) for a historic perspective on federal estate taxation.

be audited). Others argue that, given the economies of scale for tax avoidance and evasion, the tax burden might actually be lower for larger estates.

We propose a complementary way to assess the burden of estate taxation. We assume a simple functional form for estate taxation that allows for an exemption level and a constant tax rate above such a level, and we use our model-generated data to match the fraction of estates paying estate taxes, and estate tax revenues as a fraction of output. Interestingly, we find numbers that fall well within the bounds proposed by the previous literature. Given that our model matches asset holdings so well for both entrepreneurs and workers, and given the considerable uncertainty about effective estate tax avoidance and evasion, we see this as a useful way to proceed.

Legislation passed in 2003 gradually decreases statutory marginal tax rates and gradually increases statutory exemption levels every year until 2010. In 2010, all estates are to be taxed at 0 percent. In 2011, however, these temporary cuts are scheduled to vanish, and the statutory taxation schedule is to revert to much higher levels. Many interpret this path as compelling evidence that a reform is needed.

III. The Model

In this model, the households have heterogeneous ability as workers and entrepreneurs, they choose their occupation every period, and they care about the welfare of their offspring.

Since we compute the transition dynamics between the steady states corresponding to a given policy experiment, we make time subscripts explicit whenever relevant.

A. Demographics

We adopt a life-cycle model with intergenerational altruism. To reconcile the computational necessity of few stages of life and the realism of short time periods, we adopt a modeling device introduced by Olivier J. Blanchard (1985) and generalized by Mark Gertler (1999) to a life-cycle setting.

Our model period is one-year long. Households go through two stages of life, young and old age. A young person faces a constant probability of aging during each period ($1 - \pi_y$), and an old person faces a constant probability of dying during each period ($1 - \pi_o$). When an old person dies, his offspring enters the model, carrying the assets bequeathed to him by the parent.

Appropriately parameterized, this framework generates households for which the average length of the working period and the retirement period is realistic. There is a continuum of households of measure 1.

B. Preferences

The household's flow of utility from consumption is given by $c_t^{1-\sigma}/(1 - \sigma)$. The households discount the future at rate β and are perfectly altruistic toward their descendants.

C. Technology

Each person possesses two types of ability, which we take to be exogenous, stochastic, positively correlated over time, and uncorrelated with each other. Entrepreneurial ability (θ_t) is the capacity to invest capital and labor more or less productively by using one's own production function. Working ability (y_t) is the capacity to produce income out of labor by working for others.

At the beginning of each period the current ability levels are known with certainty, while next period's levels are uncertain. A young individual starts the period with assets a_t , entrepreneurial ability θ_t , and worker ability y_t , and chooses whether to be an entrepreneur or a worker during the current period.

The entrepreneurs can borrow, invest capital, hire labor, and run a technology whose return depends on their own entrepreneurial ability. When the entrepreneur invests k , production net of depreciation, this is given by

$$(1) \quad f(k_t, n_t) = \theta(k_t^\gamma (1 + n_t)^{1-\gamma})^\nu + (1 - \delta)k,$$

where $\nu, \gamma \in [0, 1]$, and n is hired labor ($n \geq 0$). We normalize the labor of the entrepreneur to one. Entrepreneurs thus face decreasing returns from investment, as their managerial skills become gradually stretched over larger and larger projects (as in Robert E. Lucas, Jr. 1978).

Many firms are not controlled by a single entrepreneur and are not likely to face the same financing restrictions that we stress in our model. Therefore, as in Quadrini (2000), we model two sectors of production: one populated by the entrepreneurs and one by "nonentrepreneurial" firms. The nonentrepreneurial sector is represented by a standard Cobb-Douglas production function,

$$(2) \quad F(K_t^c, L_t^c) = A(K_t^c)^\alpha (L_t^c)^{1-\alpha} - \delta K_t^c,$$

where K_t^c and L_t^c are the total capital and labor inputs in the nonentrepreneurial sector and A is a constant. In both sectors, capital depreciates at a rate δ .

D. Credit Markets

Workers can save, but not borrow, at a riskless rate of return. Entrepreneurs can borrow. Their borrowing constraints are endogenously determined in equilibrium and stem from the assumptions that contracts are imperfectly enforceable, as in Albert Marcet and Ramon Marimon (1992), Timothy J. Kehoe and David K. Levine (1993), Rui Albuquerque and Hugo A. Hopenhayn (2004), and Thomas Cooley, Marimon, and Quadrini (2004).

Imperfect enforceability of contracts means that the creditors will not be able to force the debtors to fully repay their debts as promised, and that the debtors fully repay only if it is in their interest to do so. Since both parties are aware of this feature and act rationally, the lender will lend to a given borrower an amount (possibly zero) that will be in the debtor's interest to repay as promised.³

E. Government and Taxation

The government is infinitely lived. It levies taxes, pays a pension p_t to each retiree, provides a certain level g_t of public purchases (which do not enter the households' utility function), and pays interest on the accumulated debt. During every period, tax revenues from income, consumption, and estate taxes are equal to government purchases, pension payments, and interest payments on the debt.

We model progressive taxation of total income (as in David Altig and Charles T. Carlstrom 1999), and we allow the tax schedules to be different for entrepreneurs and nonentrepreneurs

³ See Alexander Karaivanov, Anna Paulson, and Townsend (2008) for a discussion of different types of contract enforceability.

(including workers and retirees). We adopt Miguel Gouveia and Robert P. Strauss's (1994) functional form and assume the average federal tax rate $\tau^i(Y_t)$ on total income Y_t is given by

$$(3) \quad \tau^i(Y_t) = b^i - b^i(s^i Y_t^{p^i} + 1)^{-1/p^i},$$

where $i = e, w$: entrepreneurs and workers. Gouveia and Strauss (1994) have shown that this functional form is flexible enough to approximate well the effective average tax rate. As explained in the calibration section, we estimate the parameters b^i , s^i , and p^i from microeconomic data, separately for entrepreneurs and nonentrepreneurs.

Total income taxes paid by each household are given by

$$(4) \quad T_t^i(Y_t) = \tau^i(Y_t)Y_t + \tau_t^s Y_t,$$

where τ_t^s captures state and other income taxes (other than federal). The government also levies a sales tax on consumption, at rate τ_t^c . Estates larger than a given value e_t are taxed at rate τ_t^b on the amount in excess of e_t . The tax rates τ_t^s , τ_t^c , and τ_t^b are potentially time-varying, depending on the policy experiment under consideration.

F. Households

The Young's Problem.—The value function of a young person is

$$(5) \quad V_t(a_t, y_t, \theta_t) = \max\{V_t^e(a_t, y_t, \theta_t), V_t^w(a_t, y_t, \theta_t)\},$$

where $V_t^e(a_t, y_t, \theta_t)$ is the value function of a young individual who manages an entrepreneurial activity during the current period. The term $V_t^w(a_t, y_t, \theta_t)$ is the value function if he chooses to be a worker during the current period. Working capital k_t includes own assets and borrowed money.

The young entrepreneur's problem can be written as

(6)

$$V_t^e(a_t, y_t, \theta_t) = \max_{c_t, k_t, n_t, a_{t+1}} \{u(c_t) + \beta\pi_y E_t V_{t+1}(a_{t+1}, y_{t+1}, \theta_{t+1}) + \beta(1 - \pi_y) E_t W_{t+1}(a_{t+1}, \theta_{t+1})\},$$

subject to

$$(7) \quad Y_t^e = \theta(k_t^\gamma(1 + n_t)^{(1-\gamma)})^\nu - \delta k_t - r_t(k_t - a_t) - w_t n_t,$$

$$(8) \quad a_{t+1} = Y_t^e - T_t^e(Y_t^e) + a_t - (1 + \tau_t^c)c_t,$$

$$(9) \quad u(c_t) + \beta\pi_y E_t V_{t+1}(a_{t+1}, y_{t+1}, \theta_{t+1}) + \beta(1 - \pi_y) E_t W_{t+1}(a_{t+1}, \theta_{t+1}) \geq V_t^w(fk_t, y_t, \theta_t).$$

This constraint reflects the assumption that the entrepreneurs who borrow can either invest the money in their business and repay their debt at the end of the period, or can be workers for that period. In the latter case, the defaulting workers retain a fraction f of their working capital k_t (which includes borrowed and own funds) and their creditors seize the rest. The lender will

rationally lend an amount such that the value of repaying and being an entrepreneur is no smaller than the value of defaulting and being a worker for this period:

$$(10) \quad a_t \geq 0,$$

$$(11) \quad n_t \geq 0,$$

$$(12) \quad k_t \geq 0.$$

The term Y_t^e represents the entrepreneur's total profits. The expected value of the value function is taken with respect to (y_{t+1}, θ_{t+1}) , conditional on (y_t, θ_t) . Equation (9) determines the maximum amount that an entrepreneur with given state variables can borrow. The term $W_t(a_{t+1}, \theta_{t+1})$ is the value function of the old entrepreneur at the beginning of the period, before deciding whether to stay in business or retire. We have

$$(13) \quad V_t^w(a_t, y_t, \theta_t) = \max_{c_t, a_{t+1}} \{u(c_t) + \beta \pi_y E_t V_{t+1}(a_{t+1}, y_{t+1}, \theta_{t+1}) + \beta(1 - \pi_y) W_{t+1}^r(a_{t+1})\},$$

subject to equation (10) and

$$(14) \quad Y_t^w = w_t y_t + r_t a_t,$$

$$(15) \quad a_{t+1} = (1 + r_t) a_t - T_t^w(Y_t^w) - (1 + \tau_t^c) c_t,$$

where w_t is the equilibrium wage rate.

The Old's Problem.—An old entrepreneur can decide to keep the activity going or retire, while a retiree cannot start a new entrepreneurial activity.

The old entrepreneur's state variables are thus his current assets a_t and his entrepreneurial ability level θ_t . His value function is given by

$$(16) \quad W_t(a_t, \theta_t) = \max \{W_t^e(a_t, \theta_t), W_t^r(a_t)\},$$

where $W_t^e(a_t, \theta_t)$ is the value function for the old entrepreneur who stays in business, and $W_t^r(a_t)$ is the value function of the old retired person. Define the inherited assets, net of estate taxes, as $a_{t+1}^n = a_{t+1} - \tau_{t+1}^b \max(0, a_{t+1} - e_{t+1})$. We have

$$(17) \quad W_t^e(a_t, \theta_t) = \max_{c_t, k_t, n_t, a_{t+1}} \{u(c_t) + \beta \pi_o E_t W_{t+1}(a_{t+1}, \theta_{t+1}) + \beta(1 - \pi_o) E_t V_{t+1}(a_{t+1}^n, y_{t+1}, \theta_{t+1})\},$$

subject to equations (7), (8), (10), (11), and (12), and

$$(18) \quad u(c_t) + \beta \pi_o E_t W_{t+1}(a_{t+1}, \theta_{t+1}) + \beta(1 - \pi_o) E_t V_{t+1}(a_{t+1}^n, y_{t+1}, \theta_{t+1}) \geq W_t^r(fk_t).$$

This constraint reflects that the old entrepreneur's alternatives are either to invest and repay the debt, or to run away with a fraction of the total working capital and be retired from that period on.

The child of an entrepreneur is born with ability level (θ_{t+1}, y_{t+1}) . The expected value of the child's value function with respect to y_{t+1} is computed using the invariant distribution of y_t , while the one with respect to θ_{t+1} is conditional on the parent's θ_t and evolves according to the same

Markov process that each person faces for θ_t while alive. This is justified by the assumption that the child of an entrepreneur inherits the parent's firm.

A retired person (who is not an entrepreneur) receives pensions and social security payments (p_t) and consumes his assets. His value function is

$$(19) \quad W_t^r(a_t) = \max_{c_t, a_{t+1}} \{u(c_t) + \beta \pi_o W_{t+1}^r(a_{t+1}) + \beta(1 - \pi_o) E_t V_{t+1}(a_{t+1}^n, y_{t+1}, \theta_{t+1})\},$$

subject to equation (10), and

$$(20) \quad a_{t+1} = (1 + r_t)a_t + p_t - T_t^w(p_t + r_t a_t) - (1 + \tau_t^c)c_t.$$

The expected value of the child's value function is taken with respect to the invariant distribution of y_t and θ_t .

G. Equilibrium Definition

Let $\mathbf{x}_t = (a_t, y_t, \theta_t, z_t)$ be the individual's state vector, where z distinguishes young people, old entrepreneurs, and old retirees. From the decision rules that solve the maximization problem and the exogenous Markov process for income and entrepreneurial ability, we can derive a transition function $M_t(\mathbf{x}_t, \cdot)$, which provides the probability distribution of \mathbf{x}_{t+1} (the state next period) conditional on the current state \mathbf{x}_t .

At each time t an equilibrium is given by

$$\left\{ \begin{array}{l} \text{sequences of the risk free interest rates } r_t \text{ and wage rates } w_t, \\ \text{sequences of taxes } (T_t^w(\cdot), T_t^e(\cdot), \tau_t^c, \tau_t^b, e_t) \text{ and social security payments } p_t, \\ \text{allocations } c_t(\mathbf{x}), \text{ and occupational choices } a_t(\mathbf{x}), \\ \text{entrepreneurial labor hiring } n_t(\mathbf{x}), \text{ and investments } k_t(\mathbf{x}), \\ \text{and a distribution of people over the state variables } \mathbf{x}_t: m_t(\mathbf{x}), \end{array} \right.$$

such that, given the sequences of prices and government taxes and transfer schedules:

- The functions c_t , a_t , n_t , and k_t solve the maximization problems described above.
- The capital and labor markets clear. Total labor supplied by the workers equals the total labor employed in the nonentrepreneurial sector and total labor hired by the entrepreneurs. Total household savings in the economy equal the sum of the total capital employed in the nonentrepreneurial and entrepreneurial sectors plus government debt.
- The marginal product of labor and the marginal product of capital (net of depreciation) in the nonentrepreneurial sector are equal to w_t and r_t .
- The government budget is satisfied: total taxes collected plus net borrowing equal government purchases, transfers, and interest payments on debt:

$$\begin{aligned} & \int (T_t^x(Y_x) + \tau_t^c c(\mathbf{x}) + I_o(\mathbf{x}) \tau_t^b (1 - \pi_o) \max(0, a_{t+1}(\mathbf{x}_t) - e_t)) dm_t(\mathbf{x}) \\ & = p_t \pi_r + g_t + (1 + r_t) D_t - D_{t+1}. \end{aligned}$$

The integral is over all of the population, I_o is equal to one if the person is old and zero otherwise, and π_r is the fraction of retired persons in the population. In steady state $D_t = \bar{D}$.

- The distribution of people m_t is induced by the transition matrix of the system as follows:

$$m'_{t+1} = M_t(\mathbf{x}_t, \cdot)' m'_t.$$

In steady state, $m_t = m^*$ is the invariant distribution for the economy; debt, prices, and government policies are constant; and the individual's decision rules are time-independent.

H. *The Transition Path between Steady States*

Our economy starts from an initial steady state in which there is estate taxation. Unexpectedly, the government abolishes estate taxes and makes up for the change in government revenues by varying either government spending as a fraction of output, or the consumption tax, or the proportional part of the tax on total income.

When we use either the income tax or the consumption tax, we allow the government to adjust this policy instrument for ten years, and after this period the tax is set at its final steady-state level. The level of the tax during these years is determined by the requirement that the government budget constraint has to be satisfied in present value. The shape of the tax change over this time period is constrained to be piecewise linear and continuous over two five-years subperiods. That is, during these ten years the government could, for example, raise the chosen tax instrument for five years, and then lower it to its final steady-state value for the other five years. This gives us exactly one free parameter (the level of the tax rate after the first five years), which is used to balance the budget.

In these experiments, government purchases are kept fixed as a fraction of total output, both during the transition and in the final steady state. For all final steady states, we set government debt to be the same constant fraction of total capital as in the initial steady state.

When we change government spending as a result of the abolition of the estate tax, we keep all other tax rates fixed at their initial steady-state value, and we take government debt to be a constant fraction of capital also during the transition path. Budget balance for the government then implies how much government purchases are.

As soon as people learn about the new policy, households reoptimize their behavior, taking as given the new path of government policy and prices. Barring any other changes, the economy will eventually settle down on a final steady state as a result of the new tax code. During the intervening years, the economy will be in a transition. The transition will take longer than the period over which taxes change because the distribution of people over state variables will take a while to reach its steady-state level, and because of general equilibrium effects (prices will take a while to get close to their steady-state levels).

IV. Calibration of the Initial Steady State

Tables 1 and 2 list the parameters of the model. Table 1 lists the parameters that we take as given and do not use to match model-generated moments with moments in the data. Table 2 lists the parameters of the model that we choose so that the data generated by the initial steady state of the model match some relevant counterpart of the observed data.

Regarding the first set of parameters, we take the coefficient of relative risk aversion to be 1.5, a value close to those estimated by, among others, Orazio P. Attanasio et al. (1999). As is standard, we choose a depreciation rate δ of 6 percent and the capital share in the nonentrepreneurial

TABLE 1—FIXED PARAMETERS AND THEIR SOURCES

Parameter	Value	Source(s)
Preferences, technology, and demographics		
σ	1.5	Attanasio et al. (1999)
δ	0.06	Nancy L. Stokey and Sergio Rebelo (1995)
α	0.33	Douglas Gollin (2002)
A	1	Normalization
π_y	0.98	Average working life: 45 years
π_o	0.91	Average retirement life: 11 years
Labor income process and social security payments		
y, \mathbf{P}_y	See Appendix A	Mark Huggett (1996), Lee A. Lillard and Robert J. Willis (1978)
p	40 percent average yearly income	Kotlikoff, Smetters, and Walliser (1999)
Public purchases, government debt, and taxes		
g	18.7 percent GDP	Economic Report of the President (2000)
D	see text	Altig et al. (2001)
τ_c	11 percent	Altig et al. (2001)
b_w	0.32	Our estimates
b_e	0.26	Our estimates
s_w	0.22	Our estimates
p_w	0.76	Our estimates
p_e	1.4	Our estimates
s_e	0.42	Our estimates

TABLE 2—CALIBRATED PARAMETERS

Calibrated parameter	Value
β	0.9
θ	{0, 0.6}
\mathbf{P}_θ	see text
ν	0.88
γ	0.84
f	0.75
τ_b	0.16
e	120

production function of 0.33. The probability of aging and of death are such that the average length of the working life is 45 years and the average length of the retirement period is 11 years. This implies that the fraction of young people in the population is about 80 percent. The logarithm of the income y process for working people is assumed to follow an AR(1). We take its persistence to be 0.95, as estimated by, for instance, Kjetil Storesletten, Chris Telmer, and Amir Yaron (1999). The variance is chosen to match the Gini coefficient for earnings of 0.38, the average

found in the Panel Study of Income Dynamics (PSID). We assume that the income process and the entrepreneurial ability processes evolve independently; the exact values for the income and ability processes are described in Appendix A. The social security replacement rate is 40 percent of average gross income (see Laurence J. Kotlikoff, Kent Smetters, and Jan Walliser 1999).

We set the ratio of g to output at 18.7 percent. This was the average ratio of government purchases to GDP over the 1990–1999 period (Economic Report of the President 2000).

As in David Altig et al. (2001), we take the tax rate on consumption to be 11 percent. The ratio of total indirect taxes to personal consumption expenditure in the National Income and Product Accounts (NIPA) has been quite stable, at around 11–12 percent from 1989 to 1999.

We pick the level of government debt (as a fraction of output) so that, in the initial steady state, total interest payments on government debt equal 3 percent of output (as in Altig et al. 2001).

We estimate the parameters of the tax function on total income using PSID data for 1989 (see Appendix B for details). Figure 1 displays our estimated average tax rates as a function of total income for the whole population and for the subpopulations of entrepreneurs and workers.

There are many people who call themselves self-employed but who are not entrepreneurs in the spirit of our model. We use the Survey of Consumer Finances (SCF) to identify the empirical

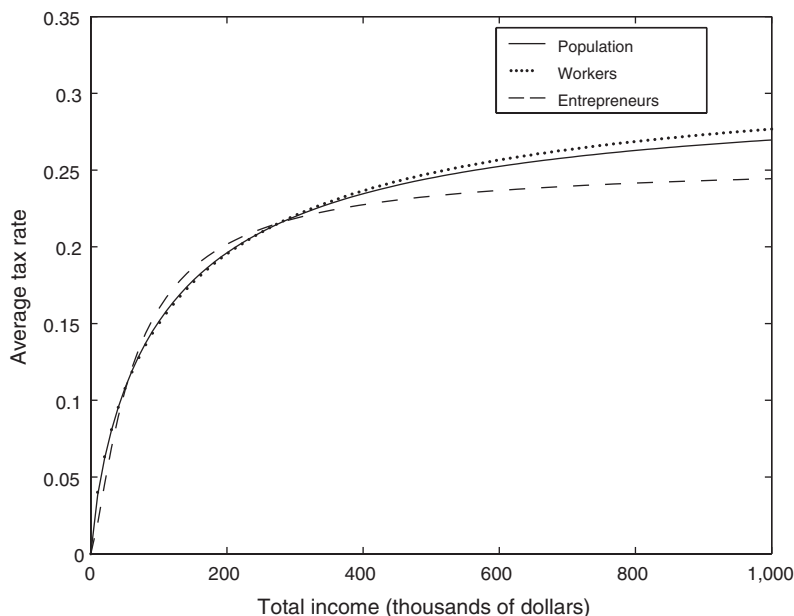


FIGURE 1. ESTIMATED AVERAGE TAX RATES FOR THE WHOLE POPULATION, WORKERS, AND ENTREPRENEURS

counterpart of our entrepreneurs as the self-employed business owners who actively manage their own firm(s). See Cagetti and De Nardi (2006) for a discussion of the various empirical counterparts to the notion of entrepreneurship.

Table 2 lists the remaining parameters of the model and their corresponding values in the baseline calibration. We consider only two values of entrepreneurial ability—zero (no entrepreneurial ability) and a positive number—for two reasons. The first is that, as we will see, the rich endogenous heterogeneity generated by our parsimonious calibration does fit many important aspects of the data extremely well. The second is due to computational running time: computing a general equilibrium steady state with one exogenous entrepreneurial ability level takes several days on a state-of-the-art computer and with Fortran coding, due to the nature of the borrowing constraints.

Our choice on the number of exogenous entrepreneurial ability levels implies that \mathbf{P}_θ is a two-by-two matrix. Since its rows have to sum to one, this gives us two parameters to calibrate. We also have to choose values for ν , the degree of decreasing returns to scale to entrepreneurial ability, γ , the share of income going to entrepreneurial working capital, f , the fraction of working capital the entrepreneur can keep in case he defaults, the estate tax rate, and its corresponding exemption level.

There are thus nine parameters to use to match nine moments of the data. We target the following moments: the capital-output ratio (3.0), the fraction of entrepreneurs in the population (7.6 percent), the fraction of entrepreneurs exiting entrepreneurship during each period (22 percent), the fraction of workers becoming entrepreneurs during each period (2.3 percent),⁴ the ratio of median net worth of entrepreneurs to that of workers (6.5–7 percent), the fraction of people with

⁴ Both in the model and in the data, entry and exit rates refer only to people who were in the model (or survey) in both periods and transitioned from one occupation to the other; they do not include people who die while running an enterprise, nor people who start their enterprise at the beginning of their economic life. For this reason, entry, exit, and the steady-state fraction of entrepreneurs are not linked by the identity that would hold in an economy with infinitely lived agents.

zero wealth (7–13 percent), the fraction of entrepreneurs hiring workers on the labor market (50–60 percent), the revenue from estate and gift taxes (0.3 percent of output), and the fraction of the estates that pay estate taxes (2 percent).

Our calibration matches all of our targets well. Appendix C reports some sensitivity analysis about two key parameters of the entrepreneurial production function, ν and γ , and shows the effects of allowing no intergenerational transmission of ability between parent entrepreneurs and their children.

Our calibration strategy uses our framework to provide a measure of effective estate taxation by using the fraction of estates that pay estate taxes to determine the effective exemption level, and the ratio of aggregate estate taxes to output to determine the tax rate above the exemption level. These parameters are pinned down given the underlying distribution of wealth generated by the model. Given that our model provides such a good fit of observed net worth holdings, we argue that this is a good way to measure effective estate taxation. We find that the current statutory estate taxation code implies a large effective exemption level (about 5 million dollars per household), and a fairly low effective marginal tax rate (16 percent). These numbers are consistent with people rationally using legal exemptions, special provisions, and favorable valuation methods to lower the estate tax burden, and with previous estimates (for an overview, see Gale, Hines, and Slemrod 2001). They are also consistent with previous arguments according to which the exemption level is high enough to imply that the impact of estate taxes on family farms and businesses is not a major concern for most estates (see, for example, Harl 1995; Gale and Slemrod 2001).

V. Results: Evaluating Our Model-Generated Data against the Actual Data

We now compare some important features of the actual data for the US economy with the corresponding features of our model-generated data. A good fit of the model to aspects of the data that were not matched by construction in our calibration procedure increases our faith in the policy projections generated by the model.

A. Wealth Distribution

Table 3 compares some data for the US economy (from the 1989 SCF; the data from other years are similar) and for the model-generated data, and Figures 2 and 3 compare the wealth distribution for the same US data and for the model, respectively, for the whole population and for the subpopulation of entrepreneurs.

Our framework with entrepreneurial choice fits the observed wealth distribution very well, both for the whole population, and for the subpopulation of the entrepreneurs. Cagetti and De Nardi (2006) discuss the role of entrepreneurship in shaping wealth concentration, the relationship between borrowing constraints and entrepreneurial entry, and entrepreneurial returns.

TABLE 3—BASELINE CALIBRATION

	Wealth Gini	Percentage of wealth held by top			
		1 percent	5 percent	20 percent	40 percent
US data	0.78	30	54	81	95
Model	0.82	30	60	85	95

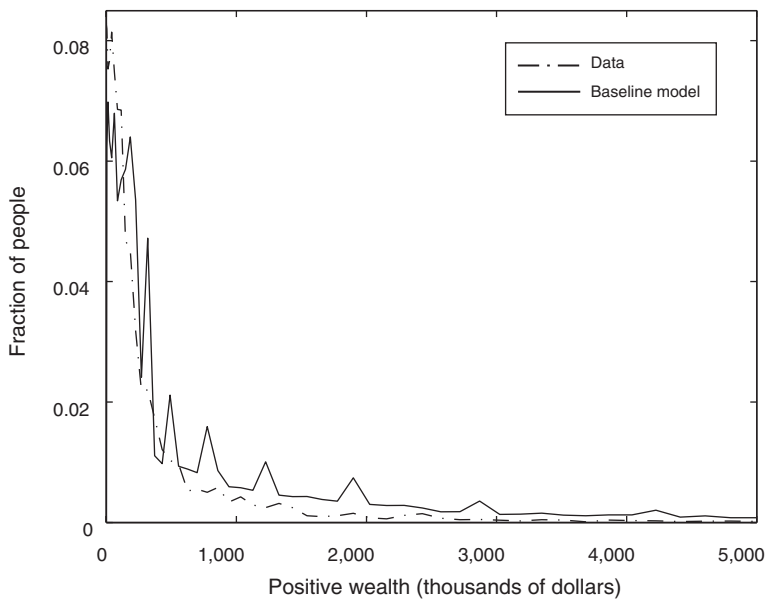


FIGURE 2. DISTRIBUTION OF WEALTH FOR THE WHOLE POPULATION

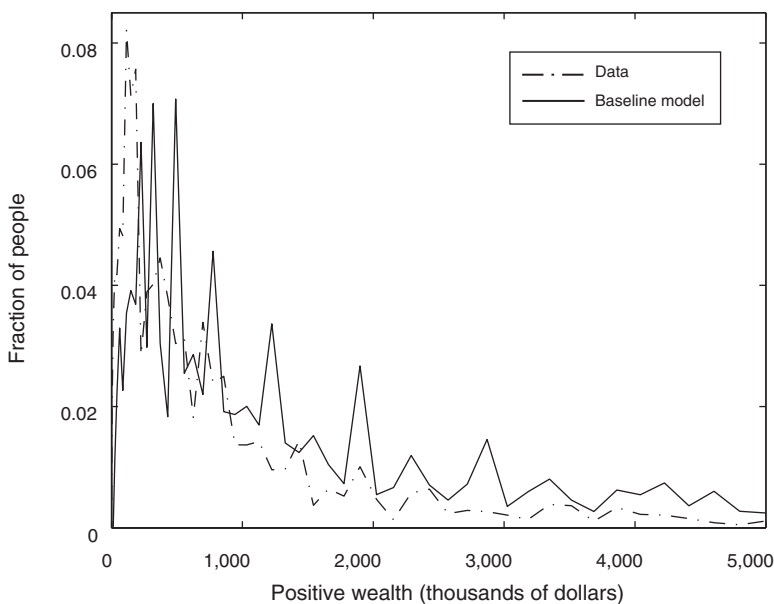


FIGURE 3. DISTRIBUTION OF ENTREPRENEURS' WEALTH

B. *Wealth Mobility*

To evaluate the policy implications of the model, it is also important to evaluate whether the dynamics of the model are consistent with those in the observed data. We evaluate here the relationship between wealth mobility and occupational choice.

Unfortunately the SCF, which is the dataset specifically designed to study the wealth and behavior of the wealthy (see Cagetti and De Nardi 2008) does not have much of a panel dimension. Hence, we use data from the wealth supplement of the PSID, which are available every five years. We report the transition dynamics for the 1989–1995 period (the results from the other years look similar).

Following Quadrini (1999, 2000), we separately compute net worth terciles for all of the sample. We then divide the sample as follows: workers who remain workers, workers who become entrepreneurs, entrepreneurs who remain entrepreneurs, and entrepreneurs who switch to being workers. For each of these subcategories we compute wealth mobility across the worth terciles.

Table 4 reports both the results and the number of observations corresponding to each cell. These numbers highlight that some of the transition matrices are based on a small number of observations, so their interpretation requires caution.

TABLE 4—WEALTH MOBILITY: DATA FROM THE PSID, 1989 TO 1994

PSID data					
Staying workers			Switching workers		
0.79	0.18	0.03	0.47	0.44	0.08
0.21	0.64	0.15	0.04	0.42	0.54
0.02	0.23	0.75	0.00	0.23	0.77
Observations for each cell					
661	148	29	17	16	3
163	507	115	1	11	14
16	135	440	0	3	10
Switching entrepreneurs			Staying entrepreneurs		
0.75	0.25	0.00	0.50	0.33	0.17
0.20	0.70	0.10	0.21	0.51	0.28
0.06	0.29	0.65	0.02	0.07	0.91
Observations for each cell					
6	2	0	6	4	2
2	7	1	9	22	12
2	9	20	3	10	138

This said, the transition matrices indicate more upward mobility in wealth for the entrepreneurs who stay entrepreneurs than for the workers who stay workers. Although the mobility matrices off the main diagonal (workers to entrepreneurs, and entrepreneurs to workers) are based on a very small sample size, they seem to broadly indicate that the workers who become entrepreneurs are more upwardly mobile than those who remain workers, and that the entrepreneurs who switch to being workers are more downwardly mobile than those who remain entrepreneurs.

We compute the analogous occupation and wealth mobility transition matrix generated by our model (also over a five-year period). The results are in Table 5. The transition matrices estimated using our model include all of the population, and therefore do not have the small-sample problem. This table shows that our model matches extremely well the wealth transitions of the workers to workers (the one for which the PSID has more observations), and that it also matches quite well the important patterns of the PSID data that we have discussed above, such as more upward mobility for the entrepreneurs, and for the workers who become entrepreneurs.

TABLE 5—WEALTH MOBILITY: MODEL, FIVE-YEAR TRANSITIONS

Staying workers			Switching workers		
0.76	0.23	0.01	0.16	0.60	0.24
0.22	0.58	0.20	0.01	0.28	0.71
0.00	0.21	0.79	0.00	0.01	0.99
Switching entrepreneurs			Staying entrepreneurs		
0.38	0.45	0.17	0.03	0.14	0.83
0.08	0.42	0.50	0.02	0.08	0.92
0.00	0.03	0.97	0.00	0.01	0.99

In a previous working paper version, we have also documented that our model matches well observed consumption inequality. See Cagetti and De Nardi (2007) for this discussion and comparisons of the model-generated consumption inequality and the one in the observed US data.

VI. Abolishing Estate Taxation

We now turn to the effects of abolishing estate taxes. Every experiment first compares steady states and then computes welfare along the complete transition path.

A. Abolishing Estate Taxation and Adjusting Government Purchases

Government purchases are wasteful in this framework. It is therefore not surprising that cutting a distortionary tax at the expense of government purchases raises total output and capital (Table 6, row 2). The interesting finding here is that the effects are substantial when compared to the small revenue coming from the estate tax. The elimination of the estate tax increases output by a factor of four times the revenue raised by the estate tax, and raises capital by at least a factor of eight. Interestingly, abolishing estate taxation changes long-run consumption and wealth inequality very little.

Abolishing estate taxation especially increases the return to saving for rich and old entrepreneurs, and benefits newborn entrepreneurs, who inherit larger estates and can run larger firms and make money more quickly as a result. More funds in the economy are thus invested in the more productive technology: the entrepreneurial one. This increase in investment is further amplified by the reduction in the interest rate, which represents the opportunity cost of funds for the entrepreneurs. This price change benefits all of the entrepreneurs.

TABLE 6—ABOLISHING THE ESTATE TAX AND ADJUSTING ANOTHER POLICY INSTRUMENT, COMPARING INITIAL AND FINAL STEADY STATES

K	Y	Interest rate	Percentage entrepreneurs	Percentage wealth held by top			
				1 percent	5 percent	10 percent	20 percent
Benchmark economy							
9.02	3.00	3.33	7.6	29.5	59.5	73.6	85.4
No estate tax, lower g/Y							
+2.4%	+1.3%	3.14	7.6	30.5	60.6	74.2	85.8
No estate tax, higher τ_c							
+2.7%	+1.4%	3.12	7.6	30.5	60.6	74.2	85.8
No estate tax, higher τ_s							
+0.8%	+0.1%	3.22	7.6	30.4	60.3	74.0	85.7

Despite the resulting increases in investment, capital, and output, the government has to cut government purchases as a fraction of output to reestablish fiscal balance. However, while the revenue from estate taxes in the initial steady state is 0.3 percent of output, the government has to cut spending by only 0.05 percent as a fraction of output (with respect to the initial steady state) because of the increase in output (and thus tax revenues) generated by the abolition of estate taxes.

Figure 4 plots the path of total capital in the economy, from the initial steady state to the final steady state of the economy. When the estate tax is eliminated but no other tax is changed, total capital increases for about 50 years. Aggregate output follows a very similar path.

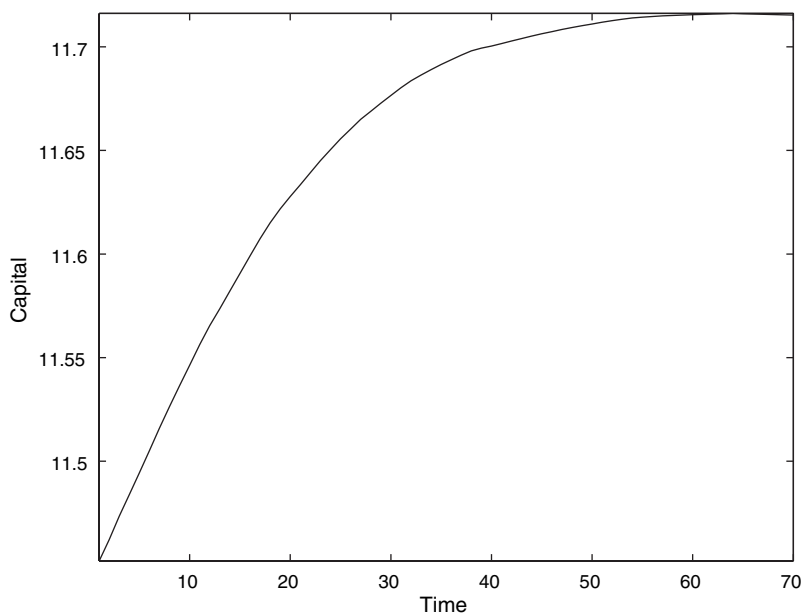


FIGURE 4. TOTAL CAPITAL OVER TIME AFTER ELMINATING ESTATE TAXES BUT CHANGING NO OTHER TAX

Figures 5 and 6 display the welfare gains and losses for this reform. The welfare costs and benefits are expressed in terms of the fraction of consumption needed to have someone indifferent between the new and the old tax system, taking the whole transition path into account. Positive numbers indicate gains from the tax reform. The horizontal axis represents one's net worth at the moment the reform is announced. The solid line is the cumulative distribution of either young or old people at the time of the announcement of the reform. The scale for this variable is on the right-hand side of the graph. The other two lines display the welfare gain or loss for a person with a middle ability level as a worker and, respectively, the lowest ability level as an entrepreneur (dashed line) and the highest ability level as an entrepreneur (dash-dot line). For all policy experiments, the welfare costs and benefits for workers of other ability levels are very similar to the ones reported.

Who gains and who loses from this reform?

Those who are very rich, and especially the old among them, benefit. The old people at the top of the wealth distribution experience a consumption gain of 7 percent, while the gain of their young counterparts is less than 1 percent. This is because the old are much closer to leaving a bequest, and thus value the estate tax break more. The young whose net worth is below \$500,000

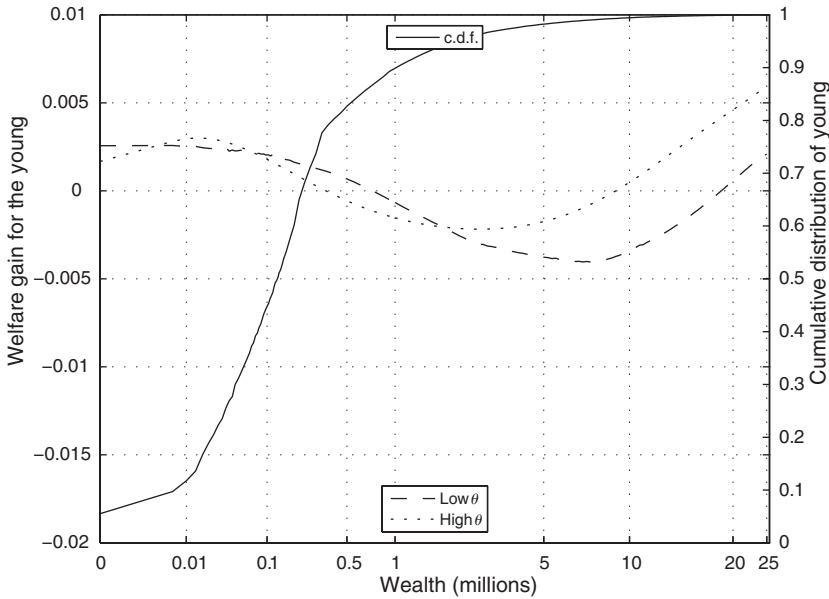


FIGURE 5. INITIAL YOUNG'S WELFARE GAINS OF ELIMINATING ESTATE TAXES AND CHANGING NO OTHER TAX

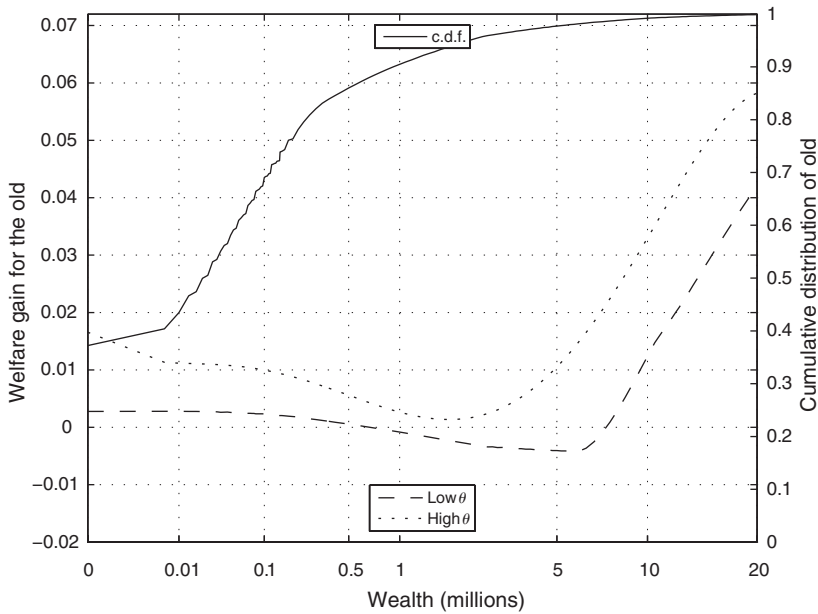


FIGURE 6. INITIAL OLD'S WELFARE GAINS OF ELIMINATING ESTATE TAXES AND CHANGING NO OTHER TAX

gain because of the increase in wages resulting from more aggregate capital accumulation. For them, wage income makes up for most of total income.

The losers are the young who are not poor enough and not rich enough: those whose net worth is above \$500,000, but below \$10 million or \$20 million (depending on their entrepreneurial

ability level). This is because capital income makes up for a large share of their total income, and the interest rate drops as a result of this reform.⁵ Similarly, the old with low entrepreneurial ability and assets above \$1 million, but below \$7 million, are hurt by the decrease in the interest rate. They also do not benefit from the estate tax break, given that they were below the effective exemption level, or close to it, before the reform took place.

The cumulative distribution of either the young or the old shows that almost 80 percent of the young and over 90 percent of the old benefit from this reform. The young make up for 80 percent of the population. The average welfare gain from this reform is on the order of 0.2 percent of yearly consumption.

B. Abolishing Estate Taxation while Adjusting the Consumption Tax

The consumption tax hike needed to balance the government budget constraint in the final steady state is small: this tax increases from 11 percent to 11.3 percent. Table 6 shows that the long-run effects of this reform are very similar to those in the reform in which no other taxes are raised. Capital and output increase by similar amounts and wealth inequality changes little. The fraction of entrepreneurs also remains unchanged. There is little change in consumption inequality as well.

Figure 7 plots the implied path of the tax rate on consumption over time. During the transition period the consumption tax peaks slightly above 11.5 percent before declining to its final steady-state level of 11.3 percent. Figure 8 highlights that capital overshoots its final steady-state level slightly during the transition, but that 50 years after the policy reform has taken place the

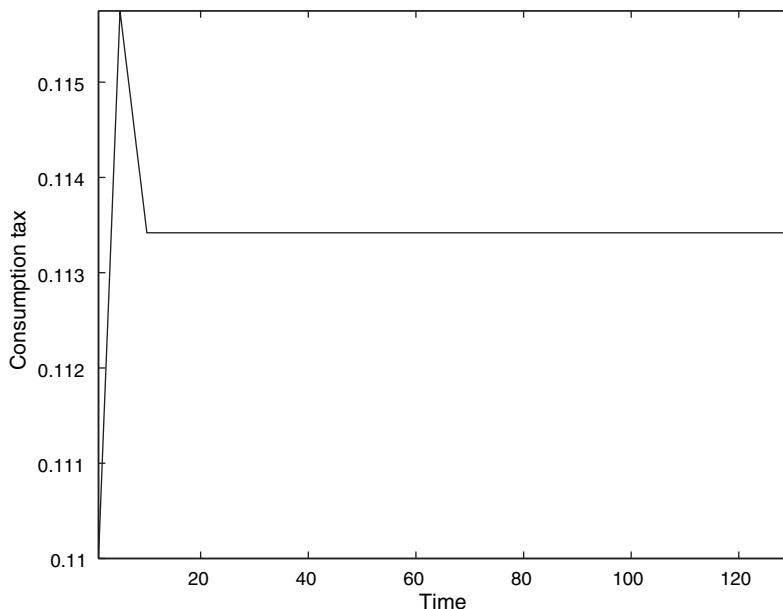


FIGURE 7. CONSUMPTION TAX OVER TIME WHEN ELIMINATING ESTATE TAXES AND INCREASING CONSUMPTION TAXES

⁵ Jeffrey R. Campbell and Zvi Hercowitz (2005) document a similar redistribution from interest rate changes following credit market reforms.

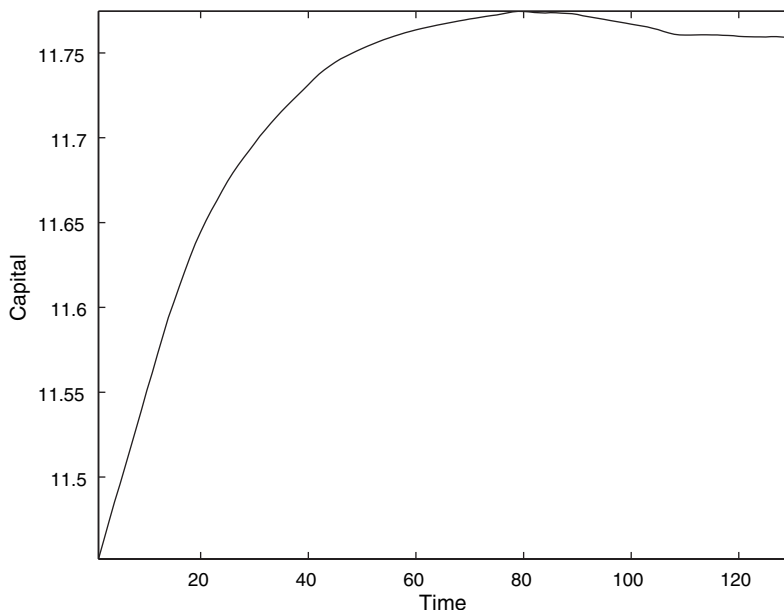


FIGURE 8. TOTAL CAPITAL OVER TIME WHEN ELIMINATING ESTATE TAXES AND INCREASING CONSUMPTION TAXES

majority of the transition in capital accumulation has occurred. Aggregate output behaves similarly to aggregate capital.

Figures 9 and 10 report the consumption compensations for this reform. Most people lose from switching to this tax system: they are not rich enough to benefit from the estate tax break, and they have to pay higher consumption taxes. A young person has to own at least \$15–20 million (depending on their entrepreneurial ability) to benefit from the tax reform, and even for the very richest young people the benefits are small. Many of the elderly are also hurt by the reform, given that they must hold \$4–10 million (depending on the ability level) to benefit from the tax reform. The costs, for those incurring them, are under 1 percent of yearly consumption. The benefits for the very rich are large, of the order of 7 percent of yearly consumption. Since most people incur small losses, the average welfare cost from this reform is on the order of 0.3 percent of consumption.

C. Abolishing Estate Taxation while Adjusting the Proportional Income Tax

To balance the government budget constraint, the proportional part of the income tax increases from 3.6 percent to 4.0 percent. This change not only affects all of the households in the economy, but also decreases the return (net of taxes) from investing in capital for the entrepreneurs. The entrepreneurs hit more harshly by this tax increase are most of the young ones (for which the expected time of death is still far in the future, and for whom the benefits from the elimination of the estate tax are small) and the old ones who are not rich enough to benefit from the abolition of the estate tax. As a result, there is only a very small increase in output with respect to the initial steady state, and the aggregate gains are much smaller compared to the ones in the previous two reforms.

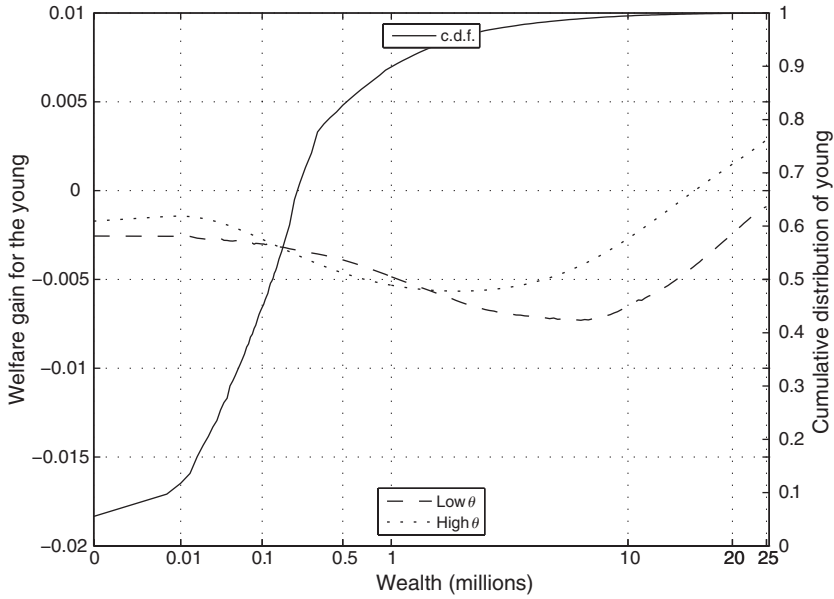


FIGURE 9. WELFARE GAINS FOR THE INITIAL YOUNG WHEN ELIMINATING ESTATE TAXES AND INCREASING CONSUMPTION TAXES

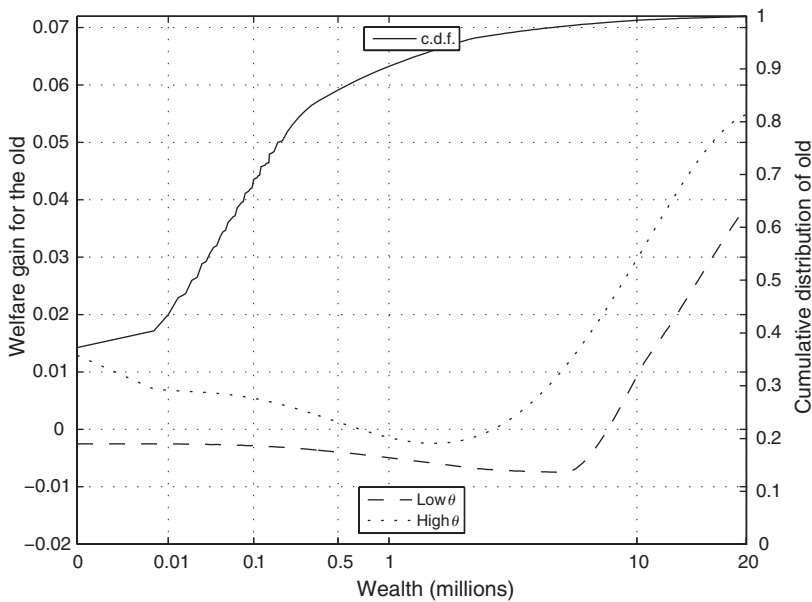


FIGURE 10. WELFARE GAINS FOR THE INITIAL OLD WHEN ELIMINATING ESTATE TAXES AND INCREASING CONSUMPTION TAXES

The long-run effects of this policy on consumption and wealth inequality are very modest, as in all of the other policies that we have considered.

The consumption compensations required by this reform are similar to the ones that we reported when the consumption tax is raised. As in that policy, increasing the income tax to make up for lost revenues from the estate tax implies small welfare losses for most of the population.

The average welfare cost for this reform is on the same order of magnitude as when the consumption tax is raised. As in the reform with an increase in the consumption tax, this reform has a bigger effect on the welfare of the old and redistributes from most people to a small fraction of rich people.

As one could have expected, this is the tax reform that casts estate taxation reform under the least favorable light among the experiments we consider. It is, however, the most plausible adjustment to expect.

Castañeda, Díaz-Giménez, and Ríos Rull (2003) analyze the effects of a similar reform in a model with no entrepreneurial choice, in which the key force driving wealth inequality is that the rich are subject to very large idiosyncratic earnings shocks (which are calibrated to match inequality in wealth holdings). As in our model, they find that the abolition of the estate tax generates only a small increase in wealth inequality. Compared to us, they obtain a long-run aggregate increase of 0.4 percent for output, which is four times larger than what we obtain, and a somewhat larger effect on total capital accumulation (0.87 percent compared to 0.78 percent). The additional channel at work in our framework is the disincentive effect on entrepreneurial investment due to the higher income tax. Since in our framework the entrepreneurial technology is much more productive than the nonentrepreneurial one, smaller investment by the entrepreneurs results in much lower aggregate income than smaller investment by the workers.

Laitner (2001) also studies the effects of a similar reform. He adopts a more stylized economy in which some households are altruistic while others do not care about their descendants. His main message is that, in his framework, abolishing the estate tax generates a significant increase in the share of total net worth held by the richest 1 percent, while the effects on the aggregates are relatively small for most parameterizations, but can be positive or negative depending on the fraction of altruistic households.

VII. Conclusions

We consider three different policy reforms that abolish estate taxation. Surprisingly, even the reform that was designed to be most favorable to the elimination of estate taxation (one in which no other tax is raised and wasteful government spending is cut as a fraction of output) generates welfare costs for some of the population. In this experiment, these costs could be traded off with the gains for the rest of the population and increased total output and capital. It should be noted, however, that this experiment is not very realistic: it is unlikely that government spending is completely wasteful, and it is likely politically difficult to cut it as a fraction of total output.

More realistic experiments increase either the consumption tax or the income tax to reestablish fiscal balance. These taxes are obviously distorting and cast the repeal of estate taxation in a less favorable light. This is particularly true in the income tax case, which hits capital income as well, and thus has a significantly negative effect on entrepreneurial saving and investment. As a result of a necessary tax hike in either consumption or total income, both experiments generate welfare costs for much of the population. While increasing the consumption tax at least preserves almost all of the aggregate increases in aggregate output and capital, increasing the income tax wipes out much of these aggregate gains.

We find that none of these reforms would increase wealth or consumption inequality significantly.

It should also be noted that there might be features of reality that could provide additional reasons to abolish or reduce estate taxation. For example, our model does not consider tax avoidance costs. Significant amounts of resources might be spent to decrease the tax burden, through the use of lawyers and accountants. The cost of tax avoidance might generate a deadweight loss that should be considered in the overall evaluation of any change in the estate tax. (See Aaron

and Munnell (1992) and Schmalbeck (2001) for a discussion of the avoidance costs.) This is an important and, to a large extent, unexplored issue that we leave for future research.

APPENDIX A: INCOME AND ENTREPRENEURIAL ABILITY

The income process is an AR(1), and we approximate it with a five-point discrete Markov chain as in George Tauchen and Robert Hussey (1991). The grid points y for the income process (normalized to 1) that we use are

$$\left[\begin{array}{ccccc} 0.2468 & 0.4473 & 0.7654 & 1.3097 & 2.3742 \end{array} \right]$$

and the transition matrix \mathbf{P}_y is

$$\left[\begin{array}{ccccc} 0.7376 & 0.2473 & 0.0150 & 0.0002 & 0.0000 \\ 0.1947 & 0.5555 & 0.2328 & 0.0169 & 0.0001 \\ 0.0113 & 0.2221 & 0.5333 & 0.2221 & 0.0113 \\ 0.0001 & 0.0169 & 0.2328 & 0.5555 & 0.1947 \\ 0.0000 & 0.0002 & 0.0150 & 0.2473 & 0.7376 \end{array} \right].$$

The transition matrix \mathbf{P}_θ is given by

$$\left[\begin{array}{cc} 0.97 & 0.03 \\ 0.2 & 0.8 \end{array} \right].$$

APPENDIX B: FEDERAL TAX SCHEDULES

We estimate equation (2) using nonlinear least squares. The data are for 1989 and are taken from the PSID. This dataset asks questions that allow us to classify households as entrepreneurs and nonentrepreneurs, and, until 1989, it also provides computed data on total taxes paid by the respondents.

Our measure of total monetary income includes all forms of labor income, capital income, transfers, and income from entrepreneurial activities. Total federal taxes paid is the variable computed in the PSID (in our case, V18862 in the 1990 file). The dependent variable in the regression, average tax rate, is the ratio of federal taxes paid to total monetary income.

To obtain a representative sample, we exclude the poverty and Latino samples. To obtain the appropriate tax rate for our model (in which the lowest income level is positive), we also drop all observations with income smaller than \$1,000 or negative taxes paid. To make the data on entrepreneurs consistent with those that we use from the SCF dataset and the model we employ, we define as entrepreneurs those who declare themselves to be self-employed and own or have a financial interest in a business activity. The resulting sample of entrepreneurs has very similar characteristics to those from the SCF. Our estimates would be very similar if we were to assume a somewhat smaller or larger cutoff for the amount of business income received during the period.

TABLE 7—ESTIMATES FOR THE FEDERAL AVERAGE TAX RATES

Parameter	Point estimate
Whole sample	
b	0.30
p	0.82
s	0.24
Workers only	
b_w	0.32
p_w	0.76
s_w	0.22
Entrepreneurs only	
b_e	0.26
p_e	1.40
s_e	0.42

We perform the estimation on three samples: the whole population of households, including workers and entrepreneurs, the subpopulation of workers only, and the subpopulation of entrepreneurs only. The estimated values for the three groups are shown in Table 7 and plotted in Figure 1.

APPENDIX C: SOME SENSITIVITY ANALYSIS

This section displays sensitivity analysis for two parameters governing the entrepreneurial production function and for the transmission of ability from entrepreneurial parents to their offspring. The first two sensitivity checks are meant to question whether a different calibration of the entrepreneurial production function could have matched the moments that we want to hit. The last check, instead, is meant to reassure us that our results are reasonably robust to our assumed degree of intergenerational transmission of ability.

All of these checks fix prices and taxes at their equilibrium value in the initial steady state, and change one or two parameters of interest in each column.

The first column of Table 8 first reports the nine moments that our baseline model matches by construction and then reports two other important moments generated by our model. The second column reports the values of each moment for our baseline calibration.

The third column of the table lowers the degree of returns to scale to the entrepreneurial production function. The fourth column of the table also lowers the parameter γ .

The first two sensitivity checks show that these two parameters mainly affect the fraction of entrepreneurs who hire on the labor market, and the ratio of the median net of entrepreneurs to the median net worth of workers. These checks show that two such moments are quite sensitive to the parameters of the entrepreneurial production function, allowing us to pin them down fairly precisely.

The interaction between these two parameters is not trivial. A high ν is necessary to generate a large enough ratio of the median net worth of entrepreneurs to the one of the workers. This happens because the parameter ν affects optimal firm size in terms of invested capital and, in presence of borrowing constraints, a larger optimal firm size increases median and average wealth holding by entrepreneurs (who use their own wealth to invest in their business and as collateral for their business).

When the entrepreneur can use both capital and labor, for given ν , γ affects both the degree of decreasing returns to capital (hence optimal firm size) and the optimal mix of capital and hired labor.

The last column of the table checks the sensitivity of our results to the degree of intergenerational transmission of ability between parent entrepreneurs and their offspring. In our baseline calibration, we did not pick this parameter to match any moment of the data, but we simply assumed it to be the same as the persistence of entrepreneurial ability over one's life.

To check the effects of this assumption, the last column of the table assumes the opposite, extreme, view that there is no intergenerational transmission of entrepreneurial ability. This column shows that our calibration does not crucially depend on this assumption.

The last two rows of the table show two important moments that we do not match by construction: the fraction of total net worth held by entrepreneurs, and the fraction of net worth held by the richest 1 percent of people in the population. These two lines show that all of these sensitivity checks lower the amount of wealth held by entrepreneurs in a counterfactual way (if anything, the baseline calibration underestimates this moment), and they also lower wealth concentration. The implied reduction of wealth concentration explains why in all of these checks we obtain reduced revenues from estate taxes and the fraction of estates that pay taxes. This observation confirms the importance of a good match of inequality in wealth holdings to estimate effective estate taxation and to study the effects of reforming this tax.

TABLE 8—SENSITIVITY ANALYSIS WITH RESPECT TO ν AND γ

Moment	Baseline	Sensitivity 1	Sensitivity 2	No ability inheritance
	$\nu = 0.88$ $\gamma = 0.84$	$\nu = 0.86$ $\gamma = 0.84$	$\nu = 0.86$ $\gamma = 0.82$	
Capital/output	3.0	3.1	3.2	3.0
Percentage entrepreneurs	7.6	7.5	7.4	7.5
Entrepreneurs to workers	22.4%	22.5%	22.7%	22.8%
Workers to entrepreneurs	2.33%	2.32%	2.29%	2.33%
Net worth entrepreneurs/workers	6.5	6.4	5.7	6.8
At zero net worth	11.8%	12.5%	13.0%	11.9%
Entrepreneurs hiring workers	53%	45%	43%	48%
Estate tax revenue	0.3%	0.11%	0.05%	0.22%
Estates paying taxes	2.2%	0.9%	0.5%	1.6%
Net worth held by entrepreneurs	27.4%	26.8%	26.0%	26.4%
Wealth held by top 1 percent	29.5%	23.1%	22.1%	27.6%

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