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Abstract

The 'noise trader' model of De Long et al. provides a plausible account of the determination of the equity premium. Extension of the model to allow for privatization of publicly-owned assets yields insights into the positive political economy of privatization and into the normative question of how policies should be evaluated in the presence of mistaken beliefs.

JEL Classification: E62

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1 Introduction

Privatization of public assets has been a widely-adopted policy in recent years. In addition to the widespread privatization accompanying the downfall of Communism, there have been numerous privatizations in both developed and less developed countries. Privatization has been advocated on a number of grounds, including improvements in operating efficiency and the desire to subject managers to the discipline of takeover markets.

An important element of the case for privatization is the claim that the sale of publicly-owned assets permits an improvement in the financial position of governments, and, in particular, a reduction in public debt. This argument has been prominent in the advocacy of privatization by the World Bank, summarized by Kikeri, Nellis and Shirley (1992). This motivation is particularly important in the case of partial privatization, where governments retain majority ownership, so that there is no reason to anticipate changes in operating efficiency or beneficial effects of capital market discipline.

Despite the frequency with which privatization is recommended as a fiscal expedient, it is frequently the case, particularly in developed countries, that the sale proceeds realized through privatization are less than the expected earnings of the enterprise under continued public ownership, discounted at the real bond rate (Vickers and Yarrow 1988, Quiggin 1995). In some cases, particularly where privatization is undertaken through an initial public offering of stock, the difference is partly due to the fact that the offer price is well below the market price revealed on the first day of trading. The case of British Telecom, examined by Vickers and Yarrow, is illustrative.

A more fundamental reason for the divergence between sale prices and future earnings is the substantial difference, referred to as the equity premium, between the rate of return demanded by holders of equity and the rate of return demanded by the holders of government bonds. As was first observed by Mehra and Prescott (1985), the magnitude of the equity premium is a puzzle, since application of the standard consumption capital asset pricing model (CCAPM) with plausible parameters suggests that the premium should be less than one percentage point. By contrast, typical empirical estimates of the equity premium are around six percentage points.

Kocherlakota (1996) surveys a large number of papers in which attempts are made to explain the large observed values of the equity premium and concludes that 'it's still a puzzle'. Although the explanations surveyed by Kocherlakota differ in many respects, all of them are based on the assumption that holdings of equity can be regarded simply as claims to a particular proportion of corporate profits, with no account being taken of the properties of the stock markets in which equities are bought and sold. In the terminology of Hirshleifer and Riley (1992) these models only deal with event uncertainty and do not consider issues of market uncertainty such as the optimal search for trading partners or disequilibrium processes and price dynamics. Implicitly, some version of the efficient markets hypothesis is assumed to apply to stock markets, although failures in other financial markets (such as insurance markets) are postulated in some cases.

The work of Shiller (1989) suggests an alternative approach to the equity premium puzzle. If, as Shiller argues, financial markets display excess volatility, then returns to holdings of equity are riskier than are the associated streams of corporate profits. Shiller's insight has been formalized in the 'noise trader' model of De Long et al. (1990). In this model, risk over and above that due to the dividend-generating process is introduced into the economy by the distorted and stochastic, beliefs of misinformed investors referred to as 'noise traders'. De Long et al. observe that this excess risk implies an increase in the equity premium relative to the case when all investors have rational expectations, but they do not consider the policy implications of this observation. De Long et al. show that, although both noise traders and sophisticated investors are made better off in *ex ante* terms (given their beliefs) by the availability of trade, this apparent welfare improvement arises at the expense of those holding equity when trade is introduced, such as entrepreneurs making initial public offerings.

A large number of subsequent writers have developed the work of Shiller (1989) and De Long et al. (1990) on market volatility. Although the use of terms like 'excess volatility' implies some departure from efficiency and therefore some potential policy implications, these issues have received relatively little attention.[1] In particular, the implications of volatility generated by noise traders for the appropriate risk premium for public investments, and for the welfare and distributional effects of privatization, have not been considered.

In this paper, we address the latter issue. We modify the De Long et al. model to allow for the existence of an asset that is initially publicly owned, but is otherwise similar to the private asset considered by De Long et al. We then examine the consequences of privatization for asset prices and demands, and for the welfare of different groups. Since the notion of welfare is ambiguous in the presence of systematically distorted beliefs, we consider both 'subjective' and 'objective' notions of welfare. Finally, we consider the implications of the model for the political economy of privatization.

2 The Analysis

Following De Long et al. (1990) we introduce a stripped-down overlapping generations model with two-period lived agents. There is a single consumption good but there is no consumption when young, no labor supply decision and no bequest motive. The only decision an agent makes is her choice of portfolio when young to finance her consumption when old.

There is no fundamental risk and all assets pay a fixed real dividend r. One asset, the *safe* asset, is in perfectly elastic supply. Any unit of the safe asset can be converted into

[1] Orosel (1996) discusses potential adverse welfare implications arising from the availability of public information in stock markets. Palley (1999) considers the implications of a 'noise trader' model for taxes on international financial transactions.

one unit of the consumption good, and vice versa. As De Long et al. note, the safe asset is formally equivalent to a storage technology that pays a real net return of r. Furthermore, if we take the consumption good in each period as the numeraire, the price of the safe asset is always one. A second asset, that we shall interpret as the *pre-privatization* economy-wide portfolio of equity, is in fixed supply, normalized to one. The price of this equity asset in period t is denoted by p_t^e. De Long et al. point out that if the price of the equity asset were simply the net present value of its future dividends, then its price in every period would also be 1. But, in the presence of noise traders, De Long et al. show that this is not the case.

Extending De Long et al., we introduce a third asset that is also in fixed supply, $x < 1$, and that generates a real dividend r. Initially, this asset is owned by the government and financed entirely through short-term (one-period) government debt. Government debt, the fourth asset in our model, pays a guaranteed fixed real interest r. As government debt is a perfect substitute for the safe asset, its price in every period is always one.

Every generation is the same size and can be divided into two classes: a proportion λ who are noise traders (denoted N) whose behavior is described in more detail in subsequent subsections below, and a proportion $1 - \lambda$ who are sophisticated investors (denoted I). In each period, the representative sophisticated investor has rational expectations about the distribution of returns from holding a portfolio with risky assets, and so maximizes her expected utility given the distribution of her wealth implied by her portfolio choice.

2.1 The Pre-Privatization Equilibrium

For any period t in which the third asset remains in government ownership, the government issues x units of new debt (of one-period maturation) which is purchased by individuals who are young in period t. Using the proceeds of this bond sale together with the real dividend generated by the government-owned asset, the government pays out the amount $(1 + r)\,x$ to the holders of the x units of government debt that was issued in period $t - 1$ and that has matured in period t.

In each period t, the representative noise trader who is young in that period misperceives the expected price of the asset in period $t + 1$ by a normally-distributed random variable

$$d_t^e \sim N\left(d^*, \sigma_d^2\right).$$

We assume that both sophisticated investors and noise traders are expected utility maximizers characterized by a constant coefficient of absolute risk aversion equal to γ. Thus, an agent who is young in period t, chooses her portfolio to maximize her *certainty equivalent consumption* in period $t + 1$. That is, she maximizes $\overline{w} - \gamma\sigma_w^2/2$, where $\overline{w}$ is the expected final wealth in period $t + 1$, and σ_w^2 is the variance of her period $t + 1$ wealth.

De Long et al. (1990) show that, in a stationary equilibrium, that is, where one imposes the requirement that the unconditional distribution of p_{t+1}^e be identical to the distribution of p_t^e, the pricing rule for equity takes the form

$$p_t^e = 1 + \frac{\lambda \left(d_t^e - d^*\right)}{1+r} + \frac{\lambda d^*}{r} - \frac{\gamma \lambda^2 \sigma_d^2}{r\left(1+r\right)^2}, \tag{1}$$

where $\lambda^2 \sigma_d^2 / \left(1+r\right)^2$ is the constant one-period-ahead variance of p_t^e.[2]

Since noise traders allocate more of their wealth to equity than do sophisticated investors, and earn negative capital gains on average, they can earn higher expected returns than sophisticated investors only if the dividend on equity amounts to a higher rate of return on average than the same dividend on the safe asset (and the government bond). That is, equity must sell at an average price *below* its fundamental value of one. As De Long et al. (1990, p. 731) observe "[i]t is important to stress that our model sheds light on the Mehra–Prescott puzzle only if equities are underpriced ..".

Hence we shall assume that equities are underpriced, that is, $\mathrm{E}\left[p_t^e\right] < 1$, or equivalently,

$$\frac{\gamma \lambda \sigma_d^2}{\left(1+r\right)^2} - d^* > 0. \tag{2}$$

Provided the variance of the representative noise trader's misperception of the expected price of the asset tomorrow is sufficiently large, this is consistent with the hypothesis that noise traders are "bullish" on average, that is, $d^* > 0$.

2.2 The Post-Privatization Equilibrium

We shall now consider the situation where the government announces at the beginning of period 0 that it is privatizing the third asset which it has held in government ownership up to that date. The amount $\left(1+r\right)x$ owing on the outstanding stock of government bonds which are held by the current old generation, will be paid out of the dividend xr generated by the asset and the revenue $p_0^{ne}x$ generated by the sell-off of the x units of supply of this asset at the price p_0^{ne}. Any shortfall (respectively, windfall) will be met by a stream of higher (respectively, lower) taxes in each subsequent period that has the same net present value as the shortfall (respectively, windfall).

As a natural generalization of the De Long et al. model, we assume that the misperceptions in period t (for $t \geq 0$) of the expected price of equity and the expected price of the privatized asset (the "new equity") in period $t+1$ are independently and identically distributed as bivariate normal

$$\begin{pmatrix} d_t^e \\ d_t^{ne} \end{pmatrix} \sim N\left(d^* \begin{pmatrix} 1 \\ 1 \end{pmatrix}, \sigma_d^2 \begin{pmatrix} 1 & \beta \\ \beta & 1 \end{pmatrix}\right).$$

We assume that the government has to make its decision to privatize the asset *before* d_0^e and d_0^{ne} are realized.

[2] See De Long et al. (1990) pp. 708–11 for the derivation.

To aid the exposition let us introduce the following notations:

$$\begin{aligned}
\mathbf{d}_t &= \begin{pmatrix} d_t^e \\ d_t^{ne} \end{pmatrix}, \mathbf{p}_t = \begin{pmatrix} p_t^e \\ p_t^{ne} \end{pmatrix}, \boldsymbol{\mu}_t = \begin{pmatrix} \mu_t^e \\ \mu_t^{ne} \end{pmatrix} = \mathrm{E}_t\left[\begin{pmatrix} p_{t+1}^e \\ p_{t+1}^{ne} \end{pmatrix}\right], \\
\boldsymbol{\Sigma}_t &= \left[\mathrm{E}_t\left[\left(p_{t+1}^i - \mu_t^i\right)\left(p_{t+1}^j - \mu_t^j\right)\right]_{i,j=e,ne}\right] \text{ and } \mathbf{1} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}.
\end{aligned}$$

Consider a sophisticated investor with an amount c_0 to invest in period t. Her objective is to choose a portfolio $\mathbf{q}_I^{\mathrm{T}} = (q_I^e, q_I^{ne})$, where q_I^e is her holding of equity and q_I^{ne} is her holding of the privatized asset, and the remainder of her wealth $(c_0 - \mathbf{p}_t^{\mathrm{T}}\mathbf{q}_I)$ is invested in the safe asset and/or government bonds. Her optimal portfolio choice maximizes:

$$c_0(1+r) + [r\mathbf{1} + \boldsymbol{\mu}_t - (1+r)\mathbf{p}_t]^{\mathrm{T}}\mathbf{q}_I - \frac{\gamma}{2}\mathbf{q}_I^{\mathrm{T}}\boldsymbol{\Sigma}_t\mathbf{q}_I. \tag{3}$$

Similarly, the representative noise trader with an amount c_0 to invest in period t, chooses a portfolio $\mathbf{q}_N^{\mathrm{T}} = (q_N^e, q_N^{ne})$ that maximizes

$$c_0(1+r) + [r\mathbf{1} + \boldsymbol{\mu}_t - (1+r)\mathbf{p}_t]^{\mathrm{T}}\mathbf{q}_N - \frac{\gamma}{2}\mathbf{q}_N^{\mathrm{T}}\boldsymbol{\Sigma}_t\mathbf{q}_N + \mathbf{d}_t^{\mathrm{T}}\mathbf{q}_N. \tag{4}$$

The only difference between (3) and (4) is the last term of (4) which reflects the noise traders' misperceptions of the expected returns from holding equity and from holding the privatized asset.

The corresponding first order conditions derived from (3) and (4) yield the asset demands

$$\begin{aligned}
\mathbf{q}_I &= \frac{1}{\gamma}\boldsymbol{\Sigma}_t^{-1}[r\mathbf{1} + \boldsymbol{\mu}_t - (1+r)\mathbf{p}_t] \\
\mathbf{q}_N &= \frac{1}{\gamma}\boldsymbol{\Sigma}_t^{-1}[r\mathbf{1} + \boldsymbol{\mu}_t - (1+r)\mathbf{p}_t + \mathbf{d}_t].
\end{aligned}$$

Solving for the market-clearing prices we obtain

$$\mathbf{p}_t = \frac{1}{1+r}[r\mathbf{1} + \boldsymbol{\mu}_t + \lambda\mathbf{d}_t] - \frac{\gamma}{1+r}\Sigma_t\begin{pmatrix} 1 \\ x \end{pmatrix}. \tag{5}$$

We confine attention to steady-state equilibria by imposing the requirement that the unconditional distribution of $\mathbf{p}_{t+1}$ be identical to the distribution of $\mathbf{p}_t$. As was the case in the pre-privatized situation, we can solve (5) recursively to obtain

$$\mathbf{p}_t = \mathbf{1} + \frac{\lambda}{1+r}(\mathbf{d}_t - d^*\mathbf{1}) + \frac{\lambda d^*}{r}\mathbf{1} - \frac{\gamma}{r}\Sigma_t\begin{pmatrix} 1 \\ x \end{pmatrix}. \tag{6}$$

Inspection of (6) reveals a time-invariant variance–covariance matrix for $\mathbf{p}_t$ of

$$\Sigma = \frac{\lambda^2 \sigma_d^2}{(1+r)^2} \begin{pmatrix} 1 & \beta \\ \beta & 1 \end{pmatrix}$$

That is, we have

$$p_t^e = 1 + \frac{\lambda\left(d_t^e - d^*\right)}{1+r} + \frac{\lambda d^*}{r} - \frac{\gamma \lambda^2 \sigma_d^2}{r(1+r)^2}(1+\beta x), \tag{7}$$

$$p_t^{ne} = 1 + \frac{\lambda\left(d_t^{ne} - d^*\right)}{1+r} + \frac{\lambda d^*}{r} - \frac{\gamma \lambda^2 \sigma_d^2}{r(1+r)^2}(\beta + x). \tag{8}$$

Notice that for small x, the correlation coefficient β is approximately equal to the 'beta' coefficient that would come out of the standard CAPM.

2.3 Welfare Effects of the Privatization

The intertemporal production technology for the consumption good implicitly embodies a real net return of r. Hence, welfare changes across generations in this economy can be characterized in terms of the net present value of the changes in consumption streams using a discount rate of r.

For $t \geq 0$, let $\Delta\,\mathrm{CE}_t^I$ (respectively, $\Delta\,\mathrm{CE}_t^N$) denote for the representative sophisticated investor (respectively, noise-trader) who is young in period $t-1$, the change that results from the privatization in his or her certainty equivalent consumption in period t. Notice that for $t \geq 1$, $\Delta\,\mathrm{CE}_t^N$ is calculated with respect to the *misperceived* estimate of the prices of old equity and the privatized asset for period t that is made by the noise traders in the period in which they are young (that is, period $t-1$). Let ΔB_0 denote the change in the government's budget in period 0 that arises as a result of the privatization. If we let ΔW denote the sum of ΔB_0 and the net present value of the changes in the certainty equivalent consumption of every generation, then the *ex ante* change is given by

$$\mathrm{E}[\Delta W] = \mathrm{E}[\Delta B_0] + \sum_{t=0}^{\infty} \frac{(1-\lambda)\,\mathrm{E}\left[\Delta\,\mathrm{CE}_t^I\right] + \lambda\,\mathrm{E}\left[\Delta\,\mathrm{CE}_t^N\right]}{(1+r)^t}. \tag{9}$$

Let $\overline{y}$ denote the value the variable y would have taken if the government had not privatized the asset in period 0. We consider the changes to each group in turn.

Government

$$\begin{aligned} \mathrm{E}[\Delta B_0] &= \mathrm{E}[p_0^{ne}]\,x + xr - x(1+r) \\ &= x\left(\mathrm{E}[p_0^{ne}] - 1\right) \\ &= \frac{\lambda x}{r}\left(d^* - \frac{\gamma \lambda \sigma_d^2}{(1+r)^2}(\beta + x)\right). \end{aligned} \tag{10}$$

Assuming that condition (2) is satisfied, so that there is a positive equity premium, the government will be worse off whenever $\beta + x$ is sufficiently close to or greater than 1. Notice that although this is more likely to hold the larger is the scale of the privatization relative to the existing equity market (i.e. the larger is x), even a small scale privatization may worsen the government's financial position, if the representative noise-trader's misperceptions of the expected price of equity and the expected price of the privatized asset are sufficiently highly correlated (that is, β is sufficiently close to 1).

Consumers in period 0.

These consumers have already made their portfolio choice in the previous period. The only action they undertake in period 0 is to sell their portfolio on the market to finance their consumption. Inspection of (1) and (7) reveals that $\overline{p}_0^e$ and p_0^e have the same variance. Hence it follows that:

$$(1-\lambda)\,\mathrm{E}\left[\Delta\,\mathrm{CE}_0^I\right] + \lambda\,\mathrm{E}\left[\Delta\,\mathrm{CE}_0^N\right] = \mathrm{E}\left[p_0^e - \overline{p}_0^e\right] = -\frac{\gamma\lambda^2\sigma_d^2}{r\,(1+r)^2}\beta x,$$

which means that consumers in period 0 will lose (respectively, gain) if the noise traders' misperception of the expected price of the newly privatized asset in the next period is positively (respectively, negatively) correlated with their misperception of the expected price of the old equity in the next period.

Consumers in period $t \geq 1$.

For the sophisticated investor who will consume in period t we have

$$\begin{aligned}
&\Delta\,\mathrm{CE}_t^I \\
=\;& \left[r\mathbf{1} + \boldsymbol{\mu}_{t-1} - (1+r)\,\mathbf{p}_{t-1}\right]^{\mathrm{T}}\mathbf{q}_I - \frac{\gamma}{2}\mathbf{q}_I^{\mathrm{T}}\boldsymbol{\Sigma}\mathbf{q}_I - \left(r + \mathrm{E}_{t-1}\left[\overline{p}_t^e\right] - (1+r)\,\overline{p}_{t-1}^e\right)\overline{q}_I^e + \frac{\gamma}{2}\frac{\lambda^2\sigma_d^2}{(1+r)^2}\left(\overline{q}_I^e\right)^2
\end{aligned}$$

In the appendix, we show this may be expressed as

$$\Delta\,\mathrm{CE}_t^I = \frac{(1+r)^2}{2\gamma\sigma_d^2} \times \frac{\left(\beta d_{t-1}^e - d_{t-1}^{ne}\right)^2}{\left(1-\beta^2\right)} + x\left(\frac{\gamma\lambda^2\sigma_d^2}{(1+r)^2}\left(\beta + \frac{x}{2}\right) - \lambda d_{t-1}^e\right).$$

Thus,

$$\mathrm{E}\left[\Delta\,\mathrm{CE}_t^I\right] = \frac{(1+r)^2\left((1-\beta)\,(d^*)^2 + (1+\beta)\,\sigma_d^2\right)}{2\gamma\,(1+\beta)\,\sigma_d^2} + x\lambda\left(\frac{\gamma\lambda\sigma_d^2}{(1+r)^2}\left(\beta + \frac{x}{2}\right) - d^*\right). \quad (11)$$

Similarly, for a noise trader who will consume in period t we have

$$\begin{aligned}
&\Delta\,\mathrm{CE}_t^N \\
=\;& \left[r\mathbf{1} + \boldsymbol{\mu}_{t-1} - (1+r)\,\mathbf{p}_{t-1} + \mathbf{d}_{t-1}\right]^{\mathrm{T}}\mathbf{q}_N - \frac{\gamma}{2}\mathbf{q}_N^{\mathrm{T}}\boldsymbol{\Sigma}\mathbf{q}_N
\end{aligned}$$

$$
\begin{aligned}
& - \left(r + \mathrm{E}_{t-1}\left[\overline{p}_t^e\right] - (1+r)\,\overline{p}_{t-1}^e + d_{t-1}^e\right)\overline{q}_N^e + \frac{\gamma}{2}\frac{\lambda^2\sigma_d^2}{(1+r)^2}\left(\overline{q}_N^e\right)^2 \\
= \;& \frac{(1-\lambda)^2}{\lambda^2} \times \frac{(1+r)^2}{2\gamma\sigma_d^2} \times \frac{\left(\beta d_{t-1}^e - d_{t-1}^{ne}\right)^2}{\left(1-\beta^2\right)} + x\left(\frac{\gamma\lambda^2\sigma_d^2}{(1+r)^2}\left(\beta+\frac{x}{2}\right) + (1-\lambda)\,d_{t-1}^e\right).
\end{aligned}
$$

Thus,

$$
\mathrm{E}\left[\Delta\,\mathrm{CE}_t^N\right] = \frac{(1-\lambda)^2}{\lambda^2}\frac{(1+r)^2\left((1-\beta)\,(d^*)^2 + (1+\beta)\,\sigma_d^2\right)}{2\gamma\,(1+\beta)\,\sigma_d^2} + x\left(\frac{\gamma\lambda^2\sigma_d^2}{(1+r)^2}\left(\beta+\frac{x}{2}\right) + (1-\lambda)\,d^*\right). \tag{12}
$$

Hence the per capita change in the *ex ante* certainty equivalent consumption for the generation who will be consumers in period t (≥ 1) is

$$
\begin{aligned}
& (1-\lambda)\,\mathrm{E}\left[\Delta\,\mathrm{CE}_t^I\right] + \lambda\,\mathrm{E}\left[\Delta\,\mathrm{CE}_t^N\right] \\
= \;& \frac{(1-\lambda)}{\lambda}\frac{(1+r)^2\left((1-\beta)\,(d^*)^2 + (1+\beta)\,\sigma_d^2\right)}{2\gamma\,(1+\beta)\,\sigma_d^2} + x\left(\frac{\gamma\lambda^2\sigma_d^2}{(1+r)^2}\left(\beta+\frac{x}{2}\right)\right).
\end{aligned} \tag{13}
$$

This yields in net present value terms

$$
\begin{aligned}
& \mathrm{E}\left[\Delta W\right] \\
= \;& \frac{\lambda x}{r}\left(d^* - \frac{\gamma\lambda\sigma_d^2}{(1+r)^2}(\beta+x)\right) - \frac{\gamma\lambda^2\sigma_d^2}{r\,(1+r)^2}\beta x \\
& + \frac{(1-\lambda)\,(1+r)^2\left((1-\beta)\,(d^*)^2 + (1+\beta)\,\sigma_d^2\right)}{2r\lambda\gamma\,(1+\beta)\,\sigma_d^2} + \frac{x}{r}\left(\frac{\gamma\lambda^2\sigma_d^2}{(1+r)^2}\left(\beta+\frac{x}{2}\right)\right) \\
= \;& \frac{\lambda x}{r}\left(d^* - \frac{\gamma\lambda\sigma_d^2}{(1+r)^2}\left(\beta+\frac{x}{2}\right)\right) + \frac{(1-\lambda)\,(1+r)^2\left((1-\beta)\,(d^*)^2 + (1+\beta)\,\sigma_d^2\right)}{2r\lambda\gamma\,(1+\beta)\,\sigma_d^2}.
\end{aligned} \tag{14}
$$

Alternative measure – expected utility with respect to "true distribution".

An alternative measure of the welfare effects of the privatization is to evaluate the expected utility of every agent with respect to the *true* distribution of consumption. The only agents this affects are the noise traders who will be consuming in periods $1, 2, \ldots$. Let $\Delta\widehat{\mathrm{CE}}_t^N$ denote this value.

$$
\Delta\widehat{\mathrm{CE}}_t^N = \Delta\,\mathrm{CE}_t^N - \left(\mathbf{d}_{t-1}^{\mathrm{T}}\mathbf{q}_N - d_{t-1}^e\overline{q}_N^e\right).
$$

Recall

$$
\mathbf{q}_N = \frac{1}{\gamma}\Sigma^{-1}\left[r\mathbf{1} + \boldsymbol{\mu}_{t-1} - (1+r)\,\mathbf{p}_{t-1} + \mathbf{d}_{t-1}\right].
$$

From (5) we have

$$
r\mathbf{1} + \boldsymbol{\mu}_{t-1} - (1+r)\,\mathbf{p}_{t-1} + \mathbf{d}_{t-1} = \gamma\Sigma\begin{bmatrix} 1 \\ \\ x \end{bmatrix} + (1-\lambda)\,\mathbf{d}_{t-1},
$$

and hence

$$\mathbf{d}_{t-1}^{\mathrm{T}}\mathbf{q}_N - d_{t-1}^{e}\overline{q}_N^{e} = xd_{t-1}^{ne} + \frac{(1-\lambda)(1+r)^2}{\gamma\lambda^2\sigma_d^2\left(1-\beta^2\right)}\left(\beta^2\left(d_{t-1}^{e}\right)^2 - 2\beta d_{t-1}^{e}d_{t-1}^{ne} + \left(d_{t-1}^{ne}\right)^2\right).$$

This gives us a "corrected" measure of the change in *ex ante* welfare of

$$\mathrm{E}\left[\Delta\widehat{W}\right] = -\frac{\gamma\lambda^2\sigma_d^2}{r(1+r)^2}\left(\beta x + \frac{x^2}{2}\right) - \frac{(1-\lambda)(1+r)^2\left((1-\beta)(d^*)^2 + (1+\beta)\sigma_d^2\right)}{2r\lambda\gamma(1+\beta)\sigma_d^2}. \quad (15)$$

Notice that the difference between (14) and (15) is

$$\frac{\lambda x}{r}d^* + \frac{(1-\lambda)(1+r)^2\left((1-\beta)(d^*)^2 + (1+\beta)\sigma_d^2\right)}{r\lambda\gamma(1+\beta)\sigma_d^2}.$$

The first term reflects the extra consumption that noise traders' misperceptions lead them to expect, on average, to receive by holding the privatized asset while the second term reflects the certainty-equivalent consumption cost of the risk associated with taking bets based on misperceived expected future prices of the privatized asset.

3 The political economy of privatization

The analysis above yields a range of insights into the political economy of privatization. First, consider the impact on government. From (10), privatization will, for plausible parameter values, reduce the net worth of government. However, this reduction is obscured by the standard system of government financial statistics (GFS) in which the returns from asset sales are treated as revenue (or sometimes negative expenditure) in the year in which sales take place. Thus, from the viewpoint of ministers and officials relying on the GFS statistics, privatization always yields an improvement in the government's financial position (provided the sale price exceeds one year's earnings, that is, $p_0^{ne} > r$ in our model). This was an important element of the case for privatization in the United Kingdom (Zahariadis 1995) and Australia (Quiggin 1995).

The effect on the government may also be considered as the effect on a taxpayer–voter who satisfies Ricardian equivalence but does not participate in the equity market. In general, non-shareholders have been hostile to privatization, suggesting that they may be closer to Ricardian equivalence than experts using the Government Financial Statistics system.

The effect on period-zero consumers may be taken as a proxy for the effect on holders of private equity at the time of privatization, and particularly on those who wish to sell equity, for example, through initial public offerings. Large-scale privatizations have frequently raised concerns that the creation of large quantities of new equity will exceed the willingness of markets to buy equity at existing prices (which will be the case in our model when $\beta > 0$). This is one reason for the popularity of partial privatization (in our model, small values of x).

The most interesting welfare issues arise with respect to consumers in periods greater than $t \geq 1$. We may consider three possible policy frameworks, referred to as 'paternalist', 'preference-maximizing' and 'libertarian.' A 'paternalist' government would seek to maximize an 'objective' welfare measure based on the true probability distribution. Under the assumptions of the model presented above, such a government would always retain full public ownership. A 'preference-maximizing' government would undertake privatization if and only if the expected aggregate benefit (15) was positive.[3] Finally, a 'libertarian' government would always undertake privatization.

It is of interest to consider the circumstances under which these approaches would obtain the political support of voters. For the paternalist case, suppose that voters know that market fluctuations are generated by noise traders with mistaken beliefs and do not know whether their own beliefs are mistaken. If individuals acted on this knowledge as traders, common priors and common knowledge of rationality would imply a no-trade equilibrium (Milgrom and Stokey 1982). To derive a 'self-paternalist' outcome we assume instead, following Elster (1979), that individuals know that, as traders, they will act on their beliefs. As voters they are therefore willing to bind themselves in advance not to trade. Under the conditions of the model presented above, all self-paternalist voters will prefer the pre-privatization outcome to the post-privatization outcome.[4]

A libertarian policy may be justified on grounds of process alone, without reference to welfare outcomes (Nozick 1974). Alternatively, given a methodological commitment to core hypotheses of market efficiency and individual rationality, models such as that of De Long et al. (1990) must be rejected in favor of models in which the market price of equity reflects the true social cost of risk. If a model of the latter class is correct, government ownership conceals risks that are, in reality, borne indirectly by taxpayers (Domberger 1995). If this view is accepted, then all voters will prefer privatization.

An intermediate case arises if all voters believe their own estimates of risks and returns are unbiased. In this case, privatization will generally be viewed as beneficial by both sophisticated traders and noise traders (assuming they ignore any losses incurred by governments), but will, under the conditions noted above, reduce the net worth of government and the welfare of period 0 consumers. In the absence of compensation, the political outcome will be determined by the relative strength of gainers and losers. Suppose the effects of reductions in government net worth are borne primarily by net recipients of government expenditure

[3] Note that losers such as period 0 consumers may be compensated in such a way that all groups experience an improvement in subjective expected utility.

[4] One might object that people with such meta-beliefs should simply refrain from trading in risky equities and hold only debt. However, the equity premium puzzle is accompanied by a 'risk-free rate puzzle' in that the rate of return to riskless debt is lower than appears reasonable, so that an individual decision to refrain from trade in equities does not eliminate the loss generated by noisy trade. Because of the simplifying assumption that the riskless asset is in perfectly elastic supply, the risk-free rate puzzle does not arise in the De Long et al model.

and by taxpayers who do not hold, or wish to hold, equity. We will refer to this group simply as 'government supporters'. Similarly, the effects on period 0 consumers is a proxy for the effects on those who hold substantial equity and expect to be net sellers. We will refer to this group as 'old money' voters.

Then, in the absence of compensation, the political feasibility of privatization depends on the formation of a coalition of sophisticated and noisy traders which can overcome the resistance of government supporters and 'old money' voters. This seems to be an accurate description of the support base of the Thatcher government in the United Kingdom (Zahariadis 1995). Similarly, and perhaps more surprisingly, large-scale privatisations were undertaken by labor governments in Australia and New Zealand. These governments attracted support from rising entrepreneurs, the financial sector and from upwardly mobile voters. Opposition was divided between 'old money' voters, who continued to support traditionally conservative parties and government supporters who had traditionally supported the labor parties.[5] In all the cases discussed above, the divided nature of the opposition allowed governments to retain office for some years with the support of around 40 per cent of voters.

If lump-sum compensation is feasible and is always paid to losers, voters will prefer privatization as long as (14) is positive. The sign of (14) will depend on the magnitude of the aggregate bias $\frac{\lambda x}{r}d^*$, the riskiness of equity markets, and on the risk-aversion of the representative voter/consumer. Thus we might expect the political popularity of privatization to vary in line with social changes that affect risk-aversion and with changes in estimates of the riskiness of equities. It is interesting to observe that the rise of privatization in the 1980s coincided with a rapid decline in the proportion of voters and politicians old enough to recall the Great Depression.

The analysis above must be modified to take account of other factors that will affect the desirability of privatization. Where privatization is accompanied by an increase in operating efficiency the benefit from this increase should be taken into account. One possibility is to assume that the true return in period 1 is greater than r. On the other hand, the fiscal and social returns to privatization may be reduced if governments are unable to commit themselves regarding the possibility of renationalization or adverse regulation (Zeckhauser and Horn 1989) or if the privatized firm is characterized by monopoly power and/or externalities requiring close regulation (King & Pitchford 1999).

In the analysis presented above, governments are assumed to respond directly to the *ex ante* preferences of voters. The model could be enhanced by consideration of strategic behavior such as that considered by Perotti and Biais (2001). In their model, governments seek to reduce support for redistribution by using privatisation to ensure that the median voter holds shares and is therefore more likely to oppose policies of redistributing income from capital to labor.

[5] Traditionally conservative parties also changed their policies to support privatization. However, in both Australia and New Zealand, the lead in implementing privatization was taken by labor governments.

4 Concluding comments

The well-known equity premium puzzle is closely related to the less familiar, but equally surprising, observation that the proceeds from privatization are frequently lower than plausible estimates of the present value of future earnings, discounted at the real bond rate. In this paper, it has been shown that if the equity premium arises from the mistaken beliefs of noise traders, privatization may reduce public sector net worth. Moreover, evaluated in terms of the correct beliefs of sophisticated investors, there is a reduction in social welfare associated with privatization that must be balanced against any improvements in operating efficiency.

More generally, if the equity premium arises because of capital market imperfections, the market rate of return on risky assets is, in general, greater than the socially optimal risk-adjusted discount rate and privatization may reduce welfare. However, continued public ownership may be dominated by a first-best policy that addresses the relevant market failure directly.

Appendix

Derivation of change in certainty equivalent consumption of sophisticated consumer who will consume in period t as a result of the privatization.

$$\begin{aligned}
&\Delta\,\mathrm{CE}_t^I \\
=\;& \left[r\mathbf{1}+\boldsymbol{\mu}_{t-1}-(1+r)\,\mathbf{p}_{t-1}\right]^{\mathrm{T}}\mathbf{q}_I-\frac{\gamma}{2}\mathbf{q}_I^{\mathrm{T}}\boldsymbol{\Sigma}\mathbf{q}_I-\left(r+\mathrm{E}_{t-1}\left[\overline{p}_t^e\right]-(1+r)\,\overline{p}_{t-1}^e\right)\overline{q}_I^e+\frac{\gamma}{2}\frac{\lambda^2\sigma_d^2}{(1+r)^2}\left(\overline{q}_I^e\right)^2 \\
=\;& \frac{1}{2\gamma}\Bigg(\left[r\mathbf{1}+\boldsymbol{\mu}_{t-1}-(1+r)\,\mathbf{p}_{t-1}\right]^{\mathrm{T}}\boldsymbol{\Sigma}^{-1}\left[r\mathbf{1}+\boldsymbol{\mu}_{t-1}-(1+r)\,\mathbf{p}_{t-1}\right] \\
&-\frac{(1+r)^2}{\lambda^2\sigma_d^2}\left(r+\mathrm{E}_{t-1}\left[\overline{p}_t^e\right]-(1+r)\,\overline{p}_{t-1}^e\right)^2\Bigg).
\end{aligned}$$

Since

$$\begin{aligned}
(1+r)\,\overline{p}_{t-1}^e &= 1+r+\lambda\left(d_{t-1}^e-d^*\right)+\frac{\lambda d^*(1+r)}{r}-\frac{\gamma\lambda^2\sigma_d^2}{r(1+r)} \\
\text{and }\ \mathrm{E}_{t-1}\left[\overline{p}_t^e\right] &= 1+\frac{\lambda d^*}{r}-\frac{\gamma\lambda^2\sigma_d^2}{r(1+r)^2},
\end{aligned}$$

it follows that,

$$r+\mathrm{E}_{t-1}\left[\overline{p}_t^e\right]-(1+r)\,\overline{p}_{t-1}^e=\frac{\gamma\lambda^2\sigma_d^2}{(1+r)^2}-\lambda d_{t-1}^e,$$

and from (5) we have

$$r\mathbf{1}+\boldsymbol{\mu}_{t-1}-(1+r)\,\mathbf{p}_{t-1} = \gamma\Sigma\begin{pmatrix}1\\x\end{pmatrix}-\lambda\mathbf{d}_{t-1}$$

$$= \frac{\gamma\lambda^2\sigma_d^2}{(1+r)^2}\begin{pmatrix} 1+\beta x \\ \\ \beta + x \end{pmatrix} - \lambda \begin{pmatrix} d_{t-1}^e \\ \\ d_{t-1}^{ne} \end{pmatrix},$$

yielding

$$\Delta\,\mathrm{CE}_t^I = \frac{(1+r)^2}{2\gamma\sigma_d^2} \times \frac{(\beta d_{t-1}^e - d_{t-1}^{ne})^2}{\left(1-\beta^2\right)} + x\left(\frac{\gamma\lambda^2\sigma_d^2}{(1+r)^2}\left(\beta + \frac{x}{2}\right) - \lambda d_{t-1}^e\right).$$

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