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Intergenerational altruism and house prices: evidence from bequest tax reforms in Italy*

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Abstract

We identify the degree of intergenerational altruism in an OLG framework *à la* Barro exploiting the quasi-experimental variation generated by reforms of bequest taxation (estate or inheritance tax, in the U.S.) and taxes on *inter vivos* real estate donations (gift tax, in the U.S.) that were enacted in Italy between 2000 and 2001. Employing a unique data set containing information on the housing stock and house prices in 13 large Italian cities between 1993 and 2004, we identify the structural parameter of interest via the effect of changes in the tax rate on house prices. We find that the intergenerational altruism parameter is about 20%. Given the possible anticipation of the reform this estimate should be interpreted as a lower bound.

Keywords: altruism, bequests, inheritance tax, gift tax, house prices
JEL codes: E60, E65, H24

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1 Introduction

The degree of intergenerational altruism is a key parameter in dynamic models with overlapping generations. It is usually embedded into "Barro-type" preferences of the kind $U_j + \rho U_{j+1}$. However, only a few estimates of such parameter, ρ, have been produced in the literature. Furthermore, these estimates are typically based on incidental indirect inference in calibration exercises. For instance, Nishiyama (2002) matches the actual US wealth distribution with the one produced by a model *à la* Barro with Cobb-Douglas constant relative risk aversion preferences; he infers $\rho = 0.5$, approximately, when the coefficient of relative risk aversion is set equal to 2. Han and Mulligan (2001) observe in a similar model that the steady state implies $\rho = 0.3$, a substantially smaller estimate, when the annual rate of return on financial investments is 5%. Barczyk (2012) matches inter-vivos transfers data from the Survey of Consumer Finance in a continuous time economy with two generations, and he estimates $\rho = 0.1$ for the young household and $\rho = 0.3$ for the old household.

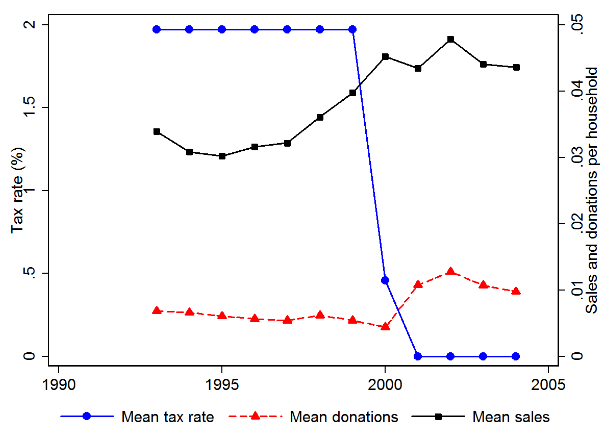
In this paper we provide a direct, structural estimate of ρ exploiting the quasi-experimental variation in the tax treatment of bequests and *inter vivos* real estate donations that occurred in Italy between 2000 and 2001.[1] The variation we exploit is quasi-experimental (thus facilitating identification) because it is generated by tax reforms motivated by the 2001 electoral contest in Italy, and unrelated to asset prices. Until year 2000 the tax rate on bequests and donations in Italy had a progressive structure (see Table 2 in Section 3), and was particularly unpopular. On October 13, 1999 the Italian Parliament rejected a bill proposed by the center-right opposition leader Silvio Berlusconi which, if passed, would have repealed the tax. With a general election looming ahead in the Spring of 2001, the proposal of the opposition leader was clearly part of an early electoral campaign. As a consequence, the incumbent government was forced to act and reform the tax: two weeks later, then finance minister Vincenzo Visco announced at a gathering of entrepreneurs in Milan that a reform of the inheritance and gift tax would be implemented "at the soonest, and in such a way that the tax rate will be single-digit". The government pushed through the Italian Parliament a reform as soon as the following month (December 1999), during the approval of the 2000 budget. This reform introduced a flat rate of 4% and increased the exemption threshold, and became effective at the end of 2000. The complete abolition of the inheritance and gift tax occupied a prominent position in the political platform of the conservative coalition for the 2001 general election. In June 2001, just one month after winning the elections, the new government led by Silvio Berlusconi repealed the tax. Later on, in 2006, bequest taxation was reintroduced by the new center-left government led by Romano Prodi, at the same 2001 flat rate but with a very

[1] In virtually all fiscal systems, these taxes are effectively unified to prevent the use of donations as a means to avoid the inheritance tax. Therefore, we think of them as a single tax and refer, henceforth, to the "bequest tax".

high exemption threshold relative to the past, making the tax little more than symbolic—because of such a high threshold, the average tax rate is still virtually zero.[2]

In order to exploit these events to estimate ρ, we built a unique panel data set from a variety of sources and containing information on house prices, the housing stock, and non-housing consumption for the 13 largest cities in Italy over the period 1993-2004. We structure our empirical investigation around a stylized OLG model in which individuals may either sell their assets or donate them to their offspring. The model formalizes a mechanism through which the bequest tax affects market and non-market real estate transactions and so the dynamics of house prices. The use of a model with both house sales and house donations is motivated by the data reported in Figure 1. As the figure shows, when the bequest tax rate was sharply reduced, the number of donations per household increased almost threefold, to unprecedented levels, while sales slowed down.

Figure 1: Bequest tax rate, donations, and sales in Italy, 1993–2004.



Notes: Average bequest tax rate in Italy (obtained by integrating the tax rates across the tax brackets with respect to the empirical distribution of house prices reported in the Bank of Italy's Survey of Household Income and Wealth) between 1993 and 2004, and donations and sales per household in the 13 largest Italian cities. See Section 3 for more details.

The key implication of the model for the purpose of identifying ρ is that, *ceteris paribus*, house prices change when the bequest tax rate is altered if and only if ρ is non-zero. We calibrate the model to show that it reproduces house price dynamics in Italian cities over this period relatively

[2] The distortionary effects of bequest taxation in the US have been investigated, among the other, by Holtz-Eakin and Marples (2001), Kopczuk and Slemrod (2001), and Joulfaian (2006). The optimal structure of bequest taxation when $\rho > 0$, a question we do not address in this paper, was studied by Farhi and Werning (2010). A baseline result is that in a model with a fictitious dynastic agent like the one we employ here, a zero bequest tax rate is optimal. Kopczuk (2009) provides an overview of theory and evidence.

well, and then we use it to identify ρ in the structural asset price equation. We find that ρ is about 0.20. However, as we illustrate later, since the reform may have been anticipated by about a year, this estimate should be interpreted as a lower bound.

Of course our analysis applies to any asset, not just real estate. We focus on the housing market for two reasons. First, accurate administrative data on real estate transactions is easier to find than data on transactions involving more liquid assets. For instance, it is easy to track intergenerational donations of houses; less so for the analogous transactions involving money. Second, in Italy real estate are a major medium for the intergenerational transfer of wealth. Cannari and D'Alessio (2008) estimate that in 2004 the share of household wealth that Italians had acquired via intergenerational transfers of real estate was 56% of total net wealth.

The remainder of the paper is organized as follows. Section 2 presents the model and derives the key asset pricing equation to be estimated. Section 3 illustrates the data set. In order to "test" the model for the purposes of structural estimation, in Section 4 we calibrate the house price equation and we show that our simple framework fits the data remarkably well. We then estimate in Section 5 the parameters of the house price equation in our data set, which allows us to recover ρ. Section 6 concludes.

2 The model

2.1 Setup

Consider a production economy with overlapping generations living for two periods. Generation j is a set of individuals (of unit measure) endowed with one unit of labor, inelastically supplied. Generation j is born at the beginning of period j and leaves the economy at the end of period $j+1$. Every generation consumes a non-durable consumption good in each period: c_{1j} units when young and c_{2j} units when old. In addition to these goods, each generation chooses, when young, how much housing stock, H_j, to hold during the entire lifetime. The preferences of generation j are represented by:

$$\Upsilon_j = U_j + \rho U_{j+1}, \tag{1}$$

where

$$U_j = u(c_{1j}) + u(c_{2j}) + v(H_j), \tag{2}$$

and where $u(\cdot)$ and $v(\cdot)$ denote the utility derived from consumption of non-durable goods and housing, respectively, and ρ is the degree of intergenerational altruism.[3] We assume u', $v' >$

[3] Additivity of Υ_j and U_j allows us to obtain a closed-form solution, but this assumption is not driving our results: any preferences structure *à la* Barro (1974), where a generation's utility is an increasing and monotonic function of the entire utility of the next generation would yield the same conclusions.

0, u'', $v'' < 0$, and $\rho \in [0,1]$. Although we could treat housing like any other asset, we believe there are good reasons for having it in the utility function: this special asset is both a way of transferring wealth across time (and so across generations), and the source of a valuable good—housing services.

When young, individuals split their wealth (labor income plus after-tax bequests and donations received in the form of housing and non-housing transfers) between current consumption, non-housing assets, purchase of existing houses and investment in new houses. When old, individuals split their wealth (savings and housing wealth) between consumption, and bequests and donations of either housing or the consumption good (the numeraire) to the following generation. Notice that bequests and donations are indistinguishable in this model, because both occur at the end of period $j+1$ (i.e., when generation j is old). The period budget constraints are:

$$
\begin{aligned}
c_{1j} &= w_j - s_j + p_j[(1-\tau)H_{j-1}^{don} - H_j^{used}] + (1-\tau)D_{j-1} - i_j^H, &(3)\\
c_{2j} &= s_j R_{j+1} + p_{j+1} H_j^{sale} - D_j, &(4)
\end{aligned}
$$

where w_j is labor income, s_j savings, R_{j+1} the interest factor (one plus the interest rate), p_j the price of a unit of the housing stock, H_{j-1}^{don} the amount of housing that generation j receives from generation $j-1$, H_j^{used} the amount of existing ("used") housing units held by generation j in period j, H_j^{sale} the amount of existing housing units sold by generation j when old in period $j+1$, i_j^H generation j's investment in new housing units, and D_j the amount of the consumption good donated by generation j to generation $j+1$ at the end of period $j+1$—the liquid asset. The government levies a bequest tax on intergenerational transfers: bequests or donations of either housing or the numeraire from the old to the young are taxed at rate $\tau \in [0,1]$. The tax revenue ends up outside the model.[4]

Notice how equation (3) is constructed: H_j^{used} is the number of existing ("used") housing units that generation j acquires in period j via *both* market transactions and non-market intergenerational transfers. Therefore, generation j must satisfy the following, additional "accounting" constraints on housing:

$$
\begin{aligned}
H_j^{used} &\leq H_{j-1}^{sale} + H_{j-1}^{don} &(5)\\
H_j(1-\delta) &\geq H_j^{sale} + H_j^{don}, &(6)
\end{aligned}
$$

[4]This an innocuous assumption as the revenue from bequest taxes is typically a negligible portion of the total tax revenue.

where δ is the depreciation rate of the housing stock held by generation j. Inequality (5) means that consumption of housing by generation j cannot exceed the sum of what is acquired via market and non-market transactions. The meaning of inequality (6) is that generation j decides, when old in period $j+1$, how to allocate its depreciated stock of housing, $H_j(1-\delta)$, between donation to generation $j+1$ and resale on the market.

There are two production functions; one for houses, which uses non-durable goods as the only input and which exhibits decreasing returns,

$$\begin{aligned} H_j^{new} &= f(i_j^H), \\ f' > 0,\ f'' &< 0, \end{aligned} \tag{7}$$

where H_j^{new} is the supply of newly produced housing units as a function of generation j investment in housing, i_j^H; and one for the non-durable good itself, which uses non-housing capital and labor as inputs, and which exhibits the usual properties of aggregate production functions,

$$\begin{aligned} y_j &= g(k_j), \\ g' > 0,\ g'' &< 0, \end{aligned} \tag{8}$$

where y_j and k_j are output and non-housing capital per worker, respectively, in period j. We assume that the new housing units produced by one generation become part of the housing stock of that same generation. Non-housing capital (capital, for brevity) is created at no cost from the period j consumption good, and is employed to produce consumption goods at $j+1$. We assume that capital fully depreciates in one period, so the law of motion of the per worker capital stock is

$$k_{j+1} = i_j, \tag{9}$$

where i_j is per worker investment in non-housing capital in period j. As usual, output is split between households and the government. The bequest tax is the only source of government revenue in this economy.

We impose the additional constraints $H_j^{don} \geq 0$ and $D_j \geq 0$ (i.e., bequests cannot be negative) and focus, in what follows, on the interior optimum for all of the choice variables.[5] We also assume perfect forecast about future house prices.

[5]This assumption is justified by the empirical goal of the paper: our representative agent is always at an interior in our data set.

2.2 Equilibrium

Definition 1 (Competitive equilibrium)**.** *The competitive equilibrium is a vector* $(c_{1j}, c_{2j}, i_j, i_j^H, H_j, H_j^{sale}, H_j^{don}, H_j^{used}, D_j)$ *such that, given the price vector* (p_j, R_{j+1}, w_j)*:*

(i) Agents optimize:

$$(c_{1j}, c_{2j}, i_j, i_j^H, H_j, H_j^{sale}, H_j^{don}, H_j^{used}, D_j) \in \arg\max \Upsilon_j s.t. \ (3), (4), (5), (6), \ \forall j. \tag{10}$$

(ii) The goods market clears:

$$c_{1j} + c_{2j-1} + i_j^H + i_j + \tau(p_j H_{j-1}^{don} + D_{j-1}) = g(k_j). \tag{11}$$

(iii) The housing market clears:

$$H_j = H_j^{used} + H_j^{new}. \tag{12}$$

(iv) The capital market clears:

$$k_{j+1} = s_j. \tag{13}$$

Notice that in equilibrium both (5) and (6) are binding—no valuable housing stock goes wasted, except because of depreciation. Combining these two and (12) we obtain the dynamic equation that describes the evolution of the housing stock:

$$H_j = H_{j-1}(1-\delta) + f\left(i_j^H\right). \tag{14}$$

It is easy to show that this equilibrium is self-consistent. Denoting the tax revenue by $T_j \equiv \tau(p_j H_{j-1}^{don} + D_{j-1})$ and using (11), we have:

$$c_{1j} + i_j^H + T_j + i_j = g(k_j) - c_{2j-1}. \tag{15}$$

Using equation (4), this yields:

$$s_{j-1} R_j = g(k_j) - w_j = c_{2j-1} + D_{j-1} - p_j H_{j-1}^{sale}, \tag{16}$$

so that equation (15) becomes:

$$i_j = w_j + D_{j-1} - p_j H_{j-1}^{sale} - c_{1j} - i_j^H - T_j. \tag{17}$$

Substituting for (9), we obtain:

$$k_{j+1} = w_j - c_{1j} + D_{j-1} - p_j H_{j-1}^{sale} - i_j^H - \tau(p_j H_{j-1}^{don} + D_{j-1}), \tag{18}$$

and so, by (3) and (5), $k_{j+1} = s_j$, which completes the description of the model.

2.3 House prices

Solving the maximization problem for generation j and substituting the first-order conditions for H_j^{used} and H_j^{sale} into the one for H_j we obtain:

$$v'(H_j) = p_j u'(c_{1j}) - p_{j+1} u'(c_{2j})(1-\delta). \tag{19}$$

This equation has a very simple interpretation: it states that generation j equalizes the marginal benefit of consuming an additional unit of housing (the left-hand side of the equation) to its marginal cost (the right-hand side), where the latter is given by the difference between the utility-weighted cost of purchasing housing, $p_j u'(c_{1j})$, and the utility-weighted benefit of reselling it when old, net of depreciation, $p_{j+1} u'(c_{2j})(1-\delta)$. A similar equation can be derived with respect to the optimal amount of donations, by substituting the first-order conditions for H_j^{don} into the one for H_j:

$$v'(H_j) = p_j u'(c_{1j}) - p_{j+1} \rho (1-\tau)(1-\delta) u'(c_{1j+1}). \tag{20}$$

Equation (20) can be interpreted as the equality between the marginal benefit of consuming an additional unit of housing (LHS) and its marginal cost (RHS), measured by the difference between the utility-weighted cost of purchasing housing (first term on the RHS) and the utility-weighted benefit of donating it to generation $j+1$ net of taxation and depreciation (second term on the RHS).

Taking equations (19) and (20) together, it is easy to see that at the competitive equilibrium the old generation will choose levels of consumption and donations so that its marginal utility equates the marginal utility of consumption of the following generation, weighted by the degree of intergenerational altruism, and after netting out the effect of bequest taxation:

$$u'(c_{2j}) = \rho(1-\tau) u'(c_{1j+1}). \tag{21}$$

Combining equation (21) with the first-order condition for optimal savings s_j,

$$u'(c_{1j}) = R_{j+1} u'(c_{2j}), \tag{22}$$

we obtain:

$$\frac{u'(c_{1j})}{u'(c_{1j+1})} = \rho(1-\tau)R_{j+1}. \tag{23}$$

Equation (23) summarizes the dynamic behavior of the economy. Since $R_{j+1} \geqslant 1$ and $\rho(1-\tau) \leqslant 1$, the right-hand side could be greater, equal or smaller than 1. If $\rho(1-\tau)R_{j+1} > 1$ then consumption of the young increases from one generation to the next. If instead $\rho(1-\tau)R_{j+1} < 1$ then consumption when young decreases from one generation to the next. We will conduct our structural empirical exercise under the steady state assumption.

Definition 2 (Steady state)**.** *The steady state of the economy is characterized by constant allocations across generations. That is, for all j,*

$$\begin{aligned} c_{1j} &= c_{1j+1} = c_1, && (24)\\ c_{2j} &= c_{2j+1} = c_2, && (25)\\ H_j &= H. && (26) \end{aligned}$$

Since R_{j+1} is an endogenous price, in the steady state it must adjust so that $u'(c_{1j}) = u'(c_{1j+1})$. By replacing this condition into (23), we obtain:

$$R = \frac{1}{\rho(1-\tau)}. \tag{27}$$

Combining this equation with equations (19) and (22), we obtain the key steady-state asset price equation for the housing stock:

$$p = \frac{v'(H)}{u'(c_1)[1-\rho(1-\delta)(1-\tau)]}, \tag{28}$$

This asset price equation can be used in combination with the first-order conditions for i_j^H and H_j^{used} to determine the steady state level of housing investment, i^H. The latter solves

$$p = \frac{1}{f'(i^H)}. \tag{29}$$

The steady-state effect of changes in the bequest tax rate τ is characterized by the following proposition and its corollary.

Proposition 1 (Effect of bequest taxes on steady-state house prices)**.** *If $\rho > 0$ and if a lower interest rate induces higher consumption in the first period of the life cycle, then the steady state house price, p, increases as the tax rate on bequests, τ, decreases.*

Proof. Rewriting (28) as

$$\frac{pu'(c_1)}{v'(H)} = \frac{1}{[1-\rho(1-\tau)(1-\delta)]}, \tag{30}$$

we see that when τ decreases, $pu'(c_1)/v'(H)$ must increase for this equation to be satisfied. By equation (27), a decrease in τ decreases R. Suppose a lower R increases c_1 (and so decreases $u'(c_1)$). Because $u'(c_1)$ decreases, the $p/v'(H)$ ratio must increase. Suppose p does not change. Then $v'(H)$ decreases, which means that H increases, because $v(\cdot)$ is concave. But by (14) this is possible only if i^H also increases. Then $f'(i^H)$ must decrease and, by (29), p increases, contradicting the assumption that p does not change. Now suppose that p decreases. Then $v'(H)$ must decrease even faster, which means that H increases. But this yields a contradiction too, because by (29) p must then increase. Therefore, p must increase. □

Corollary 1 (Effect of bequest taxes on steady-state housing investment and stock)**.** *Under the same conditions of Proposition 1, as the tax rate on bequests, τ, decreases, residential investment and the housing stock increase.*

Proof. Follows directly from equation (29). □

Proposition 1 has a straightforward economic interpretation. For the old, the housing stock can be employed in two ways: it can either be sold on the market or it can be transferred directly to the next generation, net of the *ad valorem* transfer tax. When the tax rate is reduced, there are two kind of effects. First, standard income and substitution effects. These work in the same direction, bringing about an increase in donations and house prices. Second, a general equilibrium effect via the interest rate. A lower bequest tax rate requires, in equilibrium, a lower interest rate because one must be indifferent, after factoring in ρ, between donating assets and saving (a "no arbitrage" requirement, see equation 27). However, since in the first period an individual is a net saver, the effect of a higher interest rate on period 1 consumption—and so on donations—is ambiguous. If, in response to the general equilibrium effect (lower R), period 1 consumption increases, then house prices unambiguously increase.[6] Notice that Proposition 1 applies to any financial asset the old can use for intergenerational transfers, as condition (21) governs the optimal trade-off between selling and donating any kind of asset. We focus here on house prices for the reasons discussed in the Introduction.

[6] Notice that, a fortiori, this result would still hold if we had assumed a small open economy where the relevant interest rate is the (exogenous) world rate of return on savings. In this case, too, an increase in house prices is needed to restore the equality between the return on housing and the fixed return on capital holdings.

3 Data set

We collected data from a variety of sources, which we use to construct a city-level panel data set for the period 1993-2004. City-level real estate prices, market transactions, and residential stocks come from the NOMISMA data base, a proprietary archive. This data base contains average prices of new and used residential units per square meter. We focus on the price of a used unit of average size (this is the notion of residential unit that is consistent with the model), where average size is taken from the 2001 Italian Census. The housing stock is missing for years prior to 2000, and missing values are predicted using the coefficients from a linear projection of the housing stock on city population, city dummies, and a linear time trend for the period 2000-2012. Data on donations were provided by the Italian Ministry of the Economy. We also use the Bank of Italy's Survey of Household Income and Wealth (SHIW) to estimate non-housing consumption. Specifically, we subtract paid rents from total family consumption.[7] All nominal quantities (house prices and non-housing consumption) are deflated using the CPI, and are expressed in constant 1993 euros. Table 1 contains key summary statistics from our sample, and Table 2 reports the changing structure of the bequest tax in Italy during the period we focus on. These rates refer to inheritances by and donations to one's spouse and direct relatives, which cover virtually all cases. As the table shows, this tax is characterized by a progressive structure, with the first bracket defining an exemption threshold. We estimate the aggregate tax rate with the weighted average across the different tax brackets in Table 2. Specifically, we integrate the tax rates across the tax brackets with respect to the empirical distribution of house prices reported in the SHIW. The result is an average tax rate of 1.97% until 1999, 0.46% in 2000, and 0% from 2001 to 2004.

4 Calibration

In order to "test" the model before employing it in structural estimation we perform a very simple, preliminary calibration exercise. The goal of the exercise is to replicate the observed price series in the sample using the asset price equation (28). Notice that this is enough to check the consistency between the model and the data because this equation subsumes all of the other first-order conditions as well. Incidentally, by focusing on prices, the calibration exercise produces a model-based estimate of the effect of the reform on house prices.

We reproduce here equation (28) after introducing the time index t:

[7] Unfortunately we have no information on house maintenance expenses.

Table 1: Summary statistics

	1993-1998					1999-2004				
	Pop	Stock	Price	Sales	Don's	Pop	Stock	Price	Sales	Don's
Bari	333.3	132.8	87.0	1.869	1.666	320.7	152.7	87.9	2.506	2.455
Bologna	379.2	188.7	120.4	5.148	0.492	372.3	206.4	129.4	7.241	0.827
Cagliari	178.1	63.6	89.6	0.687	0.749	165.9	83.4	86.3	0.975	1.130
Catania	325.0	139.6	61.8	1.747	1.358	312.9	159.3	61.0	2.018	1.950
Florence	383.1	152.6	131.0	4.867	0.498	360.6	176.6	147.7	5.765	0.860
Genoa	651.1	288.4	82.1	8.904	0.418	613.1	318.7	73.2	12.055	0.763
Milan	1314.1	701.3	131.3	22.399	3.261	1263.4	736.7	149.5	33.140	4.800
Naples	1036.6	377.0	84.4	3.389	2.922	1006.7	404.0	91.6	5.567	4.238
Padua	208.6	90.1	103.8	2.897	0.816	205.9	106.1	108.6	3.893	1.263
Palermo	697.9	283.7	70.0	3.909	1.395	688.3	302.5	70.0	2.718	1.976
Rome	2665.6	1189.9	122.1	20.070	2.429	2557.6	1248.6	127.4	37.566	3.874
Turin	929.4	439.9	83.6	22.188	1.216	872.4	477.9	82.9	27.258	1.861
Venice	296.2	110.3	102.4	5.218	0.624	274.3	134.0	124.9	4.998	0.876

Notes: The table reports annual averages of levels in two periods: 1993-1998 and 1999-2004. Legend: Pop = city population; Stock = housing units; Price: unit price in 1993 euros; Sales = number of market transactions; Don's = number of non-market transactions (donations). All figures are in thousands.

Table 2: Bequest tax rates in Italy, 1993-2004: spouse and direct relatives

Legal reference	Tax base	Bracket	Rate (%)
Law 346/1990	Total estate	0–125K	0
		125K–175K	3
		175K–250K	7
		250K–400K	10
		400K–750K	15
		750K–1500K	22
		>1500K	27
Law 342/2000	Estate per recipient	0–175K	0
		>175K	4
Law 383/2001		Any amount	0

Notes: The table reports the bequest and inter-vivos donation tax rates in Italy since 1990. These rates refer to inheritances by and donations to one's spouse and direct relatives. Rates for all other individuals are higher, see Jappelli et al. (2014) for more details.

$$p_t = \frac{v'(H_t)}{u'(c_{1t})\,[1-\rho(1-\delta)(1-\tau_t)]}. \tag{31}$$

Notice the difference between the time index t and the generation index j; equation (28) represents the steady state of a given generation, and we interpret our panel of annual data as generated by a sequence of overlapping generations, one born one year after the other (cohorts). Therefore, each period t describes a different steady state, one for each cohort. This means, in particular, that ρ must be rescaled on a 25-year basis (half the active life span in the model), as we illustrate below. Taking logs, we can write condition (31) as:

$$\ln p_t = \ln \frac{v'(H_t)}{u'(c_{1t})} - \ln[1-\rho(1-\delta)(1-\tau_t)]. \tag{32}$$

Assuming a log-log-log specification for the utility function in (2),

$$U_j = \ln c_{1j} + \zeta \ln c_{2j+1} + \theta \ln H_j, \tag{33}$$

we can rewrite (32) as:

$$\ln p_t = \ln c_{1t} - \ln H_t + \alpha - \ln[1-\rho(1-\delta)(1-\tau_t)], \tag{34}$$

where $\alpha \equiv \ln \theta$ is an unobserved city effect.[8] For the purposes of calibration, we use the first-differenced version of equation (34) to eliminate such effect:

$$\Delta \ln p_{it} = \Delta \ln c_{1,it} - \Delta \ln H_{it} - \Delta \ln[1-\rho(1-\delta)(1-\tau_t)]. \tag{35}$$

We calibrate the model parameters as follows. First, $\delta = 0.0275$. This value is taken from Harding, Rosenthal and Sirmans (2007), who estimate from the American Housing Survey that the housing stock depreciates at between 2.5% and 3% per year in the US. A young household is defined as a household whose head is between 16 and 40 years old. That is, one period in the model

[8] Alternatively, one can use a first-order Taylor expansion of the non-parametric utility function around the steady state of the current cohort, (H^*, c_1^*). In this case we can express marginal utility as

$$v'(H_t) \approx \frac{v'(H^*)H^*}{H_t};\; u'(c_{1t}) \approx \frac{u'(c_1^*)c_1^*}{c_{1t}},$$

and $\alpha \equiv \ln[v'(H^*)H^*] - \ln[u'(c_1^*)c_1^*]$ in equation (32). These expression follow from the fact that, for any function $f(x)$ and approximation point x^*,

$$f(x) \approx f(x^*) + f'(x^*)(x - x^*) = f(x^*) + f'(x^*)x^*(\ln x - \ln x^*) \Rightarrow f'(x) \approx \frac{f'(x^*)x^*}{x}$$

is 25 years. From the SHIW, we compute the mean of total (durable and non-durable) non-housing household consumption, using sampling weights.[9] Unfortunately, the lowest level of aggregation at which information in the SHIW is publicly released is the region.[10] The best we can do is to attribute to each city the average household consumption of the region where the city is located. Presumably, this procedure leads to underestimation of the level of city consumption. However, it is not obvious that the resulting growth rate is also biased.

In order to calibrate ρ, we draw from the studies mentioned in the Introduction. In Nishiyama (2002) adult life lasts 60 years instead of 50 like in ours. If we rescale his estimates to take this difference into account, then $\rho = 0.42$ when the coefficient of relative risk aversion is set equal to 2 and $\rho = 0.33$ when this coefficient is equal to 4. Han and Mulligan's (2001) estimate is $\rho = 0.29$, and Barczyk's (2012) is $\rho = 0.12$ for a young household and $\rho = 0.28$ for an old household. The average of these estimates is 0.288, implying a value of 0.951 at an annual frequency (i.e., $0.288^{1/25}$). These values imply $\rho(1-\delta) = 0.925$. We simulate the model from 1995 onward, because the fit is poor in 1993 and 1994.

The result of the exercise is reported in Figure 2. We report in this figure three different price series. First, the data. Second, the series generated by equation (35). Third, the counterfactual series generated by this equation when the tax rate is left unchanged. Notice that in the model prices adjust immediately. Therefore, in Figure 2 changes in the bequest tax rate have a permanent level effect and a transitory growth effect in 2000 and 2001. Considering that we are using a very parsimonious theory, the model reproduces the data quite well. In particular, we are able to reproduce the turning point in the price series quite accurately in most cities. The only exceptions are Venice and Genoa. The model with tax changes clearly outperforms the counterfactual with an unaltered bequest tax: the distance with the data, measured in mean square differences, is 0.029 and 0.067, respectively.

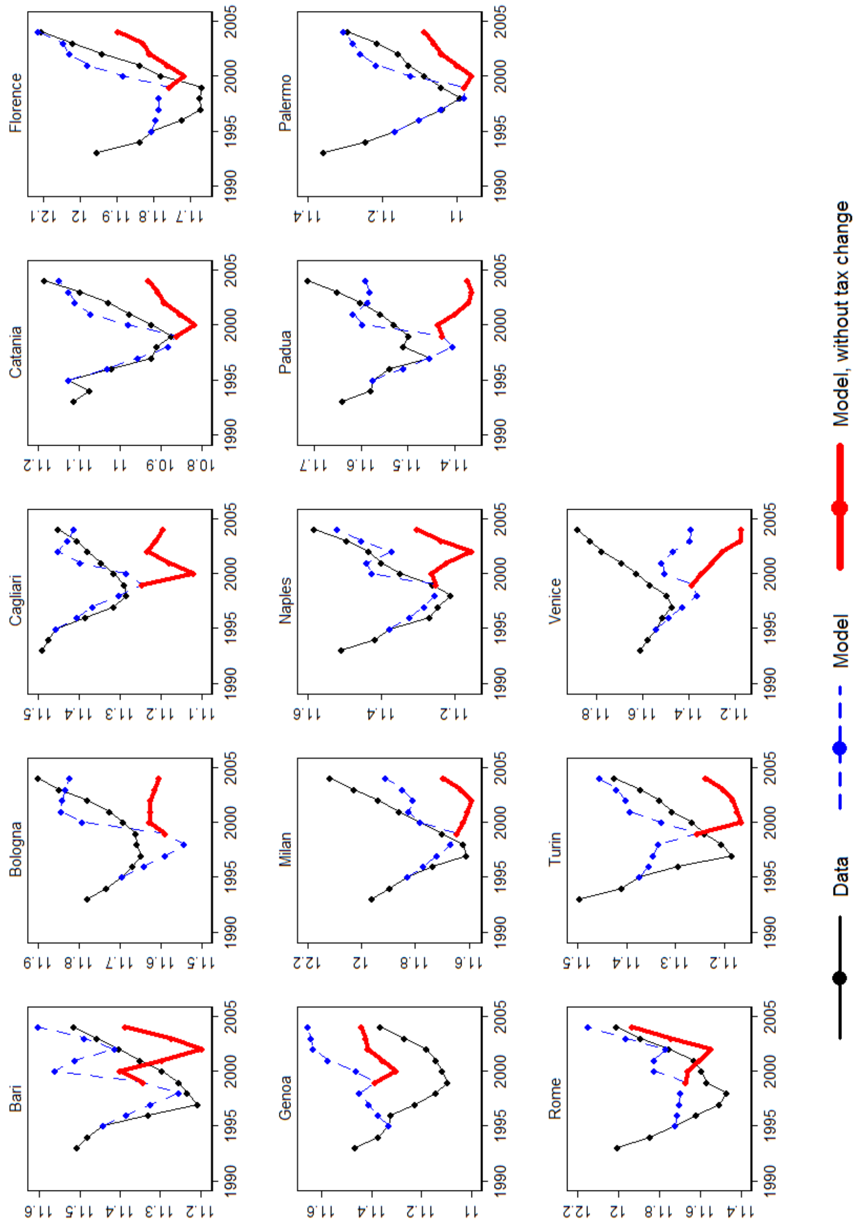
The effect of the tax on house prices in the model can be computed by comparing the variations in log prices in the two situations. These are reported in Table 3, along with the actual change.

The difference between the model's prediction with the actual tax change and the counterfactual prediction when the tax rate is held constant is a model–based estimate of the effect of the tax reduction. As the table indicates, this is 16.2% in 2000 and 5.5% in 2001. Since the reduction was 1.514 and 0.458 percentage points, respectively, these numbers correspond to a semi-elasticity of about 11%. This is admittedly a large number. It means that a 1 percentage point reduction of the average (weighted) bequest tax induces an 11% increase in house prices. In a companion

[9] The frequency of the SHIW is biennial, with the exception of a two-year lag between 1995 and 1998. All missing years are interpolated linearly.

[10] There are 20 administrative regions in Italy.

Figure 2: House prices: actual and model-generated



Notes: The figure compares the data with two model generated-series: the first is generated by the model when we consider the actual tax changes; the second is generated by the model in the counterfactual situation of no tax changes during the 1993–2004 period.

Table 3: Average variation in house prices in 2000 and 2001

		2000	2001
(a)	Data	0.049	0.046
(b)	Model, with tax change	0.134	0.051
(c)	Model, no tax change	–0.028	–0.004
	Difference ((b) – (c))	0.162	0.055

Notes: The table reports the cross-city average of $\Delta \ln p_{it}$ in 2000 and 2001. In these years the bequest tax rate was reduced, which implies a transitory growth effect in the two years. The difference between the average variation in the model and the corresponding variation when the tax rate is held constant (i.e., (b)–(c)) is a model-based estimate of the effect of the bequest tax reduction.

paper to this one, Bellettini, Taddei, and Zanella (2013), we conduct an event study of the reforms and produce a reduced-form estimates of about 5%, corresponding to a semi-elasticity of about 2.5%. This is much smaller than the model-based effect. In interpreting the latter, however, one must keep in mind that there are no frictions in the model—prices adjust immediately. In reality, housing market frictions are likely to attenuate this impact effect. Therefore, a way of interpreting the discrepancy between the model-based (11%) and the reduced-form (2.5%) semi-elasticity of house prices to the bequest tax rate is that frictions (either optimization frictions or market frictions strictly defined, or both) are possibly important during the adjustment to a new tax regime.

Given the model's ability to replicate the data fairly well, we turn to structural estimation of the main parameter of interest, ρ, in this model.

5 Structural estimation

Equation (34) can be estimated on our panel introducing a cross-sectional dimension (i) and interpreting α as a city fixed effect. That is, we estimate the following equation by Non-linear Least Squares (NLS):

$$\ln p_{it} = \alpha_i - \ln[1 - \beta(1 - \tau_t)] + \gamma \ln H_{it} + \eta \ln c_{1,it} + \varepsilon_{it}, \tag{36}$$

where ε_{it} represents shocks to the steady state not included in the model. We measure τ_t as in the calibration exercise, and we assume that the tax change is not anticipated. If it is partly anticipated (as the evidence in Bellettini, Taddei, and Zanella (2013) actually suggests) then we should interpret our estimates of ρ as a lower bound of the true degree of altruism. It is a lower bound because if the reform is anticipated then the reform-induced change in prices from just before to just after the reform would be smaller than the overall reform-induced price change.

Identification is facilitated by the exogenous nature of the tax reforms we are considering. As described in the Introduction, the reforms were motivated by the electoral competition and so were exogenous with respect to asset prices. Notice from Equation (31) that the underlying time trend in house prices is captured by the dynamics of the housing stock and consumption. The NLS estimate of β identifies $\rho(1-\delta)$. Furthermore, the structure of the model generates two testable assumptions, namely $\gamma = -1$ and $\eta = 1$. The results are reported in Table 4. The first column in this table shows that the coefficient on $(1-\tau)$ is positive and statistically significant. The coefficient on the residential stock is also significant, and negative. The coefficient on consumption of the young is positive but is not statistically different from zero. This lack of significance is likely to reflect the noise introduced by imputing region–level consumption to each city. The data do not reject the restrictions the model imposes on γ and η. Both sign and magnitude are in line with the theory. Table 5 shows that the two structural hypothesis (and a third, implied hypothesis that $\gamma + \eta = 1$) are not rejected by the data.

One may worry that the right-hand side variables $\ln H_{it}$ and $\ln c_{1,it}$ are correlated with the error term in equation (36). In this case all of the coefficients would be biased relative to the structural parameters they represent. The alternative specification in the second column of Table 4 indicates that this is not a concern. In this specification the dependent variable is $\ln(p_{it}H_{it}/c_{1,it})$, the log of the ratio of housing consumption to non-housing consumption. This specification, of course, is the direct empirical counterpart of the model's first-order conditions and avoids all potential endogeneity problems by leaving on the RHS only the bequest tax rate, whose variations are arguably exogenous. In fact, this alternative specification is equivalent to a constrained estimation of equation (34) with constraints $\gamma = -1$ and $\eta = 1$. Table 4 indicates that our estimate of β is essentially unaffected. Given that we cannot reject that $\gamma = -1$ and $\eta = 1$, we take this constrained, more efficient estimate ($\hat{\beta} = 0.908$) as our preferred estimate of $\rho(1-\delta)$.

We next use such preferred estimate to back out an estimate of the intergenerational altruism parameter, ρ. In order to do this, we just need a value for the depreciation rate. This can be taken, as in the calibration exercise, from Harding, Rosenthal, and Sirmans (2007). To check robustness, we let this parameter take three possible values: 2%, 2.75%, and 3.5%. Given a value for δ, our estimate of β implies an estimate of ρ. The results are reported in Table 6. In this table, our steady-state estimate of the intergenerational altruism parameter ρ ranges between 0.15 and 0.22, with a preferred estimate of 0.18.

Table 4: Estimation of model structure, steady state

	$\ln p_t$	$\ln \frac{p_{it} H_{it}}{c_{1,it}}$
β	0.892	0.908
	(0.023)	(0.018)
γ	–0.703	–
	(0.197)	
η	0.443	–
	(0.368)	
Constant	5.34	–0.153
	(3.61)	(0.177)
Observations	156	156
Cities	13	13
City fixed effects	Yes	Yes

Notes: Non-linear Least Squares estimates of structural parameters: β corresponds to $\rho(1-\delta)$; γ and η are the coefficients on $\ln H_{it}$ and $\ln c_{it,1}$, respectively. Standard errors are in reported in parenthesis, and are robust to heteroskedasticity and serial correlation at the city level.

Table 5: Test of structural hypotheses, steady state

H_0	p-value
$\gamma = -1$	0.159
$\eta = 1$	0.155
$\gamma + \eta = 0$	0.332

Notes: p-values from t-tests of three structural hypotheses: (1) that the coefficient on $\ln H_{it}$ (i.e., γ) is equal to –1; (2) that the coefficient on $\ln c_{it,1}$ (i.e., η) is equal to 1; (3) that the sum of the two is zero.

Table 6: Estimates of the intergenerational parameter ρ, steady state

Parameter	Description	Frequency	Estimates		
δ	Net housing deprec.	1 year	0.02	0.0275	0.035
ρ	Intergen. altruism	1 year	0.927	0.933	0.941
(s.e.)			(0.019)	(0.019)	(0.019)
ρ	Intergen. altruism	25 years	0.149	0.181	0.220
(s.e.)			(0.075)	(0.091)	(0.110)

Notes: Estimates of the intergenerational altruism parameter, ρ, at the annual and generational frequency (i.e., 25 years). For given values of δ, the former is estimated as $\hat{\rho} = \hat{\beta}/(1-\delta)$, where $\hat{\beta}$ is the preferred Non-linear Least Squares estimate reported in Table 4. The latter, instead, is computed as $\hat{\rho}^{25}$. Standard errors are computed using the delta method.

6 Conclusions

We have exploited a two-step reform of bequest taxation in Italy to identify the degree of intergenerational altruism is a basic OLG model. This is, to the best of our knowledge, the first paper in the literature that provides a direct, structural estimate of such parameter using a bequest tax reform. The key idea is that the reforms we focus on can affect house prices if and only if intergenerational altruism is nonzero. We have found that in our model the intergenerational altruism parameter is about 20%, and that this is a lower bound because of the possible anticipation of the reform. This direct estimate agrees, by and large, with existing indirect ones.

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