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Asset Price Regulators, Unite: You Have Macroeconomic Stability to Win and the Microeconomic Losses are Second-order

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The Centre of Policy Studies (COPS) is a research centre at Monash University devoted to economy-wide modelling of economic policy issues.

Asset Price Regulators, Unite:

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and the Microeconomic Losses are Second-order [1] [2]

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Abstract

The Global Financial Crisis (GFC) has rekindled debate about the desirability of governmental interference in asset markets – either through the operation of policy levers, or, through the chosen institutional setup. In this paper we quantify economic costs due to mispricing of real assets in the USAGE model of the United States. The microeconomic costs of misallocated capital are second-order small. The model suggests that regulators (or central banks) who risk mispricing by influencing asset prices do so without incurring large economic costs.

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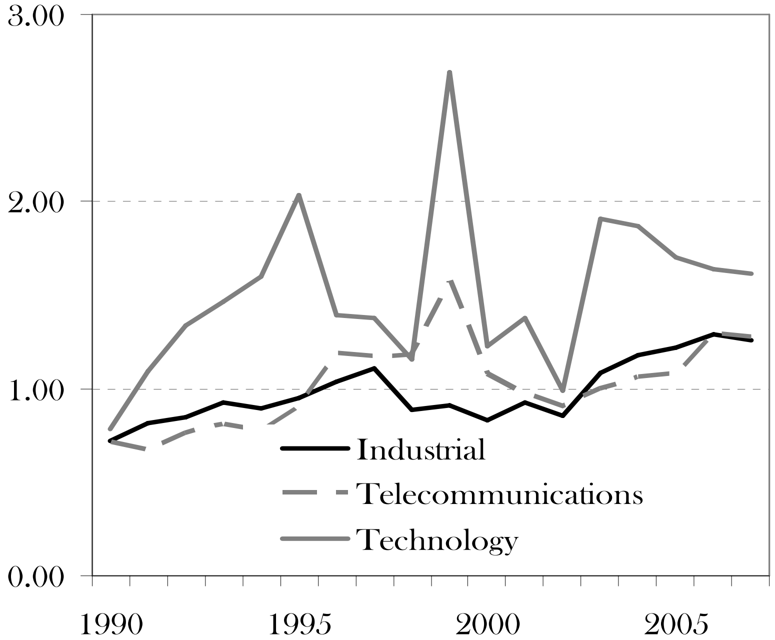
Introduction

"If the reason that the price is high today is only because investors believe that the selling price will be high tomorrow – when 'fundamental' factors do not seem to justify such a price – then a bubble exists." (Stiglitz 1990, p.13)

Asset Price Bubbles have burst onto the pages of history long before the GFC. The Dutch tulip blub bubble of 1636, the South Sea bubble of 1720 and, more recently, the internet bubble of the late 1990s (Figure 1) furnish a few spectacular examples (Kindleberger, 2000).

Figure 1: US Tobin's q: Industrials, Telecommunications and Technology



Source: Datastream

Bubbles are characterized by high levels of momentum trading and herding amongst investors. Accordingly, asset prices will continue to rise as long as the investors (i.e. speculators) believe that they can sell the asset for a higher price in the future.[3]

[3] Other definitions are given: by the New Palgrave: *"....a sharp rise in the price of an asset or a range of assets in a continuous process, with the initial rise generating expectations of further rises and attracting new buyers—generally speculators interested in profits from trading in the asset rather than its use or earnings capacity"* (Eatwell et al., 1987, p. 281); by Shiller (2003) *"a period when investors are attracted to an*

It is widely believed that the rapid boom and bust associated with asset price bubbles have real effects on the economy, with the 1929 crash and subsequent Great Depression writ large in many memories. No consensus about the magnitude or inevitability of these effects has emerged (Posen, 2006)[4] though the events of the last few years may forge one.

The blame for the GFC has been shelved home to a housing bubble and there is a prospect of a more interventionist regulatory stance to reduce the likelihood of bubbles in the price of real assets (eg. housing and equities). These policy prescriptions are informed by the literature on the impact and incidence of mispricing, which we briefly review in section 2. That literature focuses on the micro- and macro-economic mechanisms which can affect the real economy – namely capital misallocation, and, financial sector distress.[5] There is no doubt that burst bubbles can leave the economy in a sorry state, so we feel no pressing need to elaborate on model simulations to that effect. Instead, our central claim is that the microeconomic costs of plausible misallocations are relatively unimportant. A corollary is that financial re-regulation that causes plausible misallocation would have little impact on welfare. That being the case, the risk of misallocating capital is only a weak argument against financial re-regulation.

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investment irrationally because rising prices encourage them to expect, at some level of consciousness at least, more price increases. A feedback develops—as people become more and more attracted, there are more and more price increases. The bubble comes to an end when people no longer expect the price to increase, and so the demand falls and the market crashes.", and; by Siegel (2003) who proposes that a bubble is any two-standard-deviation departure from the expected return. Using his methodology, however, he fails to find a bubble in the US over the past 120 years! Monte Carlo studies also suggest low predictive power using his method (Simon 2003).

4 In his words:"*it is difficult even to establish that bubbles bursting is all that harmful, at least in developed economies, even though that harm is often taken for granted"* (op cit. 2006, p.6).

5 With regards to financial stress following a bubble, the literature on these effects presumes the ability to econometrically test for bubbles, yet this is no trivial matter. Gürkaynak (2008) provides a comprehensive survey of the tests including variance bound tests (as in Shiller, 1981), West's two-step test (1987), integration/co-integration tests (Diba and Grossman 1987, 1988) and intrinsic bubble tests (Froot and Obstfield 1991). After canvassing the strength and weakness of each type of tests, Gürkaynak summed up the state of econometric testing:*".....*[This] *survey of econometric tests of asset price bubbles shows that, despite recent advances, econometric detection of asset price bubbles cannot be achieved with a satisfactory degree of certainty. For each paper that finds evidence of bubbles, there is another one that fits the data equally well without allowing for a bubble. We are still unable to distinguish bubbles from time-varying or regime-switching fundamentals, while many small sample econometrics problems of bubble tests remain unresolved." (Gürkaynak 2008, p.166)*

1.2 The Evidence Advanced for our Central Claim

Our central claim begs two empirical questions: 1) how are the microeconomic efficiency costs quantified, and, 2) what do we mean by a *plausible* misallocation?

With regard to the first question, we turn to USAGE, a contemporary policy model of the United States (section 3). The model's credibility rests partly on its application to contemporary policy issues (US International Trade Commission, 2004 & 2007) and partly because its micro-foundations blunt the critique of Lucas (1976). The immunity from the Lucas critique admittedly comes at a cost of not incorporating realistic policy rules in the simulations. But this seems to us a small price to pay. It is hard to imagine an environment more beset by rapidly evolving policy rules and institutions than the aftermath of the GFC (Goodhart, 2009).

With regard to the second question, we define a plausible perturbation to capital in two ways. We first define it as a movement of capital which takes Tobin's q very close to the equilibrium value of unity.[6] Then, we define it as a movement in capital that shifts Tobin's q by its historic deviation from its sectoral mean (i.e. the sample standard deviation).

An alternative strategy to the one proposed in this paper would be to model a number of conceivable changes to the regulatory/monetary policy environment, and calculation the efficiency costs associated with each one. However, with land spread open before us, it is not clear which direction policymakers will head off in, and it seems better to try to quantify the welfare effects somewhat more generally.[7]

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[6] This is plausible in the sense of 'equilibrating' but substantial real-world barriers mean it could also be described as extreme, and certainly outside historical experience. For technical reasons, simulated Tobin's q settles just below 1.0 (0.98) in our simulations.

[7] Goodhart (2009) believes the policy imperative is to equip central bankers with at least one extra instrument. The experience of the 'great moderation' confirms that inflation targeting regimes are effective. But inflation is only one of the main targets of the central bank. Financial stability, for which Goodhart believes no effective instrument is yet available, is another, historically prior, target. He explores many policy options, such as

In section 4 we attempt this quantification. We first dispose of a potential shortcut which would claim that the unimportance of capital misallocation follows directly as a consequence of the envelope theorem (section 4.1). That is, small perturbations of capital from an optimal allocation have second order effects. The problems with the shortcut are a) the envelope theorem may not work for multiple sectors, b) capital is in fact not optimally allocated, c) plausible perturbations to capital may not be 'small' enough in the microeconomic sense and d) the theory of second best (Lipsey and Lancaster, 1956) combined with (b) rules out an *a priori* appeal to the envelope theorem. [8]

The USAGE model provides a way through these difficulties. USAGE contains multiple sectors meeting objection (a). Furthermore, we handle objection (b) by calibrating USAGE to empirical Tobin q's, recognizing the reality that US capital is not optimally allocated. When capital is allowed to move to equalize returns or Tobin's q, the benefits are second order small (section 4.2), implying that the function relating capital to profits could still be regarded as 'flat'. Furthermore, a realistic perturbation which shifts capital out of a capital-starved sector (Healthcare) and redistributes it across the other sectors in section 4.3 results in a NPV effect that is both small and negative. This suggests respectively that plausible perturbations in capital can indeed be considered 'small' (objection (c)), and, that the theory of second best is unimportant practically (objection (d)). We note the limitations of our argument in Section 5, the main one being that heavy-handed financial regulation may take misallocation outside our plausible range.

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counter-cyclical capital adequacy, varying the parameters of the discount window and less reliance on the inter-bank lending market.

[8] To quote Lipsey and Lancaster (op. cit. pg. 11) 'It is well known that the attainment of a Paretian optimum requires the simultaneous fulfillment of all the optimum conditions. The general theorem for the second best optimum states that if there is introduced into a general equilibrium system a constraint which prevents the attainment of one of the Paretian conditions, the other Paretian conditions, although still attainable, are, in general, no longer desirable. In other words, given that one of the Paretian optimum conditions cannot be fulfilled, then an optimum situation can be achieved only by departing from all the other Paretian conditions. The optimum situation finally attained may be termed a second best optimum because it is achieved subject to a constraint which, by definition, prevents the attainment of a Paretian optimum.'

2 Asset Mispricing in the Literature

Asset price bubbles are commonly associated with an increase of debt. During the boom phase of the bubble, the large distortion in relative prices induces investors to increase their debt burden (Shiller 2003). Once the bubble bursts, however, many investors default on what prove to be unsustainable loans. Mishkin and White (2002) believe that the instability of the banking/financial system, rather than the stock market crashes *per se*, is the major macro-economic concern.

In an earlier paper (Menzies et al. 2009) we confirmed that a computable general equilibrium (CGE) model can indeed deliver large macroeconomic costs of financial fragility (see also Dixon and Rimmer, forthcoming). An extended financial crisis (three or five years) follows a two year boom.[9] The crisis is modeled by a 'capital strike', where Tobin's *q* is one-half of one standard deviation lower across the whole economy. Figure 2 shows the simulated losses to the economy in terms of the net present value (NPV) of forgone consumption and GDP.[10]

Figure 2: NPV of GDP and Consumption Deviations: percentage deviations

Scenarios	One-off %C NPV	One-off %GDP NPV
Two year boom followed by 3 year pessimism	-6.5	-4.4
Two year boom followed by 5 year pessimism	-8.9	-6.0

Financial crises are undoubtedly spectacular, in models and in reality, but there are 'quieter' microeconomic costs of mispricing associated with the disruption of the optimal allocation of resources (Chrinko and Schaller 2007; Barlevy 2007; Diamond 1965 and Oliver 2000). Once this

9 Investors hold overly optimistic expectations about returns in the Telecommunication and Technology industries (5 per cent of GDP) Tobin's q is higher in both sectors by one standard deviation over two years. However, the additional investment that flows from these unrealistic expectations is completely wasted; it doesn't add to the capital stock.

10 As discussed in Menzies et al. (2009), the effects are large because of powerful macroeconomic channels. As investment booms, the real exchange rate appreciates and this leads to an improvement to the terms of trade. The converse happens when investment collapses at the end of the bubble. Capital decumulation holds back growth, and, the Mundell-Fleming investment/exchange rate nexus superimposes a demand cycle over the lowered trend in aggregate supply. When we later quantify microeconomic costs, capital is held fixed, shutting down the Mundell-Fleming and accumulation channels.

occurs the theory of second best implies that moving any one condition closer to what would prevail in a fully optimal system may not, in isolation, be optimal (Lipsey and Lancaster, 1956).

Quantifying the effects of mispricing would be 'academic', in the bad sense of that word, were it not likely that asset prices often are, in fact, mispriced. As outlined in Barberis and Thaler (2003) limits-to-arbitrage arguments (Shleifer and Vishny 1997) have blunted Friedman's (1953) assertion that mispricing is always immediately eliminated by arbitrageurs. The risk that 'noise traders' take a security further away from its fundamental value, transforms arbitrage – which is riskless by definition – into a highly risky activity.

A beautiful example of this is furnished by Froot and Dabora (1999) who track the relative price of Royal Dutch securities to Shell securities. The unusual nature of these assets – Royal Dutch and Shell securities are each a claim on 60 per cent and 40 per cent of the *combined* cash flow of the two companies – ensure that the rational relative price ought to be 1.5. Instead, Royal Dutch is sometimes 35 per cent underpriced and sometimes 15 per cent overpriced. Given the features of this natural experiment, the only remaining risk of holding Royal Dutch must be the risk of noise trading.

Naturally, the dilemma for asset price regulators is that any conceivable attempt to attenuate phenomena like noise trading runs the risk of stopping equilibrating adjustments in asset prices. The policy pendulum swings uneasily back and forth between laissez-faire and, more recently, regulation. Monetary policymakers are likely to become more proactive in bursting bubbles, despite the controversy about the timing (see Posen 2006 and Roubini 2006), and, financial markets might be substantially re-regulated.[11] The likelihood of relatively inflexible asset prices motivates our quantification of the costs of misallocation.

[11] See Robinson and Stone (2005) for an Australian perspective on the macroeconomic desirability of controlling asset prices. Models such as these do not consider efficiency losses from influencing prices.

3 The USAGE Model

3.1 Computable General Equilibrium Models Neutralizes the Lucas Critique

USAGE is a dynamic Computable-General-Equilibrium (CGE) model of the US economy, with a similar structure to the MONASH model for the Australian economy (Dixon and Rimmer, 2002). Usage can be run with up to 500 industries, 700 occupations 23 trading partners and 51 regions (50 states plus D.C.).[12]

We chose to study the effects of asset mispricing in the US partly because USAGE is a 'state of the art' CGE model used in contemporary policy discussion (US International Trade Commission, 2004 & 2007) and because the industry data we need for Tobin's q is readily available. In any case, important economic channels transmit real shocks in the US economy to Australia (Beechey et al. 2000), and, the GFC is eloquent testimony to the contagion of US asset prices (Debelle, 2010).[13]

The version of the model used in this paper lacks an explicit financial sector or a monetary and fiscal authority. Without policy, the model relies upon a pro-cyclical exchange rate to stabilize the economy. That is, the Mundell-Fleming assumption of perfect capital mobility means that infinitesimal interest rate changes move the nominal exchange rate. Equilibrium is attained via expenditure-switching adjustments in the real exchange rate.

With all the macroeconomic adjustment coming through this channel, the movements in the real exchange rate required to obtain equilibrium are probably larger than in reality. These simulations therefore share a drawback of all macro models that rely on expenditure switching as an

12 USAGE was developed starting in 2001 as a joint project between the Centre for Policy Studies, Monash, and the US International Trade Commissiion. To date, its main uses have been for trade, energy, environment and immigration policy. While the USAGE database is thoroughly documented, there is no comprehensive description of the USAGE theory. However, its close similarity to the MONASH theory means that readers seeking further information are justified in looking at the MONASH documentation in Dixon and Rimmer (2002).

13 Debelle (op. cit.) documents a correlation between US equities and the $US value of Australian equities.

equilibrating channel; the relatively poor performance of models of nominal exchange rates (Frankel and Rose 1995).

Nevertheless, a CGE model is the analytic tool least hamstrung during times of structural change, financial innovation and turbulent policy making (Lucas, 1976). The USAGE model is built upon 'non-policy' parameters[14], in contrast to models that are driven by historically estimated specifications of policy rules. Indeed, it was precisely times such as these (eg. the turbulent 1970s) which spawned the development of CGE models in the first place.

3.2 General Structure

USAGE includes three types of dynamic mechanisms: capital accumulation; liability accumulation; and lagged adjustment processes.

Capital accumulation is specified separately for each industry. An industry's capital stock at the start of year t+1 is its capital at the start of year t plus its investment during year t minus depreciation. Investment during year t is determined as a positive function of the expected rate of return on the industry's capital.

Liability accumulation is specified for the public sector and for the foreign accounts. Public sector liability at the start of year t+1 is public sector liability at the start of year t plus the public sector deficit incurred during year t. Net foreign liabilities at the start of year t+1 are specified as net foreign liabilities at the start of year t plus the current account deficit in year t plus the effects of revaluations of assets and liabilities caused by changes in price levels and the exchange rate.

Lagged adjustment processes are specified for the response of wage rates to gaps between the demand for and the supply of labor by occupation. There are also lagged adjustment processes in

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14 USAGE contains variables describing: primary-factor and intermediate-input-saving technical change in current production; input-saving technical change in capital creation; input-saving technical change in the provision of margin services; and input-saving changes in household preferences. We assume that our shocks do not effect on technology or household preferences.

USAGE for the response of foreign demand for U.S. exports to changes in their foreign-currency prices.

In a USAGE simulation of the effects of shocks, we need two runs of the model: a basecase or business-as-usual run and a shocked run. The basecase is intended to be a plausible forecast while the shocked run generates deviations away from the basecase caused by the shock under consideration. The basecase incorporates trends in industry technologies, household preferences and trade and demographic variables. These trends are estimated largely on the basis of results from historical runs in which USAGE is forced to track a piece of history. Most macro variables are exogenous in the basecase so that their paths can be set in accordance with forecasts made by expert macro forecasting groups such as the Congressional Budget Office. This requires endogenization of various macro propensities, e.g. the average propensity to consume. These propensities must be allowed to adjust in the basecase run to accommodate the exogenous paths for the macro variables.

The shocked run in a USAGE study is normally conducted with a different closure (choice of exogenous variables) from that used in the basecase. In the shocked run, macro variables must be endogenous: we want to know how they are affected by the shock. Correspondingly, macro propensities are exogenized and given the values they had in the basecase. More generally, all exogenous variables in the shocked run have the values they had in the basecase, either endogenously or exogenously. Comparison of results from the shocked and basecase runs then gives the effects of moving the shocked variable(s) away from their basecase values.

For this paper, we assume that expected rates of return are generated by projecting current information. This is convenient because it allows the model to be solved recursively (in a sequence, one year at a time). We do not consider that the alternative, rational expectations, would add realism.

USAGE contains functions specifying the supply of funds for investment in each industry as an upward-sloping function of the industry's expected rate of return. Our shock consists of shocking the functions so that (in the case of optimism) a given expected rate of return results in higher investment, and (in the case of pessimism) the same given rate of return results in lower investment compared with the basecase. The investment function is explained in detail in Dixon and Rimmer (2002, pg. 189).

4 The Relative Unimportance of Capital Misallocation

4.1 Theoretical Benchmark

It might be thought that the envelope theorem is sufficient to assure the main claim of this paper. To see how, consider the allocation of capital to a single industry.

Assume that there is a *distribution* of capital (K) around the *optimal* allocation, κ. Optimal capital maximizes profits, π, by solving $\partial\pi/\partial K = 0$. But firms make errors in their attempts to reach κ; for simplicity let $K \sim N(\kappa, \sigma^2)$. That is, despite their best efforts firms find themselves in the neighbourhood of the maximum of a surface relating capital K to profits $\pi(K)$.

We want to know the conditions under which these departures from optimality will not matter very much for the firm. Equivalently, we want to know when the variance of π resulting from variation in K (σ^2 above) will not be large. Algebraically, we work out the variance of π where K is in the neighbourhood of κ.

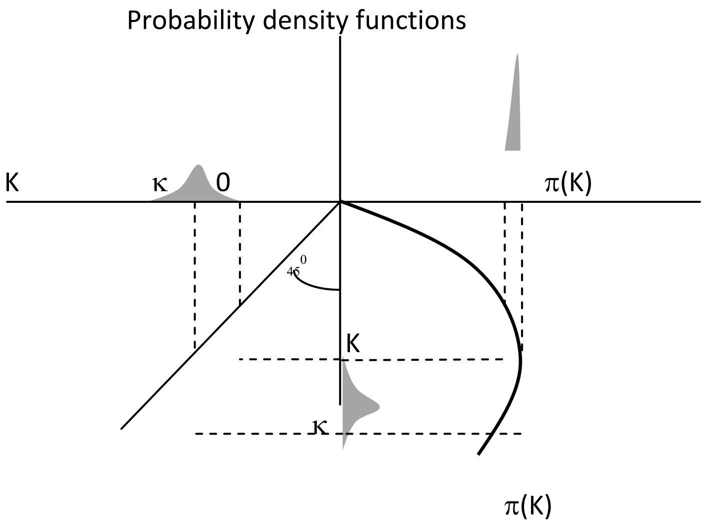
$$\pi(K) = \pi(\kappa) + \pi^{'}(\kappa).(K-\kappa) + \frac{\pi^{''}(\kappa)}{2}.(K-\kappa)^2 \qquad (1)$$

Then, we take the variance.

$$V[\pi(K)] = [\pi^{'}(\kappa)]^2\sigma^2 + \left(\frac{\pi^{''}(\kappa)}{2}\right)^2 \sigma^4 \qquad (2)$$

Equation (2) is a variant of the envelope theorem. If π'=0, and if the profit function is close to linear at the optimum (π'' approaches zero) then the effects of σ^2 are vanishingly small and perturbations in capital are unlikely to matter for profits. Informally, if the profit function is 'flat' relative to the size of volatility in capital, the costs and the final impact on profits are low. In Figure 3a, we see why the 'flat' profit function compresses the volatility in profits. The distributions are shown in grey.

Figure 3a: Misallocated Capital and Profits



To understand Figure 3a, one takes imaginary draws from the bell-shaped distribution on the left of the horizontal axis, and traces them through to the profit function (we have done so with one draw from the tail and one at the mean). Figure 3a and (2) suggest that there is a small effect on profits if capital is misallocated by 'small' amounts in a single industry, due to the envelope theorem.[15]

In the real world, however, capital is not always optimally allocated and there are multiple industries, so the theory of second best (Lipsey and Lancaster, 1956) gives us pause. Furthermore, it

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[15] The small effect on profits would then ensure a small effect on GDP, consumption and welfare.

is unclear if perturbations to capital are indeed 'small'. Each concern disarms the envelope theorem, as illustrated in Figures 3b and 3c.

Figure 3b: Non-optimal K

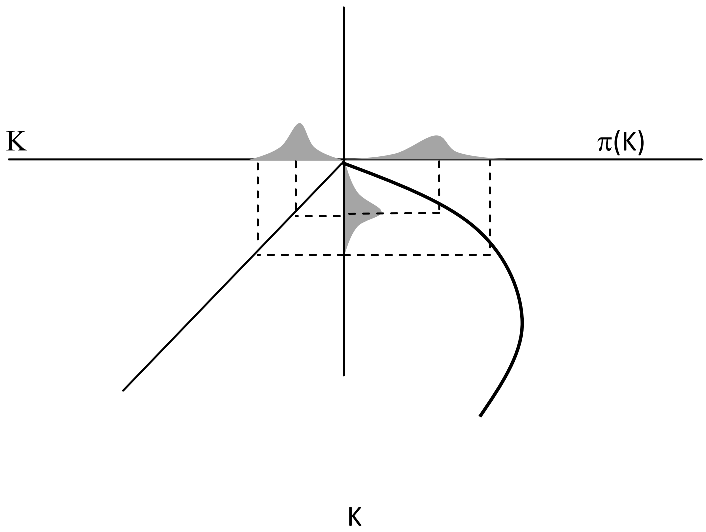
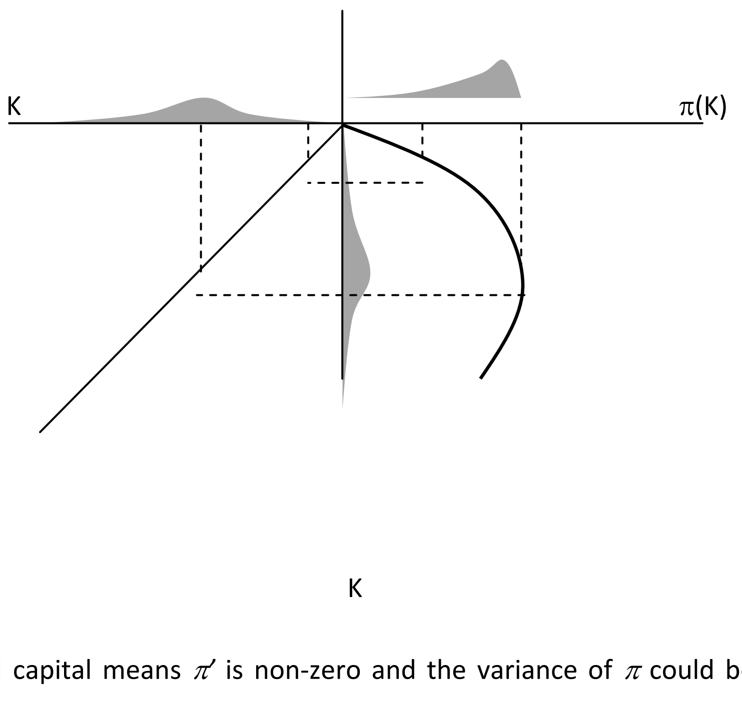


Figure 3c: Non-'small' variance of K



Non-optimal capital means π' is non-zero and the variance of π could be *even larger* than the variance of *K*. This can be seen from (2), or from sliding the distribution of K close to the origin in Figure 3a (see 3b). Furthermore, if K perturbations are large, the tail draws of K (on the left side of the distribution of 3c) may run into the steep portions of $\pi(K)$ and again the variance of profits may be large even if capital is optimal, on average.

In what follows we adopt the USAGE model to see if the effects of capital misallocation are small given that the returns to capital, and q's, differ across different US industries.[16]

Figure 4 US Tobin q's[17]

	2005	2006	2007	Average 1980-2007	stand dev
Healthcare	2.36	2.47	2.14	1.69	0.45
Technology	1.70	1.64	1.62	1.43	0.42
Oil & Gas	1.52	1.44	1.35	1.00	0.23
Consumer Services	1.27	1.36	1.23	0.95	0.18
Industrials	1.22	1.29	1.26	0.93	0.16
Consumer Goods	1.09	1.21	1.10	0.91	0.13
Basic Materials	1.41	1.73	1.70	0.90	0.30
Telecommunications	1.07	1.29	1.28	0.89	0.27
Utilities	0.81	0.90	0.90	0.85	0.07
Financials		0.90		0.85	0.26

We set up a 38 industry version of USAGE with the data calibrated so that the implied Tobin q's are consistent with those in Figure 4. In making the calibration we adjusted the initial USAGE data for capital stocks and gross operating surplus by industry.

4.2 The Effects of Reallocating Capital are Second-order Small

Working with this adjusted database, we used USAGE to compute the effects on economic welfare of:

16 Even apart from the evidence of Figure 4, anecdotal evidence suggests the returns to capital in farming and housing have traditionally been low.

17 Source: Datastream. q = (Market Value of Ordinary shares + Book Value of Preference Capital + Total Debt)/Total Assets. Industry Tobin's q is the Tobin's q of the median firm within each industry. Financials was deemed to have the average q of utilities, due to a presumption that the finance sector had too many resources in it in 2007, rather than too few. The raw average for financials was 1.21, but the subsequent crisis suggests these shares were seriously overvalued. Equating financials' q to utilities' q is not justifiable because of the industry characteristics of utilities. Rather, the adjustment is made to maximize the dispersion of q, thereby providing a 'severe test' for the unimportance of misallocation.

(1) reallocating the U.S. capital stock across industries to equate Tobin qs;

(2) reallocating the U.S. capital stock across industries to equate rates of return;

In USAGE, under various simplifying assumptions (Appendix 1), Tobin's q ($TQ_{j,t}$) and rates of return (($ROR_{j,t}$) for industry j in year t can be represented as:

$$TQ_{j,t} = \frac{Rent_{j,t} * (1 - T_t)}{\Pi_{j,t}(RINT_t + D_j)} \tag{3}$$

$$ROR_{j,t} = -1 + \frac{\left[(1 - T_t) * \left(Rent_{j,t} / \Pi_{j,t}\right) + \left(1 - D_j\right)\right]}{\left(1 + RINT_t\right)} \tag{4}$$

where

$Rent_{j,t}$ is the gross (before depreciation) profit per unit of capital in industry j in year t;

T_t is the rate of tax applying to capital income in year t;

$\Pi_{j,t}$ is the cost of constructing a unit of capital in industry j in year t;

$RINT_t$ is the safe real interest rate in year t; and

D_j is the rate of depreciation on j's capital.

From (3) and (4) we find that Tobin's q and rates of return are related by

$$ROR_{j,t} = \frac{(RINT_t + D_j)}{[1 + RINT_t]}\{TQ_{j,t} - 1\} \quad . \tag{5}$$

Theories of investor behavior suggest that in a long run equilibrium state TQs are one or equivalently RORs are zero. However, as is clear from Figure 4 and from the database of any dynamic CGE model, TQs are often far from 1 for extended periods and similarly RORs are often far from zero. Figure 5 provides an indication of how much welfare is lost by the failure of the economy to operate in its long-run equilibrium state.

Figure 5: USAGE results for the effects of capital reallocations:

percentage deviations

		Average q's		2006 q's	
		Equalizing Tobin qs	Equalizing rates of return	Equalizing Tobin qs	Equalizing rates of return
1	aggregate capital, asset wgts	0	0	0	0
2	aggregate capital, rental wgts	-0.1178	-0.2048	2.0400	2.5703
3	aggregate employment	0	0	0	0
4	real net investment	0	0	0	0
5	balance of trade	0	0	0	0
6	real GDP	-0.0322	-0.0505	0.4798	0.5989
7	real net DP	0.0095	0.0049	0.2656	0.3035
8	real consumption	0.0279	0.0250	0.2482	0.2749
9	real investment	-0.0281	-0.2810	1.2933	1.7462
10	export volumes	-0.4888	-0.5377	0.5078	0.8138
11	import volumes	-0.1912	-0.2106	0.2057	0.3275
12	terms of trade	0.1634	0.1799	-0.1687	-0.2698

Row 8, column 1 of Figure 5 indicates that U.S. welfare, measured by the deviation in consumption (public and private combined), would be 0.0279 per cent higher if capital were reallocated to equalize the TQ_js across all j. Column 2 indicates that welfare would be increased by 0.0250 per cent if capital were reallocated to equalize the ROR_js.

The critical assumption underlying these calculations is that the aggregate volume of capital stock in the U.S. is fixed. Coming from a position of non-optimality, this implied that when Tobin's q was equalized across sectors, it settled at a value close to unity (0.98). Given different depreciation rates across sectors (5) implies that equalizing rates of return is not the same as equalizing the q's.

Other assumptions are that the reallocation of capital does not affect the trade balance, aggregate employment and net investment. The assumptions explain the zeros in rows 1, 3, 4 and 5 of Figure 5. We choose these assumptions to isolate as much as possible the effects of changing the allocation of capital across industries.

Real GDP falls in both columns 1 and 2 of Figure 5. This is because the reallocation of capital in both simulations is towards industries with low depreciation rates.

As can be seen in Figure 6, in both simulations the ownership of dwellings industry, which has easily the lowest depreciation rate, gains capital. Industries with low depreciation rates tend to have low rentals per dollar's worth of capital reflecting the limited requirements for gross profits to be used in capital maintenance. Thus, capital in industries with low depreciation rates make relatively low contributions per dollar's worth of capital to *Gross* domestic product, but this doesn't apply to *Net* domestic product which shows an increase in both simulations (row 7 of Figure 5).

Another indication of the reallocation of capital towards industries with low rentals per dollar's worth of capital are the negative results in row 2 of Figure 5 for aggregate capital, rental weights. In both simulations the reallocation of capital causes reductions in exports and imports. Detailed checking would reveal that import competing industries have TQs and RORs that are high relative to those of export oriented industries. Consequently, import competing industries gain capital relative to export-oriented industries in the simulations, causing import replacement and export reduction.

Figure 6. USAGE data and results for the effects of capital reallocations

Indutry	USAGE results Percentage deviations in quantity of capital Equalizing Tobin Qs	 Equalizing rates of return	USAGE data Depreciation rates	Initial values of: TQ[a]	 ROR
1 agric	-0.2163	-0.4732	0.0756	1.00	0.0000
2 agrserv	0.3455	0.1298	0.1132	1.00	0.0000
3 mining	0.3757	-0.1031	0.0766	1.00	0.0004
4 construct	-0.7060	-0.8900	0.1149	0.93	-0.0087
5 dairySugar	-1.2214	-1.4186	0.0752	0.91	-0.0078
6 foodmanu	-1.4836	-1.6976	0.0752	0.91	-0.0078
7 tobaccoProd	-1.9486	-2.1473	0.0693	0.91	-0.0073
8 Apparel	-1.8157	-1.9771	0.0792	0.91	-0.0083
9 textiles	-2.1786	-2.3789	0.0789	0.91	-0.0083
10 WoodFurn	-1.1272	-1.3138	0.0865	0.93	-0.0068
11 PaperPub	-1.1833	-1.5095	0.0941	0.93	-0.0074
12 Chemicals	-1.8351	-2.0979	0.0846	0.93	-0.0066
13 Petrolprods	0.1241	-0.0594	0.0636	1.00	0.0000
14 Footwear	-2.0757	-2.2249	0.0673	0.91	-0.0073
15 MetalProds	-1.9353	-2.1108	0.0654	0.90	-0.0079
16 Machinery	-1.7161	-1.9368	0.0759	0.93	-0.0062
17 Computers	4.9044	4.6618	0.0759	1.43	0.0384
18 ElectMach	8.0567	7.8215	0.0891	1.43	0.0440
19 MotorVeh	-1.7221	-1.9767	0.1046	0.93	-0.0082
20 TransEquip	-1.4573	-1.6344	0.0772	0.93	-0.0063
21 ManuNEC	-1.1095	-1.3335	0.0917	0.93	-0.0072
22 Communicat	-2.5492	-2.8047	0.0621	0.89	-0.0082
23 Utilities	-1.4531	-1.7556	0.0512	0.85	-0.0095
24 TradMarg	-0.6630	-0.8731	0.0867	0.95	-0.0048
25 OwnoccDwell	0.7267	0.9091	0.0182	1.00	0.0000
26 BusFinServ	-2.2239	-2.3578	0.0984	0.85	-0.0165
27 MedicServ	10.5934	10.4330	0.0736	1.69	0.0600
28 Education	-0.6040	-0.6743	0.0416	0.95	-0.0027
29 SocialServ	-0.7060	-0.8668	0.0823	0.95	-0.0046
30 Enterprise	-0.0746	0.0412	0.0273	0.95	-0.0020
31 MiscServ	-0.6870	-0.8570	0.0782	0.95	-0.0045
32 GovtServ[b]	-0.8368	-0.8918	0.0344	0.95	-0.0024
37 TransMarg	-0.7519	-0.9638	0.0815	0.95	-0.0047
38 AutoRent	0.1525	-0.0805	0.0700	0.95	-0.0041

(a) Tobin q's were allocated to USAGE industries from Figure 4. No information relevant for agriculture or ownership of dwellings was available from Figure 4. For these industries we assumed TQs of one.

(b) Industries 33 to 36 have no capital.

With the contractions in trade, the Figure 5 simulations show improvements in the terms of trade (row 12). The improvements in the terms of trade together with the gains in real net domestic product (row 7) combine to explain the welfare gains in row 8.

The last two columns of Figure 5 do a sensitivity analysis where the 2006 q's are used, instead of the average q's. The consumption gain is 0.2656 when q's are equalized. This is a small number, but larger than the effect where average q's are used. This raises the question of robustness, which we address in Appendix 2. It is demonstrated analytically there that that the gain in real net domestic product (NDP) will be no greater than ½ per cent, which implies the positive effects on consumption will likewise be small.

4.3 Adverse Shocks Have Second-order Small effects

As we saw earlier the envelope theorem suggests that reallocating the capital stock from an optimal allocation in a single industry will have a vanishingly small effect on economic welfare. The theory of second best prohibits what might seem like a commonsense corollary, namely; if we start in a situation where capital in several sectors is not optimally allocated moving capital in one sector away from its optimal allocation harms welfare.. The theory does not claim that adverse movements in capital *will definitely* improve welfare; rather, it simply claims that this is a *possibility* in a general equilibrium setting. To rule this out we need a model that recognizes misallocation, like USAGE.

Figure 7 Costs of Increasing HealthCare q by 1 standard deviation:

percentage deviations

		Average q's off initial database	off database with equalized RORs	2006 q's off initial database
1	aggregate capital, asset wgts	0	0	0
2	aggregate capital, rental wgts	-0.1404	-0.1107	-0.1179
3	aggregate employment	0	0	0
4	real net investment	0	0	0
5	balance of trade	0	0	0
6	real GDP	-0.0239	-0.0180	-0.0245
7	real net DP	-0.0193	-0.0064	-0.0227
8	real consumption	-0.0207	-0.0076	-0.0241
9	real investment	-0.0356	-0.0637	-0.0237
10	export volumes	0.0342	0.0318	0.0354
11	import volumes	0.0135	0.0125	0.0140
12	terms of trade	-0.0114	-0.0106	-0.0118

The first column of Figure 7 report results in which we start from the initial situation (with the average q's from Figure 4 in place) and simulate the effects of an increase of 0.45 (one-standard-deviation) in the q for Healthcare. Capital (and labour) go to the other sectors, leaving the aggregate capital stock unchanged. This is clearly a move in the wrong direction: Capital should be moving into Healthcare on a q criterion.

Welfare falls (by 0.0207 per cent, row 8, column 1). In column 2 of Figure 7, we repeat the column-1 experiment but instead of using the initial situation as the starting point, we use the situation arrived at when we equalized rates of return (the final equilibrium of the Figure 5 simulation). Consistent with the envelope theorem, the increase in health-care q now causes a relatively small loss of welfare (0.0076 per cent compared with 0.0207 per cent).

But both numbers are really quite small. Assuming a discount rate of 5 per cent, the losses should be multiplied by 20 for Net Present Value figures. That is, an aberrant shock from a position of optimality costs NPV 0.15 per cent and an adverse shock from the USAGE allocation is NPV 0.41 per cent of consumption. The fact the effect is negative shows that the theory of second best is practically unimportant (at least for this shock), and, the NPV size suggest that plausible perturbations in the capital stock are ‘small’, as required by the envelope theorem.

Columns 3 conduct a sensitivity analysis. We repeat the exercise of column 1 but with the initial levels of q set at their 2006 levels. The results are basically identical.

5 Conclusion

In this paper, we have argued for the relative unimportance of plausible capital misallocation in USAGE. We have been able to calibrate USAGE with empirical Tobin q’s and proceed with sensible analysis recognizing that US capital is not optimally allocated. We have established that when capital is allowed to move to equalize returns or Tobin’s q, the benefits are second order small. Furthermore, when a one-standard-deviation perturbation takes capital away from a capital-starved sector (Healthcare) and distributes it to other sectors the NPV effect is both negative and small. This suggests respectively that the theory of second best is unimportant practically, and, that the plausible perturbation in capital associated with historic share market volatility is ‘small’ in the microeconomic sense. That is, the intuition of the envelope theorem carries over to a realistic CGE model, though we could not have known this without doing the modeling exercise.

We therefore conclude that the risk of the misallocation of capital entailed in financial intervention is only a weak argument against it. However, we would be remiss not to mention a number of other obvious caveats.

First, the results naturally depend on the validity of the USAGE model as a descriptor of the US economy. This is always a consequence of using a particular empirical model to answer a policy question. However, the advantage of using such a model is that it forces assumptions onto the table for scrutiny, warts and all. If other frameworks do not do this, their lack of *explicit* assumptions should not be mistaken for their absence. Furthermore, the back-of-the-envelope calculation in Appendix 2 shows that the basic insights would remain valid for a broader class of models that embody fairly standard micro-foundations.

Second, while the gain in welfare from a full reallocation of capital to equate q's or real returns is small, it does not follow that distortions in an economy might not have large distributional consequences. For example, as a per cent of GDP, the benefits of full trade liberalization are generally small[18] but the global distributional consequences of, say, Europe's Common Agricultural Policy are by no means trivial.

Finally, and most importantly, excessive regulation could take misallocation outside what we have called a plausible range of volatility – away from 'small' capital perturbations. As Figure 3c suggests, this could *increase* the volatility of profits, and reduce welfare. Furthermore, we are cognizant of the Lucas critique, which we have worked hard to meet in this paper by using a CGE model. Heavy-handed regulation could distort the deep parameters of our model and weaken its conclusions.

Having made all these caveats, the overriding message of this paper is that plausible misallocations in US capital have fairly small general equilibrium effects. Regulators and policy makers thus have considerable 'room to move' as they explore what we have left unexplored in this paper – the policies and regulatory structures that limit macro-economically destabilizing movements in asset prices.

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[18] For example, detailed studies of U.S. import restraints (tariffs and quotas) imply that these generate annual welfare losses of no more than a small fraction of one per cent of GDP. See for example USITC (2004 & 2007).

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Appendix 1: Relating the expected rate of return to Tobin's q

Our starting point is (21.7) in Dixon and Rimmer (2002), where EROR_ST is now written EROR and R_INT_PT_SE is R_INT (as we ignore 'Post Tax' effects).

$$EROR_{j,t} = -1 + [(1-T_t)^* \; Q_{j,t} / \Pi_{j,t} + (1-D_j)]/(1+RINT_t), \tag{A1.1}$$

We used lower case *q* to denote Tobin's *q* in the text, to avoid confusion with the rental rate. We can define this for industry j (leaving out j for convenience) via the equation:

$$q = \frac{Q_{t+1}(1-T)}{\Pi_t(1+INT)} + \frac{Q_{t+2}(1-T)(1-D)}{\Pi_t(1+INT)(1+INT)} + \frac{Q_{t+3}(1-T)(1-D)^2}{\Pi_t(1+INT)(1+INT)^2} + \ldots\ldots \tag{A1.2}$$

In this equation Q is viewed as the present value of the stream of profits flowing from a unit of capital divided by the book value of a unit of capital (note: the book value is historic cost, so Π_t does not grow for future periods). We have made the assumption that the tax, discount and nominal interest rates are constant. If we make the additional assumption that the rental rate grows with (constant) inflation we can write *q* as follows:

$$q = \frac{(1+INF)Q_t(1-T)}{\Pi_t(1+INT)} + \frac{(1+INF)Q_t(1+INF)(1-T)(1-D)}{\Pi_t(1+INT)(1+INT)} + \frac{(1+INF)Q_t(1+INF)^2(1-T)(1-D)^2}{\Pi_t(1+INT)(1+INT)^2} + \ldots\ldots$$

$$= \frac{Q_t(1-T)}{\Pi_t(1+RINT)} + \frac{Q_t(1+INF)(1-T)(1-D)}{\Pi_t(1+RINT)(1+INT)} + \frac{Q_t(1+INF)^2(1-T)(1-D)^2}{\Pi_t(1+RINT)(1+INT)^2} + \ldots\ldots$$

where RINT=INT-INF. This is a geometric progression with ratio (1+INF)(1-D)/(1+INT) ≈ 1-(RINT+D) Summing to infinity we obtain a simplified q.

$$q = \frac{\dfrac{Q_t(1-T)}{\Pi_t(1+RINT)}}{[1-(1-(RINT+D))]} \approx \frac{Q_t(1-T)}{\Pi_t(RINT+D)} \quad . \tag{A1.3}$$

Hence, after straightforward manipulation we may connect EROR to q.

$$EROR_t = \frac{(RINT + D)}{[1 + RINT]}\{q - 1\} \tag{A1.4}$$

Appendix 2

How big a gain should we expect when capital is reallocated to equalize rates of return or Tobin Qs?

USAGE simulations give what seems at first to be surprisingly low values for the welfare gain (measured by the percentage increase in net domestic product) of reallocating capital to eliminate differences in sectoral rates of return. Here we explain the welfare gain via a back-of-the-envelope (BoTE) formula. Our formula takes account of four factors: (a) the initial divergences in rates of return; (b) the elasticity of substitution between capital and labour in production; (c) the elasticity of substitution between commodities in consumption and other final use; and (d) the share of returns to capital in net domestic product. Factor (a) determines by how much rates of return must move to reach equality. Factors (b) and (c) determine the sensitivity of inter-sectoral capital movements to movements in rates of return. Factor (d) acts as a scaling device, converting from percentage changes in the income generated by a given aggregate amount of capital to percentage changes in overall welfare.

The BoTE formula is straightforward but its derivation is quite long. Readers who are not interested in algebraic details should go immediately to equation (A2.20) and the text that follows. The algebraic symbols of this appendix are self-contained – they are defined as they appear and do not refer to the main body of the paper.

Our derivation of the BoTE formula has several steps. First, we express the percentage change in net domestic product as a function of percentage changes in sectoral capital stocks. Next we relate percentage changes in sectors capital stocks to percentage changes in rental rates on capital. Following this we relate percentage changes in rental rates to changes in rates of return.

Changes in rates of return are imposed by the move to equality. Finally, we combine results from these steps to express the percentage change in net domestic product in terms of initial rates of return.

Expressing the percentage change in net domestic product as a function of percentage changes in capital stocks

The increase in net domestic product (ΔNDP) from a reallocation of capital stocks across industries is given by:

$$\Delta NDP = \sum_i \left(P_i^{VA} * MPK_i - D * P^K \right) * \Delta K_i \qquad \text{(A2.1)}$$

where

P_i^{VA} is the price of a unit of value added in industry i;

MPK_i is the marginal product of capital in industry i;

ΔK_i is the change in the capital stock in industry i;

D is the rate of depreciation on capital; and

P^K is the price of unit of capital (asset price).

In (A2.1) we assume that the rate of depreciation and the price of a unit of capital are the same in all industries. We also ignore indirect taxes. These simplifications are not adopted in the USAGE model but are helpful, and not misleading, in deriving a back-of-the-envelope estimate of the effect on NDP of capital reallocation.

Ignoring taxes on capital income we write:

$$P_i^{VA} * MPK_i = Q_i \qquad \text{(A2.2)}$$

where

Q_i is the rental price of a unit of capital in industry i.

Under the simplifications that we have adopted, the rate of return in industry i (ROR_i) is given by

$$ROR_i = -1 + \left[\frac{Q_i}{P^K} + (1-D)\right] * \left[\frac{1}{1+R}\right] \qquad \text{(A2.3)}$$

where

R is the real rate of interest.

Ignoring second-order terms, we can rearrange (A2.3) as

$$\frac{Q_i}{P^K} = ROR_i + R + D \quad . \qquad \text{(A2.4)}$$

Because we are looking at the effects of reallocating a fixed amount of capital, it is true by definition that:

$$\sum_i S_i^A * k_i = 0 \quad . \qquad \text{(A2.5)}$$

where

k_i is the percentage change in the amount of capital in industry i ($100*\Delta K_i/K_i$); and

S_i^A is industry i's share in the asset value capital ($P^K K_i \Big/ \sum_j P^K K_j$).

Using (A2.2), (A2.4) and (A2.5) in (A2.1) we obtain

$$ndp = \left(\frac{\sum_j P^K * K_j}{NDP}\right) * \sum_i ROR_i * S_i^A * k_i \qquad \text{(A2.6)}$$

or equivalently, noting (A2.5):

$$ndp = \left(\frac{\sum_j P^K * K_j}{NDP}\right) * \sum_i G_i * S_i^A * k_i \qquad \text{(A2.7)}$$

where

G_i is the gross rate of return in industry i (ROR_i + D + R); and

ndp is the percentage change in NDP ($100*\Delta NDP/NDP$).

Relating percentage changes in capital stocks to percentage changes in rental rates

A stylized version of the demand side of our CGE model is

$$x_i = ndp - \psi * \left(p_i^{VA} - p\right) \qquad \text{(A2.8)}$$

where

x_i is the percentage change in the demand for output from industry i;

ψ is the elasticity of substitution between commodities from the point of view of demanders; and

p is the percentage change in the aggregate price index.

The zero pure profit condition can be expressed as:

$$p_i^{VA} = S_{ki} * q_i + S_{\ell i} * w \qquad \text{(A2.9)}$$

where

S_{ki} and $S_{\ell i}$ are the capital and labour shares in returns to primary factors in industry i;

q_i is the percentage change in the rental on capital in industry i; and

w is the percentage change in the wage rate.

The percentage change in the demand for capital in industry i is given by

$$k_i = x_i - \sigma * S_{\ell i}\left(q_i - w\right) \qquad \text{(A2.10)}$$

where

σ is the elasticity of substitution between capital and labour.

We adopt the simplification that capital and labour shares in each industry have the common values S_k and S_ℓ. Then using (A2.8) and (A2.9) in (A2.10) and applying (A2.5) we obtain

$$k_i = -\beta * \left(q_i - \sum_j S_j^A * q_j\right) \qquad \text{(A2.11)}$$

where

$$\beta = \psi * S_k + \sigma * S_\ell \quad . \qquad \text{(A2.12)}$$

Determining percentage changes in the rental rates on capital

We assume that Q_i is positive. Then from (A2.4) we find that

$$\frac{Q_i}{P^K}*\left(q_i - p^k\right) = 100*d\_ror_i \quad . \tag{A2.13}$$

where

d_ror_i is the change in the rate of return in industry i; and

p^k is the percentage change in the asset price of a unit of capital ($100*\Delta P^K/P^K$).

It is convenient to adopt P^K as the numeraire so that p^k equals zero. Equation (A2.13) can then be rearranged as

$$q_i = 100*\left(\frac{1}{G_i}\right)*d\_ror_i \quad . \tag{A2.14}$$

In a situation in which rates of return are being moved towards equality across industries,

$$d\_ror_i = \alpha*\left(-ROR_i + ROR_{ave}\right) \quad . \tag{A2.15}$$

where

ROR_{ave} is the average rate of return across industries; and

α is positive number between 0 and 1 indicating the fraction of the total movement to equality that is being undertaken. For example, if one per cent of the inequality between rates of return is being eliminated, then α = 0.01.

Substituting from (A2.15) into (A2.13) gives

$$q_i = 100*\left(\frac{1}{G_i}\right)*\alpha*\left(-ROR_i + ROR_{ave}\right) \tag{A2.16}$$

or equivalently,

$$q_i = 100*\left(\frac{1}{G_i}\right)*\alpha*\left(-G_i + G_{ave}\right) \tag{A2.17}$$

Bringing it all together: expressing the percentage change in NDP in terms of gross rates of return

Combining (A2.17) and (A2.11) gives

$$k_i = -\beta*100*\alpha*G_{ave}\left(\frac{1}{G_i} - \sum_j S_j^A*\frac{1}{G_j}\right) \tag{A2.18}$$

Now we substitute (A2.18) into (A2.7) to obtain:

$$\text{ndp} = -100 * \beta * S_k^N * \alpha * \left(1 - \sum_i \sum_j S_i^A * S_j^A * \frac{G_i}{G_j}\right) \tag{A2.19}$$

or equivalently,

$$\text{ndp} = 100 * \beta * S_k^N * \alpha * \left(\sum_{i>j} S_i^A * S_j^A * \frac{\left(G_i - G_j\right)^2}{G_i * G_j} \right) \tag{A2.20}$$

where

S_k^N is the share of capital rents in NDP and is given by $G_{ave} * \sum_j P^K K_j / NDP$.

Reassuringly (A2.20) implies that ndp equals zero if gross rates of return are the same in all industries. Otherwise, it is positive. Thus (A2.20) implies that reallocation of capital in a way that moves rates of return towards equality has a positive effect on NDP.

In using (A2.20) to estimate the effects of moving all the way to rate-of-return equality (α=1) we must think about movements in the coefficients appearing on the right hand side. It is reasonable to ignore movements in β and S_k^N. However the bracketed term moves from a positive value to zero as rates of return move to equality. In evaluating the total change in NDP caused by a move to equality we should use a "half-way" value for the bracketed term. Following this strategy our back-of-the-envelope (BoTE) equation for the effect on NDP of moving rates of return to equality is:

$$\text{ndp} = 100 * \beta * S_k^N * 0.5 * \left(\sum_{i>j} S_i^A * S_j^A * \frac{\left(G_i - G_j\right)^2}{G_i * G_j} \right) \tag{A2.21}$$

where coefficient values on the right hand side reflect the initial situation (before the move to equality).

Using the BoTE equation

To use (A2.21) we need values for S_k^N and β. In the USAGE database, the rental on capital as a share of NDP is about 25 per cent. This is typical for a developed economy. The USAGE value for the capital/labour substitution elasticity (σ) is 0.15. This is lower than the value used in most CGE models but as we have argued elsewhere (Dixon, 2009) it is consistent with evidence on the elasticity of demand for labour with respect to wage rates. For the elasticity of substitution between commodities (ψ) our judgement is that a value of 0.5 is representative of the myriad of demand-side substitution possibilities built into USAGE. With typical capital and labour shares in primary-factor returns being 0.25 and 0.75, β = 0.238 [= .025*0.5 + 0.75*0.15, see (A2.12)]. With these values for S_k^N and β, (A2.21) becomes

$$\text{ndp} = 2.975 * \left(\sum_{i>j} S_i^A * S_j^A * \frac{\left(G_i - G_j\right)^2}{G_i * G_j} \right) \quad . \tag{A2.22}$$

We make three applications of (A2.22). In our first and second applications we evaluated (A2.22) with the G_is reflecting the Tobin Qs given in the “average” and “2006” columns of Figure 4. The resulting values for ndp from (A2.22) were 0.04 and 0.24. These are broadly consistent with USAGE simulation results which show a very small increase (0.005 per cent) in NDP from equalization of rates of return starting from a situation in which Tobin Qs are at the “average” values in Figure 4 and a somewhat larger increase (0.30 per cent) when the Tobin Qs start at the “2006” values (see Figure 5, row 7, cols. 2&4). This gives us some confidence that (A2.22) is capturing a lot of the relevant theory and data from our CGE model.

The third application is designed to place an upper bound on the likely impact on NDP of equalization of rates of return. We consider an economy with two equal-sized sectors ($S_1^A = S_2^A = 0.5$). For the first sector we assume a gross rate of return of 0.1 and for the second sector a gross rate of return of 0.2 (G_1=0.1 and G_2=0.2). If R+D were 0.1 (a typical value in the USAGE database for an industry) then these values for gross rates of return correspond to ROR values of zero and 0.1, or equivalently Tobin Q values of 1 and about 2. This level of inequality between rates of return is considerably more extreme than observed levels (see Figure 4). With these extreme values, (A2.22) implies that ndp = 0.37.

This suggests to us that capital-market distortions causing sectoral differences in rates of return or Tobin Qs are unlikely to have a welfare cost of more than half a per cent of NDP.

Asset Price Regulators, Unite:

you have Macroeconomic Stability to Win

and the Microeconomic Losses are Second-order [1] [2]

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Abstract

The Global Financial Crisis (GFC) has rekindled debate about the desirability of governmental interference in asset markets – either through the operation of policy levers, or, through the chosen institutional setup. In this paper we quantify economic costs due to mispricing of real assets in the USAGE model of the United States. The microeconomic costs of misallocated capital are second-order small. The model suggests that regulators (or central banks) who risk mispricing by influencing asset prices do so without incurring large economic costs.

JEL Classifications: *C50, G01, F41*

Keywords: *Capital Misallocation, Financial crises, CGE modeling, real assets.*

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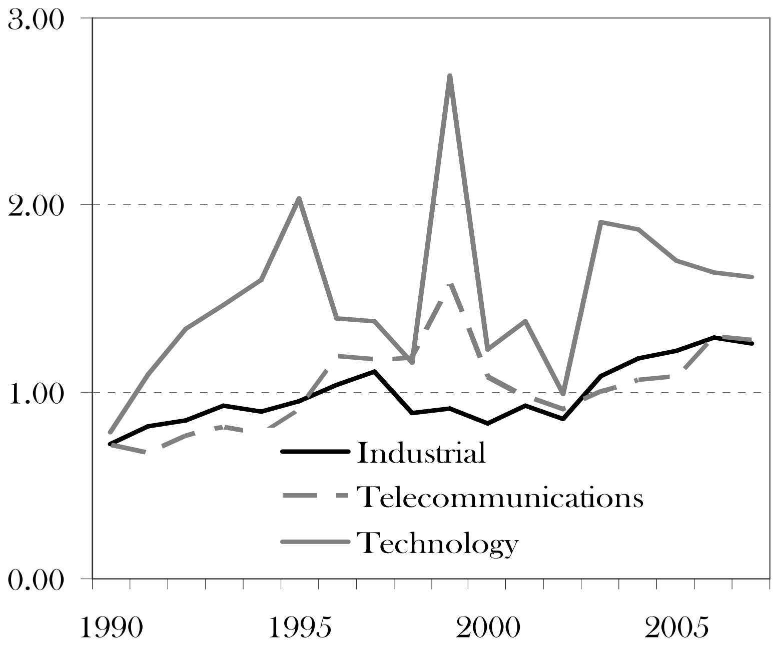
Introduction

"If the reason that the price is high today is only because investors believe that the selling price will be high tomorrow – when 'fundamental' factors do not seem to justify such a price – then a bubble exists." (Stiglitz 1990, p.13)

Asset Price Bubbles have burst onto the pages of history long before the GFC. The Dutch tulip blub bubble of 1636, the South Sea bubble of 1720 and, more recently, the internet bubble of the late 1990s (Figure 1) furnish a few spectacular examples (Kindleberger, 2000).

Figure 1: US Tobin's q: Industrials, Telecommunications and Technology



Source: Datastream

Bubbles are characterized by high levels of momentum trading and herding amongst investors. Accordingly, asset prices will continue to rise as long as the investors (i.e. speculators) believe that they can sell the asset for a higher price in the future.[3]

[3] Other definitions are given: by the New Palgrave: *"….a sharp rise in the price of an asset or a range of assets in a continuous process, with the initial rise generating expectations of further rises and attracting new buyers—generally speculators interested in profits from trading in the asset rather than its use or earnings capacity"* (Eatwell et al., 1987, p. 281); by Shiller (2003) *"a period when investors are attracted to an*

It is widely believed that the rapid boom and bust associated with asset price bubbles have real effects on the economy, with the 1929 crash and subsequent Great Depression writ large in many memories. No consensus about the magnitude or inevitability of these effects has emerged (Posen, 2006)[4] though the events of the last few years may forge one.

The blame for the GFC has been shelved home to a housing bubble and there is a prospect of a more interventionist regulatory stance to reduce the likelihood of bubbles in the price of real assets (eg. housing and equities). These policy prescriptions are informed by the literature on the impact and incidence of mispricing, which we briefly review in section 2. That literature focuses on the micro- and macro-economic mechanisms which can affect the real economy – namely capital misallocation, and, financial sector distress.[5] There is no doubt that burst bubbles can leave the economy in a sorry state, so we feel no pressing need to elaborate on model simulations to that effect. Instead, our central claim is that the microeconomic costs of plausible misallocations are relatively unimportant. A corollary is that financial re-regulation that causes plausible misallocation would have little impact on welfare. That being the case, the risk of misallocating capital is only a weak argument against financial re-regulation.

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investment irrationally because rising prices encourage them to expect, at some level of consciousness at least, more price increases. A feedback develops—as people become more and more attracted, there are more and more price increases. The bubble comes to an end when people no longer expect the price to increase, and so the demand falls and the market crashes.", and; by Siegel (2003) who proposes that a bubble is any two-standard-deviation departure from the expected return. Using his methodology, however, he fails to find a bubble in the US over the past 120 years! Monte Carlo studies also suggest low predictive power using his method (Simon 2003).

4 In his words:"*it is difficult even to establish that bubbles bursting is all that harmful, at least in developed economies, even though that harm is often taken for granted"* (op cit. 2006, p.6).

5 With regards to financial stress following a bubble, the literature on these effects presumes the ability to econometrically test for bubbles, yet this is no trivial matter. Gürkaynak (2008) provides a comprehensive survey of the tests including variance bound tests (as in Shiller, 1981), West's two-step test (1987), integration/co-integration tests (Diba and Grossman 1987, 1988) and intrinsic bubble tests (Froot and Obstfield 1991). After canvassing the strength and weakness of each type of tests, Gürkaynak summed up the state of econometric testing:*".....*[This] *survey of econometric tests of asset price bubbles shows that, despite recent advances, econometric detection of asset price bubbles cannot be achieved with a satisfactory degree of certainty. For each paper that finds evidence of bubbles, there is another one that fits the data equally well without allowing for a bubble. We are still unable to distinguish bubbles from time-varying or regime-switching fundamentals, while many small sample econometrics problems of bubble tests remain unresolved." (Gürkaynak 2008, p.166)*

1.2 The Evidence Advanced for our Central Claim

Our central claim begs two empirical questions: 1) how are the microeconomic efficiency costs quantified, and, 2) what do we mean by a *plausible* misallocation?

With regard to the first question, we turn to USAGE, a contemporary policy model of the United States (section 3). The model's credibility rests partly on its application to contemporary policy issues (US International Trade Commission, 2004 & 2007) and partly because its micro-foundations blunt the critique of Lucas (1976). The immunity from the Lucas critique admittedly comes at a cost of not incorporating realistic policy rules in the simulations. But this seems to us a small price to pay. It is hard to imagine an environment more beset by rapidly evolving policy rules and institutions than the aftermath of the GFC (Goodhart, 2009).

With regard to the second question, we define a plausible perturbation to capital in two ways. We first define it as a movement of capital which takes Tobin's q very close to the equilibrium value of unity.[6] Then, we define it as a movement in capital that shifts Tobin's q by its historic deviation from its sectoral mean (i.e. the sample standard deviation).

An alternative strategy to the one proposed in this paper would be to model a number of conceivable changes to the regulatory/monetary policy environment, and calculation the efficiency costs associated with each one. However, with land spread open before us, it is not clear which direction policymakers will head off in, and it seems better to try to quantify the welfare effects somewhat more generally.[7]

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[6] This is plausible in the sense of 'equilibrating' but substantial real-world barriers mean it could also be described as extreme, and certainly outside historical experience. For technical reasons, simulated Tobin's q settles just below 1.0 (0.98) in our simulations.

[7] Goodhart (2009) believes the policy imperative is to equip central bankers with at least one extra instrument. The experience of the 'great moderation' confirms that inflation targeting regimes are effective. But inflation is only one of the main targets of the central bank. Financial stability, for which Goodhart believes no effective instrument is yet available, is another, historically prior, target. He explores many policy options, such as

In section 4 we attempt this quantification. We first dispose of a potential shortcut which would claim that the unimportance of capital misallocation follows directly as a consequence of the envelope theorem (section 4.1). That is, small perturbations of capital from an optimal allocation have second order effects. The problems with the shortcut are a) the envelope theorem may not work for multiple sectors, b) capital is in fact not optimally allocated, c) plausible perturbations to capital may not be 'small' enough in the microeconomic sense and d) the theory of second best (Lipsey and Lancaster, 1956) combined with (b) rules out an *a priori* appeal to the envelope theorem. [8]

The USAGE model provides a way through these difficulties. USAGE contains multiple sectors meeting objection (a). Furthermore, we handle objection (b) by calibrating USAGE to empirical Tobin q's, recognizing the reality that US capital is not optimally allocated. When capital is allowed to move to equalize returns or Tobin's q, the benefits are second order small (section 4.2), implying that the function relating capital to profits could still be regarded as 'flat'. Furthermore, a realistic perturbation which shifts capital out of a capital-starved sector (Healthcare) and redistributes it across the other sectors in section 4.3 results in a NPV effect that is both small and negative. This suggests respectively that plausible perturbations in capital can indeed be considered 'small' (objection (c)), and, that the theory of second best is unimportant practically (objection (d)). We note the limitations of our argument in Section 5, the main one being that heavy-handed financial regulation may take misallocation outside our plausible range.

counter-cyclical capital adequacy, varying the parameters of the discount window and less reliance on the inter-bank lending market.

[8] To quote Lipsey and Lancaster (op. cit. pg. 11) 'It is well known that the attainment of a Paretian optimum requires the simultaneous fulfillment of all the optimum conditions. The general theorem for the second best optimum states that if there is introduced into a general equilibrium system a constraint which prevents the attainment of one of the Paretian conditions, the other Paretian conditions, although still attainable, are, in general, no longer desirable. In other words, given that one of the Paretian optimum conditions cannot be fulfilled, then an optimum situation can be achieved only by departing from all the other Paretian conditions. The optimum situation finally attained may be termed a second best optimum because it is achieved subject to a constraint which, by definition, prevents the attainment of a Paretian optimum.'

2 Asset Mispricing in the Literature

Asset price bubbles are commonly associated with an increase of debt. During the boom phase of the bubble, the large distortion in relative prices induces investors to increase their debt burden (Shiller 2003). Once the bubble bursts, however, many investors default on what prove to be unsustainable loans. Mishkin and White (2002) believe that the instability of the banking/financial system, rather than the stock market crashes *per se*, is the major macro-economic concern.

In an earlier paper (Menzies et al. 2009) we confirmed that a computable general equilibrium (CGE) model can indeed deliver large macroeconomic costs of financial fragility (see also Dixon and Rimmer, forthcoming). An extended financial crisis (three or five years) follows a two year boom.[9] The crisis is modeled by a 'capital strike', where Tobin's *q* is one-half of one standard deviation lower across the whole economy. Figure 2 shows the simulated losses to the economy in terms of the net present value (NPV) of forgone consumption and GDP.[10]

Figure 2: NPV of GDP and Consumption Deviations: percentage deviations

Scenarios	One-off %C NPV	One-off %GDP NPV
Two year boom followed by 3 year pessimism	-6.5	-4.4
Two year boom followed by 5 year pessimism	-8.9	-6.0

Financial crises are undoubtedly spectacular, in models and in reality, but there are 'quieter' microeconomic costs of mispricing associated with the disruption of the optimal allocation of resources (Chrinko and Schaller 2007; Barlevy 2007; Diamond 1965 and Oliver 2000). Once this

[9] Investors hold overly optimistic expectations about returns in the Telecommunication and Technology industries (5 per cent of GDP) Tobin's q is higher in both sectors by one standard deviation over two years. However, the additional investment that flows from these unrealistic expectations is completely wasted; it doesn't add to the capital stock.

[10] As discussed in Menzies et al. (2009), the effects are large because of powerful macroeconomic channels. As investment booms, the real exchange rate appreciates and this leads to an improvement to the terms of trade. The converse happens when investment collapses at the end of the bubble. Capital decumulation holds back growth, and, the Mundell-Fleming investment/exchange rate nexus superimposes a demand cycle over the lowered trend in aggregate supply. When we later quantify microeconomic costs, capital is held fixed, shutting down the Mundell-Fleming and accumulation channels.

occurs the theory of second best implies that moving any one condition closer to what would prevail in a fully optimal system may not, in isolation, be optimal (Lipsey and Lancaster, 1956).

Quantifying the effects of mispricing would be ‘academic’, in the bad sense of that word, were it not likely that asset prices often are, in fact, mispriced. As outlined in Barberis and Thaler (2003) limits-to-arbitrage arguments (Shleifer and Vishny 1997) have blunted Friedman’s (1953) assertion that mispricing is always immediately eliminated by arbitrageurs. The risk that ‘noise traders’ take a security further away from its fundamental value, transforms arbitrage – which is riskless by definition – into a highly risky activity.

A beautiful example of this is furnished by Froot and Dabora (1999) who track the relative price of Royal Dutch securities to Shell securities. The unusual nature of these assets – Royal Dutch and Shell securities are each a claim on 60 per cent and 40 per cent of the *combined* cash flow of the two companies – ensure that the rational relative price ought to be 1.5. Instead, Royal Dutch is sometimes 35 per cent underpriced and sometimes 15 per cent overpriced. Given the features of this natural experiment, the only remaining risk of holding Royal Dutch must be the risk of noise trading.

Naturally, the dilemma for asset price regulators is that any conceivable attempt to attenuate phenomena like noise trading runs the risk of stopping equilibrating adjustments in asset prices. The policy pendulum swings uneasily back and forth between laissez-faire and, more recently, regulation. Monetary policymakers are likely to become more proactive in bursting bubbles, despite the controversy about the timing (see Posen 2006 and Roubini 2006), and, financial markets might be substantially re-regulated.[11] The likelihood of relatively inflexible asset prices motivates our quantification of the costs of misallocation.

[11] See Robinson and Stone (2005) for an Australian perspective on the macroeconomic desirability of controlling asset prices. Models such as these do not consider efficiency losses from influencing prices.

3 The USAGE Model

3.1 Computable General Equilibrium Models Neutralizes the Lucas Critique

USAGE is a dynamic Computable-General-Equilibrium (CGE) model of the US economy, with a similar structure to the MONASH model for the Australian economy (Dixon and Rimmer, 2002). Usage can be run with up to 500 industries, 700 occupations 23 trading partners and 51 regions (50 states plus D.C.).[12]

We chose to study the effects of asset mispricing in the US partly because USAGE is a ‘state of the art’ CGE model used in contemporary policy discussion (US International Trade Commission, 2004 & 2007) and because the industry data we need for Tobin’s q is readily available. In any case, important economic channels transmit real shocks in the US economy to Australia (Beechey et al. 2000), and, the GFC is eloquent testimony to the contagion of US asset prices (Debelle, 2010).[13]

The version of the model used in this paper lacks an explicit financial sector or a monetary and fiscal authority. Without policy, the model relies upon a pro-cyclical exchange rate to stabilize the economy. That is, the Mundell-Fleming assumption of perfect capital mobility means that infinitesimal interest rate changes move the nominal exchange rate. Equilibrium is attained via expenditure-switching adjustments in the real exchange rate.

With all the macroeconomic adjustment coming through this channel, the movements in the real exchange rate required to obtain equilibrium are probably larger than in reality. These simulations therefore share a drawback of all macro models that rely on expenditure switching as an

[12] USAGE was developed starting in 2001 as a joint project between the Centre for Policy Studies, Monash, and the US International Trade Commissiion. To date, its main uses have been for trade, energy, environment and immigration policy. While the USAGE database is thoroughly documented, there is no comprehensive description of the USAGE theory. However, its close similarity to the MONASH theory means that readers seeking further information are justified in looking at the MONASH documentation in Dixon and Rimmer (2002).

[13] Debelle (op. cit.) documents a correlation between US equities and the $US value of Australian equities.

equilibrating channel; the relatively poor performance of models of nominal exchange rates (Frankel and Rose 1995).

Nevertheless, a CGE model is the analytic tool least hamstrung during times of structural change, financial innovation and turbulent policy making (Lucas, 1976). The USAGE model is built upon 'non-policy' parameters[14], in contrast to models that are driven by historically estimated specifications of policy rules. Indeed, it was precisely times such as these (eg. the turbulent 1970s) which spawned the development of CGE models in the first place.

3.2 General Structure

USAGE includes three types of dynamic mechanisms: capital accumulation; liability accumulation; and lagged adjustment processes.

Capital accumulation is specified separately for each industry. An industry's capital stock at the start of year t+1 is its capital at the start of year t plus its investment during year t minus depreciation. Investment during year t is determined as a positive function of the expected rate of return on the industry's capital.

Liability accumulation is specified for the public sector and for the foreign accounts. Public sector liability at the start of year t+1 is public sector liability at the start of year t plus the public sector deficit incurred during year t. Net foreign liabilities at the start of year t+1 are specified as net foreign liabilities at the start of year t plus the current account deficit in year t plus the effects of revaluations of assets and liabilities caused by changes in price levels and the exchange rate.

Lagged adjustment processes are specified for the response of wage rates to gaps between the demand for and the supply of labor by occupation. There are also lagged adjustment processes in

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[14] USAGE contains variables describing: primary-factor and intermediate-input-saving technical change in current production; input-saving technical change in capital creation; input-saving technical change in the provision of margin services; and input-saving changes in household preferences. We assume that our shocks do not effect on technology or household preferences.

USAGE for the response of foreign demand for U.S. exports to changes in their foreign-currency prices.

In a USAGE simulation of the effects of shocks, we need two runs of the model: a basecase or business-as-usual run and a shocked run. The basecase is intended to be a plausible forecast while the shocked run generates deviations away from the basecase caused by the shock under consideration. The basecase incorporates trends in industry technologies, household preferences and trade and demographic variables. These trends are estimated largely on the basis of results from historical runs in which USAGE is forced to track a piece of history. Most macro variables are exogenous in the basecase so that their paths can be set in accordance with forecasts made by expert macro forecasting groups such as the Congressional Budget Office. This requires endogenization of various macro propensities, e.g. the average propensity to consume. These propensities must be allowed to adjust in the basecase run to accommodate the exogenous paths for the macro variables.

The shocked run in a USAGE study is normally conducted with a different closure (choice of exogenous variables) from that used in the basecase. In the shocked run, macro variables must be endogenous: we want to know how they are affected by the shock. Correspondingly, macro propensities are exogenized and given the values they had in the basecase. More generally, all exogenous variables in the shocked run have the values they had in the basecase, either endogenously or exogenously. Comparison of results from the shocked and basecase runs then gives the effects of moving the shocked variable(s) away from their basecase values.

For this paper, we assume that expected rates of return are generated by projecting current information. This is convenient because it allows the model to be solved recursively (in a sequence, one year at a time). We do not consider that the alternative, rational expectations, would add realism.

USAGE contains functions specifying the supply of funds for investment in each industry as an upward-sloping function of the industry's expected rate of return. Our shock consists of shocking the functions so that (in the case of optimism) a given expected rate of return results in higher investment, and (in the case of pessimism) the same given rate of return results in lower investment compared with the basecase. The investment function is explained in detail in Dixon and Rimmer (2002, pg. 189).

4 The Relative Unimportance of Capital Misallocation

4.1 Theoretical Benchmark

It might be thought that the envelope theorem is sufficient to assure the main claim of this paper. To see how, consider the allocation of capital to a single industry.

Assume that there is a *distribution* of capital (K) around the *optimal* allocation, κ. Optimal capital maximizes profits, π, by solving $\partial\pi / \partial K = 0$. But firms make errors in their attempts to reach κ; for simplicity let $K \sim N(\kappa, \sigma^2)$. That is, despite their best efforts firms find themselves in the neighbourhood of the maximum of a surface relating capital K to profits $\pi(K)$.

We want to know the conditions under which these departures from optimality will not matter very much for the firm. Equivalently, we want to know when the variance of π resulting from variation in K (σ^2 above) will not be large. Algebraically, we work out the variance of π where K is in the neighbourhood of κ.

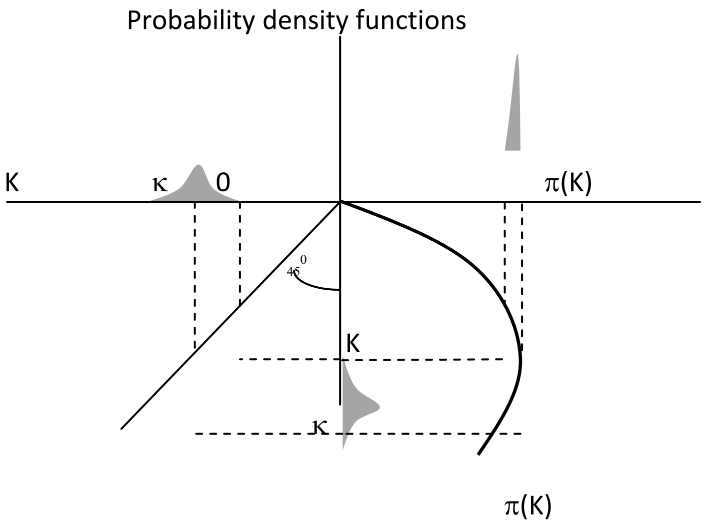
$$\pi(K) = \pi(\kappa) + \pi^{'}(\kappa).(K-\kappa) + \frac{\pi^{''}(\kappa)}{2}.(K-\kappa)^2 \qquad (1)$$

Then, we take the variance.

$$V[\pi(K)] = [\pi^{'}(\kappa)]^2\sigma^2 + \left(\frac{\pi^{''}(\kappa)}{2}\right)^2 \sigma^4 \qquad (2)$$

Equation (2) is a variant of the envelope theorem. If $\pi'=0$, and if the profit function is close to linear at the optimum (π'' approaches zero) then the effects of σ^2 are vanishingly small and perturbations in capital are unlikely to matter for profits. Informally, if the profit function is 'flat' relative to the size of volatility in capital, the costs and the final impact on profits are low. In Figure 3a, we see why the 'flat' profit function compresses the volatility in profits. The distributions are shown in grey.

Figure 3a: Misallocated Capital and Profits



To understand Figure 3a, one takes imaginary draws from the bell-shaped distribution on the left of the horizontal axis, and traces them through to the profit function (we have done so with one draw from the tail and one at the mean). Figure 3a and (2) suggest that there is a small effect on profits if capital is misallocated by 'small' amounts in a single industry, due to the envelope theorem.[15]

In the real world, however, capital is not always optimally allocated and there are multiple industries, so the theory of second best (Lipsey and Lancaster, 1956) gives us pause. Furthermore, it

[15] The small effect on profits would then ensure a small effect on GDP, consumption and welfare.

is unclear if perturbations to capital are indeed ‘small’. Each concern disarms the envelope theorem, as illustrated in Figures 3b and 3c.

Figure 3b: Non-optimal K

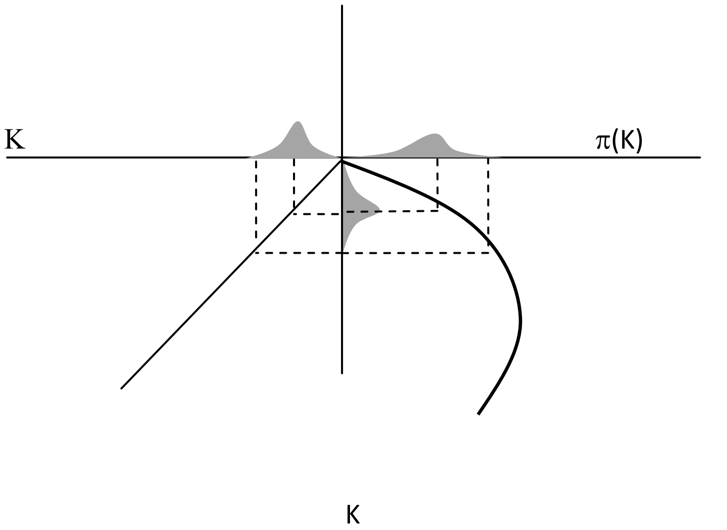
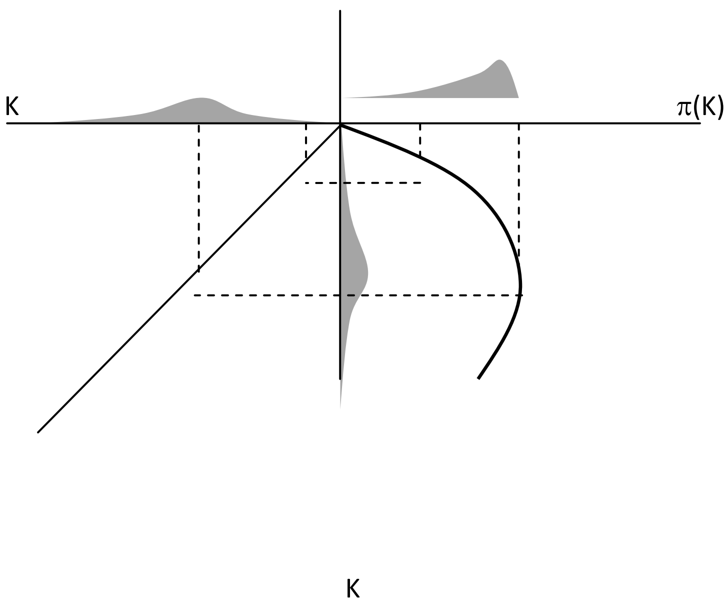


Figure 3c: Non-‘small’ variance of K



Non-optimal capital means π' is non-zero and the variance of π could be *even larger* than the variance of *K*. This can be seen from (2), or from sliding the distribution of K close to the origin in Figure 3a (see 3b). Furthermore, if K perturbations are large, the tail draws of K (on the left side of the distribution of 3c) may run into the steep portions of $\pi(K)$ and again the variance of profits may be large even if capital is optimal, on average.

In what follows we adopt the USAGE model to see if the effects of capital misallocation are small given that the returns to capital, and q's, differ across different US industries.[16]

Figure 4 US Tobin q's[17]

	2005	2006	2007	Average 1980-2007	stand dev
Healthcare	2.36	2.47	2.14	1.69	0.45
Technology	1.70	1.64	1.62	1.43	0.42
Oil & Gas	1.52	1.44	1.35	1.00	0.23
Consumer Services	1.27	1.36	1.23	0.95	0.18
Industrials	1.22	1.29	1.26	0.93	0.16
Consumer Goods	1.09	1.21	1.10	0.91	0.13
Basic Materials	1.41	1.73	1.70	0.90	0.30
Telecommunications	1.07	1.29	1.28	0.89	0.27
Utilities	0.81	0.90	0.90	0.85	0.07
Financials		0.90		0.85	0.26

We set up a 38 industry version of USAGE with the data calibrated so that the implied Tobin q's are consistent with those in Figure 4. In making the calibration we adjusted the initial USAGE data for capital stocks and gross operating surplus by industry.

4.2 The Effects of Reallocating Capital are Second-order Small

Working with this adjusted database, we used USAGE to compute the effects on economic welfare of:

16 Even apart from the evidence of Figure 4, anecdotal evidence suggests the returns to capital in farming and housing have traditionally been low.

17 Source: Datastream. q = (Market Value of Ordinary shares + Book Value of Preference Capital + Total Debt)/Total Assets. Industry Tobin's q is the Tobin's q of the median firm within each industry. Financials was deemed to have the average q of utilities, due to a presumption that the finance sector had too many resources in it in 2007, rather than too few. The raw average for financials was 1.21, but the subsequent crisis suggests these shares were seriously overvalued. Equating financials' q to utilities' q is not justifiable because of the industry characteristics of utilities. Rather, the adjustment is made to maximize the dispersion of q, thereby providing a 'severe test' for the unimportance of misallocation.

(1) reallocating the U.S. capital stock across industries to equate Tobin qs;

(2) reallocating the U.S. capital stock across industries to equate rates of return;

In USAGE, under various simplifying assumptions (Appendix 1), Tobin's q ($TQ_{j,t}$) and rates of return (($ROR_{j,t}$) for industry j in year t can be represented as:

$$TQ_{j,t} = \frac{Rent_{j,t} * (1 - T_t)}{\Pi_{j,t}(RINT_t + D_j)} \tag{3}$$

$$ROR_{j,t} = -1 + \frac{\left[(1 - T_t) * \left(Rent_{j,t} / \Pi_{j,t}\right) + \left(1 - D_j\right)\right]}{\left(1 + RINT_t\right)} \tag{4}$$

where

$Rent_{j,t}$ is the gross (before depreciation) profit per unit of capital in industry j in year t;

T_t is the rate of tax applying to capital income in year t;

$\Pi_{j,t}$ is the cost of constructing a unit of capital in industry j in year t;

$RINT_t$ is the safe real interest rate in year t; and

D_j is the rate of depreciation on j's capital.

From (3) and (4) we find that Tobin's q and rates of return are related by

$$ROR_{j,t} = \frac{(RINT_t + D_j)}{[1 + RINT_t]}\{TQ_{j,t} - 1\} \quad . \tag{5}$$

Theories of investor behavior suggest that in a long run equilibrium state TQs are one or equivalently RORs are zero. However, as is clear from Figure 4 and from the database of any dynamic CGE model, TQs are often far from 1 for extended periods and similarly RORs are often far from zero. Figure 5 provides an indication of how much welfare is lost by the failure of the economy to operate in its long-run equilibrium state.

Figure 5: USAGE results for the effects of capital reallocations:

percentage deviations

		Average q's		2006 q's	
		Equalizing Tobin qs	Equalizing rates of return	Equalizing Tobin qs	Equalizing rates of return
1	aggregate capital, asset wgts	0	0	0	0
2	aggregate capital, rental wgts	-0.1178	-0.2048	2.0400	2.5703
3	aggregate employment	0	0	0	0
4	real net investment	0	0	0	0
5	balance of trade	0	0	0	0
6	real GDP	-0.0322	-0.0505	0.4798	0.5989
7	real net DP	0.0095	0.0049	0.2656	0.3035
8	real consumption	0.0279	0.0250	0.2482	0.2749
9	real investment	-0.0281	-0.2810	1.2933	1.7462
10	export volumes	-0.4888	-0.5377	0.5078	0.8138
11	import volumes	-0.1912	-0.2106	0.2057	0.3275
12	terms of trade	0.1634	0.1799	-0.1687	-0.2698

Row 8, column 1 of Figure 5 indicates that U.S. welfare, measured by the deviation in consumption (public and private combined), would be 0.0279 per cent higher if capital were reallocated to equalize the TQ_js across all j. Column 2 indicates that welfare would be increased by 0.0250 per cent if capital were reallocated to equalize the ROR_js.

The critical assumption underlying these calculations is that the aggregate volume of capital stock in the U.S. is fixed. Coming from a position of non-optimality, this implied that when Tobin's q was equalized across sectors, it settled at a value close to unity (0.98). Given different depreciation rates across sectors (5) implies that equalizing rates of return is not the same as equalizing the q's.

Other assumptions are that the reallocation of capital does not affect the trade balance, aggregate employment and net investment. The assumptions explain the zeros in rows 1, 3, 4 and 5 of Figure 5. We choose these assumptions to isolate as much as possible the effects of changing the allocation of capital across industries.

Real GDP falls in both columns 1 and 2 of Figure 5. This is because the reallocation of capital in both simulations is towards industries with low depreciation rates.

As can be seen in Figure 6, in both simulations the ownership of dwellings industry, which has easily the lowest depreciation rate, gains capital. Industries with low depreciation rates tend to have low rentals per dollar’s worth of capital reflecting the limited requirements for gross profits to be used in capital maintenance. Thus, capital in industries with low depreciation rates make relatively low contributions per dollar’s worth of capital to *Gross* domestic product, but this doesn’t apply to *Net* domestic product which shows an increase in both simulations (row 7 of Figure 5).

Another indication of the reallocation of capital towards industries with low rentals per dollar’s worth of capital are the negative results in row 2 of Figure 5 for aggregate capital, rental weights. In both simulations the reallocation of capital causes reductions in exports and imports. Detailed checking would reveal that import competing industries have TQs and RORs that are high relative to those of export oriented industries. Consequently, import competing industries gain capital relative to export-oriented industries in the simulations, causing import replacement and export reduction.

Figure 6. USAGE data and results for the effects of capital reallocations

	USAGE results Percentage deviations in quantity of capital		USAGE data		
				Initial values of:	
Indutry	Equalizing Tobin Qs	Equalizing rates of return	Depreciation rates	TQ[(a)]	ROR
1 agric	-0.2163	-0.4732	0.0756	1.00	0.0000
2 agrserv	0.3455	0.1298	0.1132	1.00	0.0000
3 mining	0.3757	-0.1031	0.0766	1.00	0.0004
4 construct	-0.7060	-0.8900	0.1149	0.93	-0.0087
5 dairySugar	-1.2214	-1.4186	0.0752	0.91	-0.0078
6 foodmanu	-1.4836	-1.6976	0.0752	0.91	-0.0078
7 tobaccoProd	-1.9486	-2.1473	0.0693	0.91	-0.0073
8 Apparel	-1.8157	-1.9771	0.0792	0.91	-0.0083
9 textiles	-2.1786	-2.3789	0.0789	0.91	-0.0083
10 WoodFurn	-1.1272	-1.3138	0.0865	0.93	-0.0068
11 PaperPub	-1.1833	-1.5095	0.0941	0.93	-0.0074
12 Chemicals	-1.8351	-2.0979	0.0846	0.93	-0.0066
13 Petrolprods	0.1241	-0.0594	0.0636	1.00	0.0000
14 Footwear	-2.0757	-2.2249	0.0673	0.91	-0.0073
15 MetalProds	-1.9353	-2.1108	0.0654	0.90	-0.0079
16 Machinery	-1.7161	-1.9368	0.0759	0.93	-0.0062
17 Computers	4.9044	4.6618	0.0759	1.43	0.0384
18 ElectMach	8.0567	7.8215	0.0891	1.43	0.0440
19 MotorVeh	-1.7221	-1.9767	0.1046	0.93	-0.0082
20 TransEquip	-1.4573	-1.6344	0.0772	0.93	-0.0063
21 ManuNEC	-1.1095	-1.3335	0.0917	0.93	-0.0072
22 Communicat	-2.5492	-2.8047	0.0621	0.89	-0.0082
23 Utilities	-1.4531	-1.7556	0.0512	0.85	-0.0095
24 TradMarg	-0.6630	-0.8731	0.0867	0.95	-0.0048
25 OwnoccDwell	0.7267	0.9091	0.0182	1.00	0.0000
26 BusFinServ	-2.2239	-2.3578	0.0984	0.85	-0.0165
27 MedicServ	10.5934	10.4330	0.0736	1.69	0.0600
28 Education	-0.6040	-0.6743	0.0416	0.95	-0.0027
29 SocialServ	-0.7060	-0.8668	0.0823	0.95	-0.0046
30 Enterprise	-0.0746	0.0412	0.0273	0.95	-0.0020
31 MiscServ	-0.6870	-0.8570	0.0782	0.95	-0.0045
32 GovtServ[(b)]	-0.8368	-0.8918	0.0344	0.95	-0.0024
37 TransMarg	-0.7519	-0.9638	0.0815	0.95	-0.0047
38 AutoRent	0.1525	-0.0805	0.0700	0.95	-0.0041

[(a)] Tobin q's were allocated to USAGE industries from Figure 4. No information relevant for agriculture or ownership of dwellings was available from Figure 4. For these industries we assumed TQs of one.

[(b)] Industries 33 to 36 have no capital.

With the contractions in trade, the Figure 5 simulations show improvements in the terms of trade (row 12). The improvements in the terms of trade together with the gains in real net domestic product (row 7) combine to explain the welfare gains in row 8.

The last two columns of Figure 5 do a sensitivity analysis where the 2006 q's are used, instead of the average q's. The consumption gain is 0.2656 when q's are equalized. This is a small number, but larger than the effect where average q's are used. This raises the question of robustness, which we address in Appendix 2. It is demonstrated analytically there that that the gain in real net domestic product (NDP) will be no greater than ½ per cent, which implies the positive effects on consumption will likewise be small.

4.3 Adverse Shocks Have Second-order Small effects

As we saw earlier the envelope theorem suggests that reallocating the capital stock from an optimal allocation in a single industry will have a vanishingly small effect on economic welfare. The theory of second best prohibits what might seem like a commonsense corollary, namely; if we start in a situation where capital in several sectors is not optimally allocated moving capital in one sector away from its optimal allocation harms welfare.. The theory does not claim that adverse movements in capital *will definitely* improve welfare; rather, it simply claims that this is a *possibility* in a general equilibrium setting. To rule this out we need a model that recognizes misallocation, like USAGE.

Figure 7 Costs of Increasing HealthCare q by 1 standard deviation: percentage deviations

		Average q's off initial database	off database with equalized RORs	2006 q's off initial database
1	aggregate capital, asset wgts	0	0	0
2	aggregate capital, rental wgts	-0.1404	-0.1107	-0.1179
3	aggregate employment	0	0	0
4	real net investment	0	0	0
5	balance of trade	0	0	0
6	real GDP	-0.0239	-0.0180	-0.0245
7	real net DP	-0.0193	-0.0064	-0.0227
8	real consumption	-0.0207	-0.0076	-0.0241
9	real investment	-0.0356	-0.0637	-0.0237
10	export volumes	0.0342	0.0318	0.0354
11	import volumes	0.0135	0.0125	0.0140
12	terms of trade	-0.0114	-0.0106	-0.0118

The first column of Figure 7 report results in which we start from the initial situation (with the average q's from Figure 4 in place) and simulate the effects of an increase of 0.45 (one-standard-deviation) in the q for Healthcare. Capital (and labour) go to the other sectors, leaving the aggregate capital stock unchanged. This is clearly a move in the wrong direction: Capital should be moving into Healthcare on a q criterion.

Welfare falls (by 0.0207 per cent, row 8, column 1). In column 2 of Figure 7, we repeat the column-1 experiment but instead of using the initial situation as the starting point, we use the situation arrived at when we equalized rates of return (the final equilibrium of the Figure 5 simulation). Consistent with the envelope theorem, the increase in health-care q now causes a relatively small loss of welfare (0.0076 per cent compared with 0.0207 per cent).

But both numbers are really quite small. Assuming a discount rate of 5 per cent, the losses should be multiplied by 20 for Net Present Value figures. That is, an aberrant shock from a position of optimality costs NPV 0.15 per cent and an adverse shock from the USAGE allocation is NPV 0.41 per cent of consumption. The fact the effect is negative shows that the theory of second best is practically unimportant (at least for this shock), and, the NPV size suggest that plausible perturbations in the capital stock are 'small', as required by the envelope theorem.

Columns 3 conduct a sensitivity analysis. We repeat the exercise of column 1 but with the initial levels of q set at their 2006 levels. The results are basically identical.

5 Conclusion

In this paper, we have argued for the relative unimportance of plausible capital misallocation in USAGE. We have been able to calibrate USAGE with empirical Tobin q's and proceed with sensible analysis recognizing that US capital is not optimally allocated. We have established that when capital is allowed to move to equalize returns or Tobin's q, the benefits are second order small. Furthermore, when a one-standard-deviation perturbation takes capital away from a capital-starved sector (Healthcare) and distributes it to other sectors the NPV effect is both negative and small. This suggests respectively that the theory of second best is unimportant practically, and, that the plausible perturbation in capital associated with historic share market volatility is 'small' in the microeconomic sense. That is, the intuition of the envelope theorem carries over to a realistic CGE model, though we could not have known this without doing the modeling exercise.

We therefore conclude that the risk of the misallocation of capital entailed in financial intervention is only a weak argument against it. However, we would be remiss not to mention a number of other obvious caveats.

First, the results naturally depend on the validity of the USAGE model as a descriptor of the US economy. This is always a consequence of using a particular empirical model to answer a policy question. However, the advantage of using such a model is that it forces assumptions onto the table for scrutiny, warts and all. If other frameworks do not do this, their lack of *explicit* assumptions should not be mistaken for their absence. Furthermore, the back-of-the-envelope calculation in Appendix 2 shows that the basic insights would remain valid for a broader class of models that embody fairly standard micro-foundations.

Second, while the gain in welfare from a full reallocation of capital to equate q's or real returns is small, it does not follow that distortions in an economy might not have large distributional consequences. For example, as a per cent of GDP, the benefits of full trade liberalization are generally small[18] but the global distributional consequences of, say, Europe's Common Agricultural Policy are by no means trivial.

Finally, and most importantly, excessive regulation could take misallocation outside what we have called a plausible range of volatility – away from 'small' capital perturbations. As Figure 3c suggests, this could *increase* the volatility of profits, and reduce welfare. Furthermore, we are cognizant of the Lucas critique, which we have worked hard to meet in this paper by using a CGE model. Heavy-handed regulation could distort the deep parameters of our model and weaken its conclusions.

Having made all these caveats, the overriding message of this paper is that plausible misallocations in US capital have fairly small general equilibrium effects. Regulators and policy makers thus have considerable 'room to move' as they explore what we have left unexplored in this paper – the policies and regulatory structures that limit macro-economically destabilizing movements in asset prices.

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18 For example, detailed studies of U.S. import restraints (tariffs and quotas) imply that these generate annual welfare losses of no more than a small fraction of one per cent of GDP. See for example USITC (2004 & 2007).

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Appendix 1: Relating the expected rate of return to Tobin's q

Our starting point is (21.7) in Dixon and Rimmer (2002), where EROR_ST is now written EROR and R_INT_PT_SE is R_INT (as we ignore 'Post Tax' effects).

$$EROR_{j,t} = -1 + [(1-T_t)* Q_{j,t}/\Pi_{j,t} + (1-D_j)]/(1+RINT_t), \qquad \text{(A1.1)}$$

We used lower case *q* to denote Tobin's *q* in the text, to avoid confusion with the rental rate. We can define this for industry j (leaving out j for convenience) via the equation:

$$q = \frac{Q_{t+1}(1-T)}{\Pi_t(1+INT)} + \frac{Q_{t+2}(1-T)(1-D)}{\Pi_t(1+INT)(1+INT)} + \frac{Q_{t+3}(1-T)(1-D)^2}{\Pi_t(1+INT)(1+INT)^2} + \ldots\ldots \qquad \text{(A1.2)}$$

In this equation Q is viewed as the present value of the stream of profits flowing from a unit of capital divided by the book value of a unit of capital (note: the book value is historic cost, so Π_t does not grow for future periods). We have made the assumption that the tax, discount and nominal interest rates are constant. If we make the additional assumption that the rental rate grows with (constant) inflation we can write *q* as follows:

$$q = \frac{(1+INF)Q_t(1-T)}{\Pi_t(1+INT)} + \frac{(1+INF)Q_t(1+INF)(1-T)(1-D)}{\Pi_t(1+INT)(1+INT)} + \frac{(1+INF)Q_t(1+INF)^2(1-T)(1-D)^2}{\Pi_t(1+INT)(1+INT)^2} + \ldots\ldots$$

$$= \frac{Q_t(1-T)}{\Pi_t(1+RINT)} + \frac{Q_t(1+INF)(1-T)(1-D)}{\Pi_t(1+RINT)(1+INT)} + \frac{Q_t(1+INF)^2(1-T)(1-D)^2}{\Pi_t(1+RINT)(1+INT)^2} + \ldots\ldots$$

where RINT=INT-INF. This is a geometric progression with ratio (1+INF)(1-D)/(1+INT) ≈ 1-(RINT+D) Summing to infinity we obtain a simplified q.

$$q = \frac{\dfrac{Q_t(1-T)}{\Pi_t(1+RINT)}}{[1-(1-(RINT+D))]} \approx \frac{Q_t(1-T)}{\Pi_t(RINT+D)} \quad . \qquad \text{(A1.3)}$$

Hence, after straightforward manipulation we may connect EROR to q.

$$EROR_t = \frac{(RINT + D)}{[1 + RINT]}\{q - 1\} \qquad \text{(A1.4)}$$

Appendix 2

How big a gain should we expect when capital is reallocated to equalize rates of return or Tobin Qs?

USAGE simulations give what seems at first to be surprisingly low values for the welfare gain (measured by the percentage increase in net domestic product) of reallocating capital to eliminate differences in sectoral rates of return. Here we explain the welfare gain via a back-of-the-envelope (BoTE) formula. Our formula takes account of four factors: (a) the initial divergences in rates of return; (b) the elasticity of substitution between capital and labour in production; (c) the elasticity of substitution between commodities in consumption and other final use; and (d) the share of returns to capital in net domestic product. Factor (a) determines by how much rates of return must move to reach equality. Factors (b) and (c) determine the sensitivity of inter-sectoral capital movements to movements in rates of return. Factor (d) acts as a scaling device, converting from percentage changes in the income generated by a given aggregate amount of capital to percentage changes in overall welfare.

The BoTE formula is straightforward but its derivation is quite long. Readers who are not interested in algebraic details should go immediately to equation (A2.20) and the text that follows. The algebraic symbols of this appendix are self-contained – they are defined as they appear and do not refer to the main body of the paper.

Our derivation of the BoTE formula has several steps. First, we express the percentage change in net domestic product as a function of percentage changes in sectoral capital stocks. Next we relate percentage changes in sectors capital stocks to percentage changes in rental rates on capital. Following this we relate percentage changes in rental rates to changes in rates of return.

Changes in rates of return are imposed by the move to equality. Finally, we combine results from these steps to express the percentage change in net domestic product in terms of initial rates of return.

Expressing the percentage change in net domestic product as a function of percentage changes in capital stocks

The increase in net domestic product (ΔNDP) from a reallocation of capital stocks across industries is given by:

$$\Delta NDP = \sum_i \left(P_i^{VA} * MPK_i - D * P^K \right) * \Delta K_i \qquad \text{(A2.1)}$$

where

P_i^{VA} is the price of a unit of value added in industry i;

MPK_i is the marginal product of capital in industry i;

ΔK_i is the change in the capital stock in industry i;

D is the rate of depreciation on capital; and

P^K is the price of unit of capital (asset price).

In (A2.1) we assume that the rate of depreciation and the price of a unit of capital are the same in all industries. We also ignore indirect taxes. These simplifications are not adopted in the USAGE model but are helpful, and not misleading, in deriving a back-of-the-envelope estimate of the effect on NDP of capital reallocation.

Ignoring taxes on capital income we write:

$$P_i^{VA} * MPK_i = Q_i \qquad \text{(A2.2)}$$

where

Q_i is the rental price of a unit of capital in industry i.

Under the simplifications that we have adopted, the rate of return in industry i (ROR_i) is given by

$$ROR_i = -1 + \left[\frac{Q_i}{P^K} + (1-D)\right] * \left[\frac{1}{1+R}\right] \quad \text{(A2.3)}$$

where

R is the real rate of interest.

Ignoring second-order terms, we can rearrange (A2.3) as

$$\frac{Q_i}{P^K} = ROR_i + R + D \quad . \quad \text{(A2.4)}$$

Because we are looking at the effects of reallocating a fixed amount of capital, it is true by definition that:

$$\sum_i S_i^A * k_i = 0 \quad . \quad \text{(A2.5)}$$

where

k_i is the percentage change in the amount of capital in industry i ($100*\Delta K_i/K_i$); and

S_i^A is industry i's share in the asset value capital ($P^K K_i \big/ \sum_j P^K K_j$).

Using (A2.2), (A2.4) and (A2.5) in (A2.1) we obtain

$$ndp = \left(\frac{\sum_j P^K * K_j}{NDP}\right) * \sum_i ROR_i * S_i^A * k_i \quad \text{(A2.6)}$$

or equivalently, noting (A2.5):

$$ndp = \left(\frac{\sum_j P^K * K_j}{NDP}\right) * \sum_i G_i * S_i^A * k_i \quad \text{(A2.7)}$$

where

G_i is the gross rate of return in industry i (ROR_i + D + R); and

ndp is the percentage change in NDP ($100*\Delta NDP/NDP$).

Relating percentage changes in capital stocks to percentage changes in rental rates

A stylized version of the demand side of our CGE model is

$$x_i = ndp - \psi * \left(p_i^{VA} - p\right) \tag{A2.8}$$

where

x_i is the percentage change in the demand for output from industry i;

ψ is the elasticity of substitution between commodities from the point of view of demanders; and

p is the percentage change in the aggregate price index.

The zero pure profit condition can be expressed as:

$$p_i^{VA} = S_{ki} * q_i + S_{\ell i} * w \tag{A2.9}$$

where

S_{ki} and $S_{\ell i}$ are the capital and labour shares in returns to primary factors in industry i;

q_i is the percentage change in the rental on capital in industry i; and

w is the percentage change in the wage rate.

The percentage change in the demand for capital in industry i is given by

$$k_i = x_i - \sigma * S_{\ell i} \left(q_i - w\right) \tag{A2.10}$$

where

σ is the elasticity of substitution between capital and labour.

We adopt the simplification that capital and labour shares in each industry have the common values S_k and S_ℓ. Then using (A2.8) and (A2.9) in (A2.10) and applying (A2.5) we obtain

$$k_i = -\beta * \left(q_i - \sum_j S_j^A * q_j\right) \tag{A2.11}$$

where

$$\beta = \psi * S_k + \sigma * S_\ell \quad . \tag{A2.12}$$

Determining percentage changes in the rental rates on capital

We assume that Q_i is positive. Then from (A2.4) we find that

$$\frac{Q_i}{P^K} * \left(q_i - p^k\right) = 100 * d\_ror_i \quad . \tag{A2.13}$$

where

d_ror_i is the change in the rate of return in industry i; and

p^k is the percentage change in the asset price of a unit of capital ($100*\Delta P^K / P^K$).

It is convenient to adopt P^K as the numeraire so that p^k equals zero. Equation (A2.13) can then be rearranged as

$$q_i = 100 * \left(\frac{1}{G_i}\right) * d\_ror_i \quad . \tag{A2.14}$$

In a situation in which rates of return are being moved towards equality across industries,

$$d\_ror_i = \alpha * \left(-ROR_i + ROR_{ave}\right) \quad . \tag{A2.15}$$

where

ROR_{ave} is the average rate of return across industries; and

α is positive number between 0 and 1 indicating the fraction of the total movement to equality that is being undertaken. For example, if one per cent of the inequality between rates of return is being eliminated, then $\alpha = 0.01$.

Substituting from (A2.15) into (A2.13) gives

$$q_i = 100 * \left(\frac{1}{G_i}\right) * \alpha * \left(-ROR_i + ROR_{ave}\right) \tag{A2.16}$$

or equivalently,

$$q_i = 100 * \left(\frac{1}{G_i}\right) * \alpha * \left(-G_i + G_{ave}\right) \tag{A2.17}$$

Bringing it all together: expressing the percentage change in NDP in terms of gross rates of return

Combining (A2.17) and (A2.11) gives

$$k_i = -\beta * 100 * \alpha * G_{ave} \left(\frac{1}{G_i} - \sum_j S_j^A * \frac{1}{G_j}\right) \tag{A2.18}$$

Now we substitute (A2.18) into (A2.7) to obtain:

$$\mathrm{ndp} = -100 * \beta * S_k^N * \alpha * \left(1 - \sum_i \sum_j S_i^A * S_j^A * \frac{G_i}{G_j} \right) \qquad \text{(A2.19)}$$

or equivalently,

$$\mathrm{ndp} = 100 * \beta * S_k^N * \alpha * \left(\sum_{i>j} S_i^A * S_j^A * \frac{\left(G_i - G_j\right)^2}{G_i * G_j} \right) \qquad \text{(A2.20)}$$

where

S_k^N is the share of capital rents in NDP and is given by $G_{ave} * \sum_j P^K K_j / NDP$.

Reassuringly (A2.20) implies that ndp equals zero if gross rates of return are the same in all industries. Otherwise, it is positive. Thus (A2.20) implies that reallocation of capital in a way that moves rates of return towards equality has a positive effect on NDP.

In using (A2.20) to estimate the effects of moving all the way to rate-of-return equality (α=1) we must think about movements in the coefficients appearing on the right hand side. It is reasonable to ignore movements in β and S_k^N. However the bracketed term moves from a positive value to zero as rates of return move to equality. In evaluating the total change in NDP caused by a move to equality we should use a "half-way" value for the bracketed term. Following this strategy our back-of-the-envelope (BoTE) equation for the effect on NDP of moving rates of return to equality is:

$$\mathrm{ndp} = 100 * \beta * S_k^N * 0.5 * \left(\sum_{i>j} S_i^A * S_j^A * \frac{\left(G_i - G_j\right)^2}{G_i * G_j} \right) \qquad \text{(A2.21)}$$

where coefficient values on the right hand side reflect the initial situation (before the move to equality).

Using the BoTE equation

To use (A2.21) we need values for S_k^N and β. In the USAGE database, the rental on capital as a share of NDP is about 25 per cent. This is typical for a developed economy. The USAGE value for the capital/labour substitution elasticity (σ) is 0.15. This is lower than the value used in most CGE models but as we have argued elsewhere (Dixon, 2009) it is consistent with evidence on the elasticity of demand for labour with respect to wage rates. For the elasticity of substitution between commodities (ψ) our judgement is that a value of 0.5 is representative of the myriad of demand-side substitution possibilities built into USAGE. With typical capital and labour shares in primary-factor returns being 0.25 and 0.75, β = 0.238 [= .025*0.5 + 0.75*0.15, see (A2.12)]. With these values for S_k^N and β, (A2.21) becomes

$$\mathrm{ndp} = 2.975 * \left(\sum_{i>j} S_i^A * S_j^A * \frac{\left(G_i - G_j\right)^2}{G_i * G_j} \right) \quad . \qquad \text{(A2.22)}$$

We make three applications of (A2.22). In our first and second applications we evaluated (A2.22) with the G_is reflecting the Tobin Qs given in the “average” and “2006” columns of Figure 4. The resulting values for ndp from (A2.22) were 0.04 and 0.24. These are broadly consistent with USAGE simulation results which show a very small increase (0.005 per cent) in NDP from equalization of rates of return starting from a situation in which Tobin Qs are at the “average” values in Figure 4 and a somewhat larger increase (0.30 per cent) when the Tobin Qs start at the “2006” values (see Figure 5, row 7, cols. 2&4). This gives us some confidence that (A2.22) is capturing a lot of the relevant theory and data from our CGE model.

The third application is designed to place an upper bound on the likely impact on NDP of equalization of rates of return. We consider an economy with two equal-sized sectors ($S_1^A = S_2^A = 0.5$). For the first sector we assume a gross rate of return of 0.1 and for the second sector a gross rate of return of 0.2 (G_1=0.1 and G_2=0.2). If R+D were 0.1 (a typical value in the USAGE database for an industry) then these values for gross rates of return correspond to ROR values of zero and 0.1, or equivalently Tobin Q values of 1 and about 2. This level of inequality between rates of return is considerably more extreme than observed levels (see Figure 4). With these extreme values, (A2.22) implies that ndp = 0.37.

This suggests to us that capital-market distortions causing sectoral differences in rates of return or Tobin Qs are unlikely to have a welfare cost of more than half a per cent of NDP.