Predicting bubbles

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Abstract: While endogenous asset-price bubbles cannot exist without informationally monopolistic market conditions, even when such conditions exist, such bubbles occur under laissez faire only for relatively short durations and only as random and therefore unpredictable phenomena such as in mixed-strategy-equilibria. In contrast, governmentally generated bubbles – identifiable by their enormity, long-duration, and concomitant supply increases – are predictable. Two alternative causal observations reveal when one of these enormous bubbles is about to be rationally, albeit probably subconsciously, created by a state's rulers. The first causal observation, government-debt-induced-imminent-revolution, and its underlying model, predict history's most notorious stock-market bubbles (i.e. the South Sea and Mississippi Bubbles.) The modern emergence of strong central governments, which came with the advent of government-debt-holding central banks, has made such bubbles obsolete.

The second causal observation is a suddenly diminished governmental concern for its middle class. This observation predicts bubbles as a secondary part of a sequence of governmental-redistribution-based policy-complements.

Keywords: constitutional government; convergent martingales; diminished governmental concern for the middle class; government-debt-holding central banks; historic bubbles; imminent-revolution; informational monopoly; mixed-strategy manipulation; momentum trading; rational governmental deception; rational price determination.

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1 Introduction

So far, economists and historians have analysed stock and commodity market bubbles after the fact. If an asset price has been steadily rising over an extended period of time at a rate substantially exceeding the money rate of interest, contemporary economists traditionally infer the existence of high learning costs, insurance costs, transaction costs or holding costs. But if the price then plummets in the absence of any popularly recognised exogenous shock – thereby forming a classic 'bubble' – the traditional reaction of economists is that investors should have known better than to extrapolate price trends rather than rationally contemplating the fundamentals determining the long-run value of the asset.

We can do better than this. With an appropriate social and economic theory, we can even predict both the birth and death of history's most famous price bubbles and explain why these economic anomalies have been unique to the societies in which they have occurred.

Before attempting to do so, we should delineate the endogenous phenomenon we are studying.

1.1 Exogenous-bubbles and mini-bubbles

Say a series of multiple-trader-observed exogenous shocks made the price and fundamental value of an asset steadily rise, and this were followed by a very large – similarly trader-observed – negative exogenous shock that undid the prior appreciation. Few economists would call this unlikely and unpredictable price pattern a 'bubble'. Economists' bubbles require asset prices to temporarily exceed fundamental valuations. Nevertheless, many non-economists, probably reflecting their failure to appreciate the underlying shocks, call these exogenous-shock-generated price patterns 'bubbles'. Bowing toward common usage, we call such price movements *exogenous-bubbles*. For such 'bubbles', professional traders – individuals whose superior information determines the fundamental valuations used throughout this paper – correctly and competitively interpret the underlying shocks.[1]

This paper will focus on *endogenous bubbles*, which arise from the rational dynamic actions of individuals in a *given* social technology, a technology remaining unchanged throughout the discussion. But we also follow countless observers who call a price fluctuation a 'bubble' plain and simple only if it is relatively large. We correspondingly label relative small endogenous bubbles 'mini-bubbles'.

Although all of the endogenous bubbles considered in this paper are *ex ante* utility maximising to the involved individuals, the underlying informational asymmetries imply a violation of Pareto optimality (Thompson, 1966; Tirole, 1982). Nevertheless, a large class of bubbles is second best optimal: Under certain, historically relevant, conditions, the best medicine for a society's maladies is a bubble.

1.2 Outline of the paper

We consider throughout (and subsequently justify) an economy that has a unique competitive equilibrium at a given distribution of wealth and a rational learning (Baysesian Nash) environment.[2] Section 2 shows that endogenous bubbles are effectively impossible in the absence of informational monopoly. Section 3 then shows that, although endogenous laissez faire bubbles exist under private informational monopoly, these bubbles are: Short-lived; accompanied by no expansion in asset supply; and non-predictable. After classifying these laissez faire price movements as mini-bubbles, and similarly classifying market corners, short-squeezes and political business cycles, we turn to the endogenous bubbles made famous by journalists and historians. Besides requiring governmental involvement, these bubbles, although coming in two alternative forms, are: Long-lived; accompanied by substantial supply increases; and predictable. Based on a simple, welfare-economic, model of revolution, Section 4 develops an anatomy of these predictable bubbles. Section 5 shows that history's famous bubbles all possess this anatomy.

2 Why endogenous bubbles imply informational monopolies

2.1 Competitive price adjustment

First, consider a symmetric-information learning process, one with no informational monopolies.

2.1.1 Rational tatonnement

Say that the day's new buy-orders for a particular asset arrive much faster than sell orders at what was the provisional, initial price. Individually rational Walras-style price adjustment (*tatonnement*) calls for an immediate *and discrete*, substantial, price increase. This price jump occurs because discrete evidence has appeared for the existence of an excess demand for that asset. For several potential buyers and sellers immediately observe the substantial excess of new buy-orders over new sell-orders at the initial price, an excess implying that such a low price is not sustainable.

Although standard price-adjustment models (e.g. Samuelson, 1947; Arrow-Hurwicz, 1948) assume a gradual, or continuous, price increase throughout the day as a result of such excess demand signals, such a pattern is irrational under symmetric information.

Rational speculators respond to an excess-demand signal, like our order-imbalance, by re-estimating the expected equilibrium price resulting from the new evidence and *discretely* adjusting their supply and demand prices to a new rational estimate. Prices jump, not climb.

Combining the initial price and correspondingly observed excess-demand with this new price estimate and corresponding excess-demand observation creates sufficient data for the traders to linearly interpolate (or extrapolate) the price that would clear the market. As explained in Appendix I, although other prices are simultaneously adjusting, our bubble-induced interest in a single, potentially very unstable, market justifies an assumption that these other markets equilibrate conditional upon the given, possibly-far-from-equilibrium, price in the market of concern. If the resulting, *mutatis mutandis* rather than *ceteris paribus,* excess-demand function were indeed linear, then the traders' interpolated price would exactly clear the market. Otherwise, the day's third realised price and excess-demand would provide the basis for a new, quadratic, estimate of the excess-demand function and correspondingly more refined estimate of the market-clearing price. This would continue on until the increasingly accurate estimates of the excess-demand function would soon create prices that are extremely close to market-clearing (Appendix I).

2.1.2 Rational non-tatonnement price-adjustment

Alternatively, assume that there are no excess-demand observations until many, like a day's worth of, trades have occurred. As above, the immediately preceding excess-demand evidence forces the rational transaction price to jump to the price that this excess-demand evidence suggests will clear the market. So this second observed price is, as was the initial price, an unbiased estimate of the market-clearing price, giving prices the character of a martingale, where actual prices are always equal to objectively expected prices. No price trend is implied. So no endogenous bubbles occur. Also, because more information is being used to estimate the second price, it is expected to be closer to the market-clearing price than the first one. Although slower than the Walrasian dynamic – and more statistical because the significant trading at false prices creates unpredictable allocative and redistributive effects – the accumulating information still generates a convergent sequence whose expected prices always equal market-clearing prices (Appendix II).

2.1.3 Characterising the competitive price paths

Neither the *tatonnement* nor the *non-tatonnement* pricing process described above is prone to costly disequilibrium speculation. For neither generates a predictable price trend. Although prices generally erratically jump or dive from one trade to the next, they do so at decreasing expected amplitudes in that expected prices better and better approximate an equilibrium as the accumulation of market information ever-better informs the participants about which prices are too high and too low. In short, 'efficient market' prices form a convergent martingale.

2.2 Brief, unexpected informational advantages

A more challenging generalisation admits brief, unexpected, informational asymmetries. Some individuals unexpectedly obtain information relevant to the price of an asset for a short period of time, say a day, before others receive it. They then rationally speculate, that is, trade with the purpose of reversing their position when their private information becomes public. The resulting price pattern is not the efficient-markets pattern emerging from a symmetric-information model. If the speculator submitted a large order accurately reflecting her excess demand at the original price, the market price would immediately jump to her expected value, but she would then fail to profit from acquiring her knowledge.[3] To avoid this, for her, unfortunate price pattern, the freshly informed speculator merely takes existing sell orders off the market at the initial price and only slightly increases the subsequently observed prices of the commodity. She will continue to buy, but the increased prices caused by her concentrated purchases prevent her from ordering anything like her excess demand at the pre-existing prices. Prices will rapidly increase as her information is read by other traders because the price changes accompanying her rationally gradual or sporadic purchases or sales would soon indicate to other traders that a large trader is buying or selling the good (Back–Baruch, 2004). Despite the confusion created by random orders throughout the day, the price and volume increases would virtually inform the other traders of her expected price. Prices soon plateau at the revised expected value. So, with the exception of intra-day price trends and socially costly speculation, brief, unexpected, informational asymmetries are insignificant: As in above Section 2.1.2 (and Appendix II), they just slightly delay the achievement of equilibrium.

This uniform convergence to a plateau also holds whether or not ordinary 'liquidity' traders are aware of their informational disadvantages. Owners aware of their informational disadvantages would retain their positions following bullish observations. The others would lose by selling to more informed traders, including induced momentum traders, who buy when they see prices rising on high volume and thereby generate trend-accelerating speculation rather than bubbles. Were it not for these unfortunately unaware sellers, there would be very little profit to the trader with the brief information advantage and no profit at all to momentum traders, that is, there would be no significant waste of information-transaction costs on the path to the plateau.

3 Unpredictable endogenous bubbles

3.1 Market manipulation and bubbles in the presence of informational monopoly

Suppose now that the above informed speculator had long anticipated acquiring some kind of asset-specific information advantage. We assume throughout that such specialized traders, whom we label 'informational monopolists', are well-financed; otherwise they would not have bothered to put themselves in such a position. Although the above absence of endogenous bubbles and correspondingly rapid price increases to promptly reflect the informed trader's valuation are good for society, these ordinarily benign price patterns will be prevented by the rational, market-preparing, informational monopolist. That is, since the speculator now has time to 'prepare' the market, she will be

able to buy without signalling her excess demand and substantially fill this excess demand without significantly changing her transaction prices.

Thus, from the start, to optimally exploit her subsequently quite specific information advantage, an informational monopolist manipulates the market by randomly creating both positive and negative bubbles. She does this in order to prevent traders from changing their expected prices when she later, unpredictably, buys or sells to establish her final speculative position. This requires that she create brief bubbles in order to eliminate the expectation that rapid price changes and volume increases signal further such price changes in the future. Thus, at random points prior to accumulating (or selling-short) the asset, the informational monopolist rationally enters buy (or sell) orders in the same way as if she had received good (or bad) news concerning the company, thereby changing the price, but then quickly reversing her order flow. As in Hart (1997), Jarrow (1992), Allen and Gale (1992) and Aggarwal-Wu (2003), such cycle-creating transactions are profitable to zero-cost outsider-manipulators if some traders are momentum-trading or slow-learners, in which case some of the reversal trades of the manipulator would be with ill-fated momentum players or slow-learning liquidity traders. Although manipulation costs generally deter these outsiders, an informational monopolist is willing to incur substantial direct losses from manipulation in order to prevent her eventually informed, future speculative transactions from influencing future price expectations.[4]

Since other traders are correctly aware of the chance that any given price increase may reflect an accumulation pattern by an informed investor, rationally designed price reversals must exceed the prior price increases in order to maintain a rationally learned future price expectation at the original level. Longer, larger, manipulated price appreciations, although somewhat less frequent, are similarly followed by still larger price reversals. Once she has so prepared the market, an informational monopolist still expects to buy successive units at successively higher prices, but each price is only insignificantly higher than the previous one because the expected rate of deflation rises as prices rise. Although other investors increasingly infer the presence of an informational monopolist from the abnormally high volatility created by the preparatory manipulations, they also increasingly regard above-normal prices as selling opportunities. She prepares the market in the same way whether she anticipates good or bad news. Sharp increases in price volatility and volume followed by decreasing price volatility relative to volume indicate that an informational monopolist is preparing the market and prices are about to either jump or dive. For assets persistently traded by informational monopolists, the above pattern forms a long-run, rational-expectations, equilibrium. As in the model of Kyle and Vila (1991), normal (mixed strategy) volume is then very high relative to price changes, the latter occurring significantly only on public news releases.

The dominant models of trading under rational expectations in the occasional presence of a single informed trader, those of Kyle (1985) and Glosten-Milgrom (1985), implicitly assume away manipulation. In the former model, admitting such strategies would generate much higher profits to the insider and obviate the model's reliance on random liquidity trades in order to somewhat confuse the outsiders. In the latter, rational bid-ask spreads would vanish because sellers would no longer rationally expect buy-orders to signal higher future prices.

The manipulating informational monopolist facilitates the above strategy with reversals that concentrate in the moments immediately following anticipated, publicly observed, shocks (say scheduled earnings announcements) about which she has no monopolistic information advantage. During these very brief periods, price determination

is left to competing specialists who, while possessing no informational monopolies, know enough about fundamentals that other traders rationally refuse to trade until these traders have established a value for the asset (Glosten and Milgrom, 1985). In the hour following a public announcement, these relatively informed speculators use their special information to evaluate the change in asset value resulting from the shock. An active manipulator's large trades at such times cannot generally be distinguished from those of an ordinary specialist who simply believes that the asset's fundamental value is affected differently by the shock than the other specialists. However, to the extent that the prices following a public announcement are surprising to the ordinary specialist, there is a high probability that a manipulator has been in the market and is rationally reversing her position. Consequently, our manipulator, like the information-hiding insider in Foster-Viswanathan (1994), is best-off moderating her concentrated trades during these rounds. In our model, the moderation works to prevent ordinary specialists from confidently inferring the manipulator's reversal pattern.

Professional traders must make money on their shock-induced transactions when manipulators are not in the market in order to compensate them for their losses when such traders are in the market. Such increased profit margins are theoretically necessary in order to compensate professional dealers for their expected capital losses from their trades with these more informed traders. Thus, bid-ask spreads substantially increase during shock periods. (See, e.g. Melvin and Tan (1996) regarding foreign exchange markets and Madhavan, Richardson and Roomans (1997) regarding stock markets).

3.2 Endogenous bubbles stemming from informational oligopoly

Now consider asset markets possessing a few, risk-averse or financially constrained, informed traders ('informational oligopoly'). Since the above profit to manipulation is eliminated by free-riding rivals, momentum-trading may now be profitable. For such assets, typically the stocks of companies with many employees or contractors (indeed, Aggarwal and Wu (2003) show that manipulation concentrates on the small-firm level), uninformed traders might now wisely take strong positive momentum as evidence that a few, independent, informed traders have all received a positive signal. Although the latter traders compete for the stock and therefore limit the profitability of riding their coattails, liquidity and risk limit their exposure, thereby creating a possible profit to momentum-trading as in Section 2.2. In any case, prices and volume increase and the stock will rapidly climb, but not jump, to its new equilibrium.

While momentum trading has indeed produced a moderately positive expected measured profit, the entry of competing momentum traders, and corresponding decrease in the threshold required for investors to decide that informed traders are accumulating the asset, inevitably creates costly trading errors (Copeland-Friedman, 1991). Thus, on occasion, accidental momentum increases caused by coincidental increases in the buy-orders of non-informed traders will induce further price-rises as the rationally low-threshold induces a wave of unfortunate, formula-driven, price increases and an inevitable crash. A vivid example of such an endogenous bubble can be found in Avery and Zemsky (1998). Bubble-induced losses thus offset the natural profit arising from momentum trading to create a long-run, rational expectations, equilibrium.

More generally, any statistically justifiable, oligopoly-induced, trading rule used in equilibrium eliminates the expected profits of the marginal trader by creating less and

less discriminating signals until the rule-determined trading profit is offset by losses from misleading signals and corresponding bubbles.

3.3 Interpretation and application

First of all, it would be foolhardy for an outsider to *predict* the endogenous bubbles arising in the above environments. This is because bubble-creation in the environments is random. At some, externally unpredictable, time, a manipulating informational monopolist will fail to liquidate her accumulation. Or some usually reliable trading rule will begin to inflate prices but then the market collapses because of the fallibility of the signal. Trying to predict a bubble here is like trying to predict a first-pitch curve-ball.

Secondly, both manipulation (small-company) and false-signal (large-company) bubbles imply the positive intra-day as well as day-to-day autocorrelations found in numerous stock-market studies (e.g. Cheung and Ng (1992); Chan, Chan and Karolyi (1991)). Similarly revealing studies show that prices in spot asset markets are much more auto-correlated than the corresponding prices among the better-informed traders in the corresponding futures markets (Chan, 1992; Ahn et al., 2002).

Finally, in the terminology of Allen and Gale (1992), we have been discussing only 'trade-based' manipulation, for which we have seen that predictable bubbles cannot be generated. However, manipulation and bubbles can also be created by the exaggerated claims of people in a position of authority. Such 'hype' can significantly influence asset prices even when the companies are large and the purchases or sales of individual traders do not significantly influence their stock prices. All of our predictable bubbles will contain a significant element of hype. In the related, false-advertising, model of Benabou and Laroque (1992), the informational monopolist must mix true with false announcements in order to attract investors. So the private manipulation in Benabou and Laroque is similarly unpredictable.

3.4 The duration of the above, laissez faire, bubbles

An identifying feature of the above bubbles is their short duration. It is virtually impossible for any such bubble to last for more than a few weeks. The cumulative market purchases required to sustain a predominantly increasing price path over an extended period of time, which means substantially more than a few weeks, would be so enormous that the manipulator would doubtless be stuck with huge inventories after the burst of the extended bubble. Similarly, the accumulated absence of evidence of additional buying by new, subsequently informed, traders is an increasingly sure sign of a false signal.

While such inventory-accumulation or unverified-indicator problems would not affect the false-advertising variable, or 'hype', variable in the paper of Benabou and Laroque (1992), an analogous problem creates a similarly short duration of false-advertising-induced bubbles. There is not only a substantial cost of each hype-story that a speculator may purchase from the media or stock analysts in order to support her speculative position. But the stories rapidly depreciate. For each story is diluted by other information that also accumulates between the positive stories, information that cannot be expected to put the same positive spin on the asset. And the hype-stories often induce subsequent counter-stories. Thus, as above, the effective duration of a series of hype-stories is reasonably limited to a few weeks.

The predictable bubbles arising in this paper will be distinguished by their extended duration, usually measured in months, and associated significant supply increases. Although manipulation is required, something else is also involved. To keep the difference in mind, the private-manipulation-created, essentially random, intra-month, bubbles discussed in this section are classified as mini-bubbles'. The remainder of the paper will concentrate on a longer-term market dynamic by assuming that the prices discussed above are market-clearing at the end of each month for given, possibly quite false, long-term expectations.

4 The anatomy of a predictable bubble

What makes economists able to predict events that most others cannot is that economists have theories enabling them to predict the effects of certain shocks better than those untrained in the black art. For example, if a shock occurs that appears to a lion's share of the investment community to be favourable to industry but is actually unfavourable, the price of publicly traded shares of companies in those industries will rise and fall in something resembling a bubble pattern. Good economists, having witnessed the initial price increases, can confidently predict the existence of an eventual downturn.[5]

However, we are attempting here to predict an entire bubble, not just a downturn after prices have mistakenly risen. To do this requires us to predict the bubble-generating shock, the public decisions, or "legislation," generating the entire experience. Hence, we must include a theory of public choice enabling us to predict the relevant, investor-deceiving, legislative acts. Since bubble-creating legislation typically employs public policies that appear to economists and historians as if they were exogenous, these bubbles have been usually described as exogenous by traditionally accepted authorities (e.g. Garber, 1990). However, by endogenising legislative actions, we shall see that these bubbles are actually quite predictable.

4.1 Rationally deceptive legislation

Since it often takes at least several months for legislative acts to occur, we can expect the duration of the corresponding bubbles to often go way beyond that of the unpredictable mini-bubbles discussed above. A small-magnitude, macroeconomic example of a deceptive-legislation-created bubble is a 'political business cycle'. Such a cycle arises when an incumbent US President or UK Prime Minister induces his loyal monetary authorities to expand the money supply a few months before an election in order to take advantage of worker mis-perceptions of the price level to garner more votes in an upcoming election despite the inevitable boom-and-bust cycle that follows the implicitly deceptive shock.[6]

Although we would have no problem in regarding the incumbent re-election-year US stock market booms in 1948, 1964, 1972, and analogous UK stock market booms of '55 and '64, along with the immediately subsequent market declines, as 'bubbles', and highly predictable ones at that, we eschew such revisionist terminology in favour of searching out the distinguishing features of the historical price movements that have heretofore been popularly called 'bubbles'. One thing that does not distinguish political-business-cycles from these historical movements is their self-corrective nature. As the post-gold-

standard public increasingly began to catch on to this Post WWII business-cycle pattern, which implied increasing pre-election hyperinflation, the nature of the monetary authorities changed. The new authorities became strongly principled, even if only banker-serving, individuals rather than normal political appointees. The central bank leaders from the mid-70's onward were not going to cave into political pressure to expand the money supply a few months before an up-coming election in order to affect the election's outcome. In any case, historically observed political business cycles were not large enough to induce post-cycle hearings, and therefore not large enough for journalists and historians to label them 'bubbles'. So we include observed political business cycles with the above-discussed 'mini-bubbles' and go on with our search, keeping in mind that we are now searching for legislation that creates very large percentage asset-price fluctuations and post-cycle fraud hearings.

Bubble-creating policies arise only under unusual conditions. To generate these conditions, we assume that a recent exogenous shock has changed the optimum of an informed and rational ruling elite. Bubbles arise in response to such shocks as part of the ruling elite's achievement of its new optimum.

4.2 When bubble creation is a rational government policy

4.2.1 Two types of governmental deception

Bubble-creating governmental actions occur through either:

1 a sequence of positive governmental announcements widely considered to be true because of the rarity with which they are deceptive

2 legal 'reforms' reducing the legal penalties of deceptive private announcements, 'reforms' the public only understands through bitter experience.

The pressure of contrary news is much lower in these deceptive-legislation cases because, again, the announcements of governmental leaders and company executives are more credible than the advertising of investment journalists and brokers. So much larger and longer bubbles than the above-discussed false-advertising bubbles occur when the bubbles stem from rationally deceptive legislation.

Corresponding to each type of legislative deception, there is a distinct disequilibrating shock.

4.2.2 Imminent-revolution shocks

4.2.2.1 A theory of revolution

'Revolution' here occurs when an alternative domestic ruling elite physically overcomes the original defence commitment of the military leaders loyal to the existing ruling elite. We assume throughout that the alternative ruling elite is a rational subgroup of the population in the sense that the group is internally efficient, or 'cooperative'. The existing ruling elite is also assumed to be rational in that it makes rational commitments to finance and defend the state as well as to suffer the consequences if events do not enable it to survive history's slings and arrows.[7]

We also assume throughout that the entire society – at an initial formative stage – cooperates to achieve socially efficient rules (Thompson-Faith (1981). That is, the

society's military founders constrain the behaviour of their future generations in a way that maximises their utility for the expected utilities of their descendants. These constraints concern internal rent-seeking, including revolutionary activities between a rational ruling elite and rational alternative ruling elite, as detailed below.

Ordinarily, even for the governmental mismanagement case discussed in endnote #7, revolution is considered to be an extremely negative-sum game, a costly transfer that would be better achieved by a voluntary transfer rather than costly violence. That is, when the government is worth more to an alternative ruling elite than to the existing ruling elite, a simple purchase of the entire government would appear to be highly socially preferable to warfare. And when the government is worth more to the existing ruling elite than to an alternative ruling elite but revolution is still profitable, then the existing ruling elite should buy peace from the threatening rebels. This latter purchase, through conciliatory policies toward the potential rebels, is a common occurrence. But the former – the purchase of an entire government by an alternative ruling elite living in the same geographical area – is a historical rarity. Resource-costly revolutions occur instead. Any satisfactory model of revolution must explain this economic anomaly.

The value of the government to an existing ruling elite is the value of the resources it can tax away from the others in the state minus its debt, which we assume is owed to others in the state. Since the alternative ruling elites, who are alternative heirs to the founders and therefore plausibly utility-equivalent, would also receive this value under a legal transfer of the government between the two alternative, rational and informed, ruling elites, legal transfers generate no social surplus.[8]

Nevertheless, the government may still be worth much more to rational rebels than to a rational ruling elite. Although this excess value would again ordinarily be the basis for a sale of the government to the alternative ruling elite, it is conceivable that the only way for the alternative ruling elite to realise its excess value is to militarily conquer the existing ruling elite in an 'unfriendly' takeover.

In particular, debt repudiation may be much less costly to rebels than existing ruling elites. It is easy for successful rebels, who do not accept the legitimacy of the prior regime, to repudiate the national debt. In their eyes, and the eyes of many future lenders' as well, the debt belongs to the profligate incumbents, not the rebels. So rebel repudiation – in contrast to ruling-elite repudiation – generally enhances a state's future borrowing power. Hence, when a huge national debt threatens the ability of an existing state to defend itself against foreign aggressors, the resource value of the debt-encumbered state to the existing ruling elite is far less than it is to the rebels, which is a debt-free value. And the gross, as well as the net, value of a state is greater if the state is new and debt-free because it has a much greater longevity based on it's ability to effect a defence commitment because of its relative ease in borrowing to finance future defence emergencies.

The function of such a revolution to the optimal-rule-setting initial founders of the state is thus to eliminate the claims of the pre-existing governmental creditors in a way that restores the country's original borrowing power and thus its security against foreign attack. In fact, almost all pre-20th century revolutions left private property rights, other than claims against the government, in tact, although they did entail the resource-costly elimination of the military defenders of the pre-existing ruling elites and a related replacement of the political establishment loyal to the interests of state's pre-existing creditors.

The existing ruling elite could also repudiate the debt, or retire it at a depressed price. But if effective repudiation were easy, the original debt would have carried a prohibitively high interest rate. Debt is not credible in the first place without high repudiation costs. Similarly, initial welfare-maximisation requires debt-repudiating revolutions to be socially costly. We take these costs to be exogenous.

The resource value of a future revolution to the social founders is the corresponding future increase in the gross value of the state minus the total military cost of the revolution. However, while rebels internalise the value of the newly formed state, they do not internalise the military costs imposed on the previous ruling elites.[9] Nor do the rebels fully internalise the loss in value to the pre-existing ruling elites. Full internalisation of that loss would only happen if the existing ruling elite had offered the rebels' their entire gross value of the state from the state to prevent a revolution. But this does not occur because such 'protection' payments encourage unobservable investments in activities that prepare a group of potential rebels for obtaining unjustified transfers. The rational ruling elite therefore commits itself to pay only incomplete protection payments, incomplete bribes to threatening rebels. The private profit to revolution thus exceeds the social resource value of revolution so that unrestrained potential rebels see a private return to revolution that exceeds the social return of revolution. Hence, despite the silver lining offered by our revolutions in terms of improved borrowing power and defensibility of the state, there is a socially excessive private return to revolution.[10] There is thus a positive social value of contemporary revolution-deterring strategies. That is, founder-efficient societies feature extra-military methods of retarding revolution. This amounts to efficient time-t revolution-deterrence. We shall see that bubbles work to reduce the profitability of revolution. Thus, the prior maximisation of the utilities of military founders implies, and so we predict, the existence of contemporaneous revolution-preventatives such as bubbles.[11]

4.2.2.2 The basic anatomy of an imminent-revolution bubble

Once a segment of the country's population suddenly threatens revolution, the existing ruling elite must respond. Since the prime motive of the revolution is to default on the national debt, a counter-revolutionary strategy is to induce the rebels to increase their rationally zero holdings of the country's national debt. (We assume that the existing rulers are smart enough to have laws against selling their bonds short.) To do this, the ruling elite can create a series of positive shocks in a company that ends up holding a large fraction of the national debt as a by-product of exploiting its primary assets. As we have seen, such hype and hype-induced price-and-volume increases induce both news-sensitive and rationally momentum-playing outsiders, including rebels, to invest in the company and, quite incidentally to the investors, in significant amounts of governmental debt. Each government announcement is positively beneficial in drawing more of these investors to own national debt. Although these trend-following investors are not long-term investors, the boom induces the temporarily debt-holding rebels to rationally delay their revolution. Then – whether or not the ruling elite initially realised that it was inevitable – once a significant number of potential rebels have invested in the companies, the investors in the informed ruling elite will sell their inflated stock back to the company in exchange for company debt as well as cash. The positive announcements will then rationally stop. After the inevitable crash, the government, the bankrupt company's main

creditor, will own almost all of its own debt and have also redistributed away from the rebels in order to cut-off their imminent revolution at the purse strings.

If the governmental source of the redistribution were clearly understood by the threatening rebels – as it would, for example, if the policy amounted to an announced tax hike – an immediate revolution would ensue. So the redistribution must be deceptive, on an *ex post* as well as an *ex ante* basis. The would-be rebels who suffer substantial speculative losses will subsequently blame – rather than the government (who 'sympathetically' retires their post-crash stock at above-market prices) – a few scapegoat-promoters and themselves for their own ignorance and greed.

This deception occurs despite what should be a heightened awareness by the rebels that the ruling elite has an incentive to create such a bubble. To allay these rational suspicions, the ruling elite should – and does – pretend to be unconcerned or unaware of the activities of the rebels. It should also initiate the bubble so as to ostensibly benefit mainly ruling-class investors. A simple way of achieving this end is to promote an investment of particular interest to the ruling class and allow investors to trade their government bonds for stock in the promoted company. The latter both creates the appearance of benefitting the ruling class, who are initially the main owners of the national debt, and furnishes the basis for a large incidental accumulation of national debt in the company, whose distressed future condition will enable the government, in its role as the major creditor of the company, to effectively acquire its debt at bargain-basement prices and simultaneously appear to be a saviour of the almost-ruined investors.

A revolution-threatened ruling elite is much better-off when it directly announces a series of bubble-creating decisions than under the form of deception in which it 'reforms' the legal system in order to induce private promoters to produce the hype. For, under the threat of imminent revolution, the ruling elite desires to:

1 *immediately* implement their policy

2 induce a boom in the stock of firms that hold large amounts of government debt

3 attract a very specific set of victims.

Hype-creating private promoters cannot be counted on to:

1 *immediately* exploit promotion-inducing legal 'reforms'

2 promote companies holding large amounts of government debt or

3 target potential rebels.

To summarise the above, basic, anatomy: An imminent-revolution bubble rationally arises in response to revolutionary indications or uprisings that the government only publicly regards as harmless. What follows is a series of government announcements of a great new investment opportunity in a firm whose major assets will incidentally include national debt. The announcements, each of which noticeably improves the publicly expected profit prospects of an investment ostensibly designed to benefit members of the ruling class (and ultimately does, but only because they sell-out early), leaves the essentially bankrupt, government-debt-holding, company in the hands of governmental creditors and several erstwhile rebels with nobody obvious to blame other than themselves and a few embattled promoters.

4.2.2.3 Political repression

When potential rebels are more financially knowledgeable than legislators, or when the economy is not financially sophisticated in that it lacks both publicly traded shares and the sophisticated central banking institutions described in Section 4.2.2.5(e) below, the above theory predicts alternative institutions. Rather than suffering a revolution, the rational ruling class will imprison or exile individuals who are inclined toward politically rebellious behaviour.

4.2.2.4 An objection to bubbles and political repression as revolution deterrents

The above theory predicts revolution-deterring policies based on indicators of imminent revolution. Although such indicators appear in all of the cases we have studied, it is costly for the ruling elites to observe them. To cover situations in which these costs are very high, more robust revolution-deterrents should be sought, institutions eliminating the profit to revolution even when the rulers are unaware of rebel intentions.

4.2.2.5 Advanced anatomy

Suppose that the government sets up a central bank whose chief asset is government debt. In this case, a default by a new government would ruin the bank, the bank accounts of the rebels, and the ability of the post-revolutionary leaders to generate efficient financial flows. An alternative revolution deterrent thus arises in the form of a government-debt-holding central bank. Such a financial institution works to substantially lower, generally to negative levels, the profit to revolution. A national-debt-holding national bank is a 'poison pill' to potential rebels. In addition to the loss of their own bank accounts and the existing government's opportunity to use the central bank to finance defence emergencies, 'successful' rebels would be greeted with financial chaos as the member banks suddenly lose their clearing house.

Correspondingly, accompanying each one of our imminent-revolution bubbles, we will also find governmental attempts to quickly establish government-debt-holding central banks. Moreover, imminent-revolution bubbles disappear once a nation has set up a national-debt-holding central bank. And old-style, non-ideological, revolutions themselves virtually disappear once such banks appear! But this cannot be the end of the sequence. Once governmental legislators and administrators are free of revolutionary pressures, constitutional constraints assuring peaceful political competition must be employed in order to substitute for the check on their political power previously provided by revolution. Constitutional governments thus arose as militarily imposed complements to government-debt-holding central banks.

Post-WWI central banks in securely constitutional states gradually replaced the long-term government debt in their portfolios with short-term government debt (Ferguson, 2001; Simmons, 1947). This financial convenience gave potential revolutionaries the ability to default on the nation's long-term debt and still count on a liquid central bank. The modern absence of revolution in developed nations despite their unprecedented levels of national debt and taxation of the wealthy can only be explained by the success of their modern centralisations of military control and corresponding constitutional governments.

4.2.2.6 Stages of development of revolution-deterring institutions

Applying the above model to Western nation states, the historical progression has been for: Oppressive government to be the first; imminent-revolution bubbles to be the second; national-debt-holding central banks and constitutional governments to be the third and final revolution-deterrent. More specifically, prior to the emergence of a national market in the shares of the joint stock companies, the fledgling European nation-states engaged in either:

1 qualitatively efficient, regime-changing, generally Northern European, revolutions in order to restore a country's emergency borrowing power in the face of a recently expanded, huge, royal debt; or

2 inquisition and torture in heavily Church dominated Southern European countries in order to repress otherwise certain revolution while high taxes and forced loans kept the often out-dated, religiously ideologised, monarchies in place.

Thus, while revolution was a common occurrence in 16th and 17th century Northern Europe and then fell to insignificance in the subsequent two centuries (Tilly, 1993[12]), the same sharply downward trend was simultaneously experienced by the extensive torture that had characterised the Counter-Reformation. Our explanation for these sea changes is that national-debt-holding central banks rose from insignificance to pervasive European institutions during the 18th and 19th centuries.

4.2.3 A suddenly diminished concern for the middle class

Alternatively, say there is a shock in the desired distribution in favour of an established ruling class relative to ordinary people. This occurs, for example, when a new, less sympathetic but militarily stronger, ruling family inherits a monarchy. More topically, it also occurs when ruling elites who originally had to compete for their factors of production – because of a sudden expansion in the borders within which they can dictate economic policy – suddenly trap the previously competed-for factor owners within their borders (Thompson-Hickson, 2001, Ch. 2, Part II).

In either situation, a regressive trend in the tax structure will arise in a movement characterised by decreasing ruling-class humanism. This trend generates a decreasingly egalitarian distributional equilibrium between the ruling class and ordinary people. Increasingly taxed workers and small business-people, who initially have backward-bending long-run supply curves, will work increasingly long hours for decreasing before-tax and after-tax hourly returns as they devolve toward subsistence lifestyles (ibid.).

If a large number of small investors initially invested in financial assets side-by-side with ruling-class investors in an attempt to imitate them, it would be very difficult for a legally constrained ruling elite to redistribute away from these free-riders even though they wanted to. In this case, a special set of policies must be designed to accomplish the redistribution. These policies induce many small investors to jump on a bandwagon, which is then abandoned by the more informed ruling class, leaving ordinary people with radically reduced wealths due to the borrowing they did to participate in the contrived asset boom.

Besides the middle-class's triple-hit of rising taxes, declining before-tax incomes, and large stock-market losses, large personal real-estate losses are also in store for the no-longer-competed-for middle class. Because a willingness to invest large amounts in

the stock market ordinarily presupposes the possession of residential real estate, large real estate losses are rationally the last to create. Nevertheless, because these redistributions cannot be expected to fully confiscate these real assets from the middle-classes in a single bubble, what we expect here is actually a series of appropriately spaced bubbles. Besides increasing middle-class tax rates and correspondingly decreasing wage rates, what we expect here is an alternation of financial-asset and real estate bubbles in an extended era that historians would later characterise as an era of 'widespread economic fraud and market instability'. The cumulative result would be an immense shake-out, leaving most assets in ruling-class hands.

While sequences of governmental decisions are responsible for some such real estate bubbles, the government does not generally supply the hype that creates these redistribution-based bubbles. Rather, it supplies legal 'reforms' that decrease the legal punishments that ruling-class promoters face for various offences against ordinary people, who are initially unaware of the subtle change in the incentives of investment promoters. Although the governmental cause of the resulting series of fraudulent laissez faire promotions may become subsequently obvious to the victimised middle-class, no serious consequences will follow from their *ex-post* insight. In contrast, we have seen, the fraudulent promotions designed to redistribute away from imminent revolutionaries are restricted to a form that can be plausibly attributed to private promoters who appear to deceive *both* the victims and the ostensibly well-intentioned ruling elite.

These and other detailed implications regarding the differential bubble characteristics resulting from different distributional disequilibria will now be evaluated in a series of historical applications. We will also use the theory to predict bubbles that both have occurred and are about to occur.

5 Predicting both historic and future bubbles

5.1 Predicting history's imminent revolution bubbles

The two most famous bubbles in economic history are the 'South Sea Bubble' and the 'Mississippi Bubble'. Another, less famous but theoretically equivalent, bubble was the US 'Panic of 1792'. Although others writing on historical bubbles, not seeing the basic rationale behind these bubbles, describe them as separate episodes, we have no reason to do so. Rather, we point out that these three episodes were all highly predicable in that standard bubble histories tell us that each one of these bubbles satisfied the same necessary and sufficient preconditions for a rational bubble.

Each observed bubble satisfied the necessary precondition of a lack of a government-debt-holding central bank. As we have seen, most countries – virtually all of Europe other than England, Holland, and France – introduced government-debt-holding central banks prior to stock markets and therefore had no similar bubbles.

Each observed bubble also satisfied the theory's necessary precondition in which the country had no inquisition. The strong parliaments and secular legal ideologies of England, France and non-Spanish America had, by the time of their bubbles, eliminated their earlier systems of torturing political rebels.

Each observed bubble satisfied the theory's sufficiency precondition in which a recent increase in an already stifling government debt occurred. In the English and French cases, it was the same war, the highly expensive War of the Spanish Succession

(1701–1714), which followed their similarly expensive War of the Grand Alliance (1688–1697). In the US case, Alexander Hamilton had just announced that the new US Government was assuming the debts of the previous US governments, state as well as federal, despite the absence of a system of federal taxation other than customs duties. Furthermore:

Each bubble was preceded by unmistakable signs of revolution. Jacobite uprisings and urban tax riots threatened a debt-strapped England. Uprisings in Brittany, Pro-Spanish conspiracies, and similar tax-riots threatened a bankrupt France. The revolutionary character of the Anti-Federalists was reflected in Philadelphia's Whiskey Rebellion, from Hamilton's 1790 expressions of serious fear of revolution, from his concentration of the bubble in Philadelphia and New York, the homes of Anti-Federalism.

Each bubble began with a series of government announcements making investments in a specific company appear very profitable and governmental failures to reveal its growing insider knowledge of the companies' inabilities to sustain their promised dividend yields as prices rose. Besides the systematic withholding of negative fundamentals, this was done by a sequence of official announcements, each enhancing the value of the companies. Thus, in setting up her bubble, beginning in late 1718, France sold to the Mississippi Company, under favourable terms: The rights to the state's tobacco revenue; next Colbert's French East India Company; then the exclusive right to mint coins; and finally the right to collect almost all of France's taxes. In the process, the Crown received many shares in the Mississippi Company on which it would greatly profit. Similarly, following England's announcement of a plan to have the South Sea Company convert the public's illiquid bonds into liquid stocks, government-connected promoters provided the necessary stream of good news by regularly announcing, quite fraudulently, that the rapidly appreciating Company would be able to steadily maintain the same above-market dividend rate even though their prospective flows of net revenue per share were substantially falling, both fundamentally and relative to prices during the dramatic price run-ups (Scott, 1968, p.325). To initiate the US bank-stock boom of 1791, Hamilton merely had to announce a plan, likely pure deception, to transfer large parts of the national debt into various local branches, mainly in New York and Philadelphia, of the newly formed national bank.

Each observed bubble began by inducing the rebellious masses to take heavy positions in a company whose assets were largely government debt, thereby delaying the threatened revolution until a more durable solution could be devised. Both the Mississippi and South Sea Companies won their chartered monopolies by promising to hold large amounts of government debt received in exchange for their new stock. The price boom and new stock sales ended once each company had accumulated almost all of the country's respective national debt and the bust would put the rulers in position to cheaply acquire the company, and therefore much of its debt, while appearing to be a white knight. The US bubble was similarly fed by allowing the new bank issues to be purchased for government bonds at par value rather than cash, which was widely done, given the discount bonds received in the open market.

Each observed bubble was a manipulation by wealthy urbanites that victimised less financially sophisticated potential rebels. Furthermore, the Mississippi and US bubbles were blamed largely on foreigners or social outsiders who became the scapegoats (John

Law and William Duer, respectively), while England imposed only light punishments on her many vaguely implicated Members of Parliament.

Each observed bubble featured concurrent governmental efforts to set up a debt-holding national bank. France acquired John Law's bank, which was increasingly acting like a national-debt-holding central bank (Davis, 1887). The English Parliament had attempted to induce the Bank of England to hold long-term government debt, but the bank initially refused due to its already crowded portfolio and thus under-bid the South Sea Company for the right to exchange new stock issues for the privately held national debt at the birth of the South Sea Bubble in March 1720. And the US Panic of '92 was caused by a bold change in Hamilton's announced plan, a reversal retaining the national debt in the coffers of the central bank.

Each bubble exhibited a flat spot at the top, thereby giving most of the insiders a comfortable opportunity to liquidate their positions. The Mississippi Company managed their flat spot by officially fixing the price of their stock and reducing the number of repurchases by announcing a substantially above-market dividend rate at this price while the South Sea Company and US bank-stock promoters managed theirs with increasingly wildly optimistic announcements of planned dividend payments (*e.g.*, Carswell, 2001).

Each observed bubble resulted in the elimination of a serious revolutionary threat. The impoverishment of wealthy rebels, would-be financiers of revolution, occurred in every case. Moreover, the French Crown, although unfortunately liquidating it's fledgling debt-holding central bank, used it's immense trading profit from the Mississippi bubble to make itself the company's dominant creditor and thereby both retire a large part of the national debt and reacquire its previous revenue-generating rights in the bankruptcy proceedings (Theirs, 1859). The Bank of England picked up the debt of the desperate post-crash South Sea Company for a discount, thereby making itself a national-debt-holding central bank and ending the long series of English revolutions that had occurred up to that point. Similarly, the US National Bank – upon abandoning the branches around which the booms centred and thereby leaving insider-speculators even more wealthy at the expense of Anti-Federalist investors – became the chief holder of the US's debt and thus found itself immune from revolution despite the subsequently large increases in the national debt.

Finally, although our theory is rationality-based, we do not wish to attribute too much foresight to the policymakers. Evolution rather than insight may have fashioned the appropriate strategies of the ruling elites. Indeed, each observed bubble featured a two-stage, possibly quite myopic, process. In the first stage, the revolution-threatened elites employed hype to attract would-be rebels into speculative positions in companies establishing heavy positions in the national debt. In the second stage, the manipulated flat spot, the elites rationally bailed out before suffering the inevitable consequence of the initial hype. It is not clear how many of the bubble-creators foresaw the bubble that would follow from their initial hype.

5.2 A suddenly diminished concerns for the middle class

5.2.1 The Crisis of 1620

5.2.1.1 Predicting the bubble

Joint stock companies began their flourishing history in mid-16th century England. The original companies were formed out of monopoly grants from the Crown in return for

cash or a share in the revenue. Limited liability and negotiability greatly attracted England's middle-class investors to shares in a company's risky foreign venture, usually a trade voyage.

In 1603, James I, an extravagant Scot who had little sympathy for the English upper-middle class, ascended to the English throne. James would have substantially increased domestic taxes had Parliament not stood in his way. While his increasingly consumptive court initially lived off of revenues from increasing tariffs, this source of growth reached its limit around 1610. Thereafter, revenues from grants of monopoly charters accelerated as many burgeoning joint stock companies began representing themselves as permanent investor organisations rather than merely specific joint ventures. The high average rates of return on these specific ventures, typically around 100% per annum (Scott, 1968, Vol 1, Ch. VIII), were thus coming to be thought to be steadily reproducible by the new joint stock companies. The late 1610's thus featured a boom in the stocks of these companies (ibid., p.166). The ruling elite also benefitted from the boom in that company promoters required connections to the crown in order to obtain monopoly charters.

While a more benevolent ruling elite (such as possessed by their Dutch contemporaries) would have relaxed and enjoyed its increasing prosperity, James' court could not resist the myriad opportunities to redistribute away from England's middle-class investors. Both the King, through his increasing control of the law and deceptive charter policies, and the managerial elites – through their own private hype, accounting fraud, and excessive salaries – were setting up the conditions for a stock-market bubble.

Besides introducing several, essentially illegal, indirect taxes during the 1610''s (ibid., Vol. 1, Ch IX), James was succeeding in his attack on the Common Law courts, whose charge was to protect the small property owners from the ruling class. These courts had lost their predominance during this decade as the Lords-run Courts had just gained the status of a court of last appeals. Ruling class defendants could rest assured that they would receive sympathetic hearings. James predictably exploited his new opportunity to abuse his right to grant monopoly charters. And the similar-minded ruling elites exploited their new opportunities to hype new projects of the Russia, East India and recently formed Virginia Companies.

During 1620, the public became increasingly aware of the fact that the King could rescind and resell his own monopoly grants (ibid., p.178). For, as was becoming public information, he had already just done this with the largest trading monopoly, the New Merchant Adventurers, and their monopoly in the cloth trade. The disastrous consequence was the stock market crash of 1620 (ibid., Ch. IX).[13] The major concern of the understandably agitated Parliament of 1621 was not the stock crash and beginnings of the fraud investigations. Rather, it was the problem of monopoly. The seeds of the England's famous 1624 statute of monopolies, which eliminated all governmental grants of monopoly rights except for new discoveries, were sown by this Parliament. Fearful of having their charters rescinded and resold to others, the investors came to see that their best strategy was to eliminate their own monopoly charters, thereby trading, for the ancillary benefit of the consumers, their fragile monopoly rights for first-mover advantages.

5.2.1.2 Predicting the bubble from a broader social perspective

Recall that bubbles resulting from a decreased concern for the middle class are part of a sequence of policies, the first being a tax-hike on labourers and resulting decrease in their

real wages, the second a stock market bubble, and the third an attack on middle-class real estate holdings. Note that, both theoretically and empirically, the period of decreased concern for the middle classes runs the 140 year period from Henry VIII's profligate administration to the English Civil War. The fundamental basis of the sequence was not James I and Charles I's Scottish sympathies, which increasingly stripped the matter of all of its prior niceties and made the progressive redistributions more and more visible. Rather, the basis of the sequence was England's military-technology-induced switch from a citizen national army to an expensive professional army, one capable of manning the expensive and complex cannon and firearms of the period. England's citizen national armies returned from the 1640's through the 60's with the advent of flintlock firearms, which could be managed by a single marksman with a modicum of training. After that, the middle-class tax-load lightened and artisan wages rose toward historically normal levels (e.g. Phelps-Brown and Hopkins, 1957).

An easy way for an economist – even one unattuned to the social determinants of the distribution of income and the bubble-creating features of certain legislative acts – to predict a bubble from this broader perspective is thus to identify its economic precursors. The first is a tax-hike-induced decrease in real wages. Thus, there was a 60% decrease in real wages from 1510 to 1620 (ibid.), first through a decreased number of holidays, then through the successively stricter laws controlling the free movement of labour (e.g. Woodward, 1980), and then through increases in tariffs and indirect taxes (Scott, ibid.)

The next precursor is legislation decreasing the punishments on wealthy promoters and privately engineered bubbles. This occurred, as noted above, in the imposition of Equity over Common Law courts during the 1610's, marked by the 1616 dismissal of the champion of the Common Law, Sir Edward Coke, as England's Lord Chief Justice (e.g. Bowden, 1957, pp.294–363). What immediately followed, besides the King's regulatory deception effectively rescinding the Merchant Adventurer Company's charter, were simultaneous accounting and managerial frauds in the Russia, Virginia and East India Companies (e.g. Scott, (1968) Vol. II, pp 56–58, 267–282; and Bowden, p.344, respectively) as well as Ponzi-type dividend payments in these companies. The resulting bubble was a predictable outcome of the King's desire to redistribute from the trend-following middle-class investors to his ruling-class officials and insider-investors.

The final attack on the middle-class was predictably against their land holdings. This occurred in the early Stuart anti-enclosure movement that slowly began its rise in the reign of James I and accelerated under Charles I. This final redistribution away from the middle class, regarded by many authors to be a central cause of the English Civil War,[14] helps assure us of the redistributive basis of the prior bubble.

5.2.2 Predicting modern bubbles

1990 was a watershed in world history. The Cold War had just ended. The West, in particular its leader, the US, had won. Leading Western nations no longer had to compete with the East 'for the hearts and minds of men'. As discussed in Section 4.2.3, both theory and history teach that states that need not compete for people do not, in long run equilibrium, provide significant surpluses for their masses. In equilibrium, the ruling elites are the only substantial surplus recipients when states do not compete for people. Middle-class taxes rise, and wages and small business profits fall, under the impetus of a shock favouring the ruling elites. The movement in this direction in the US and UK since the early 1990s has been widely reported and needs no elaboration here.[15] Since this tax

policy cannot be counted on to redistribute capital and land away from the middle classes, redistribution-oriented stock-market and real-estate policies should successively follow the wage trend.

The deception setting up the stock-market bubble occurs, as argued in Sections 4.2.1-3, through legal 'reforms' ostensibly improving the administrative system but known to insiders to facilitate hype and exaggeration. A publicly little-noticed act of a conservative legislature, entitled 'The Private Securities Legislative Reform Act of 1995', which passed over a presidential veto after an extensive lobbying campaign by Wall Street and the computer and accounting industries (e.g. France, 2001; Girion, 2001) allowed companies to refuse to reveal information that might damage their competitive position. The Act suddenly made it extremely difficult to sue corporations, their managers, and their accountants for making deceptive statements about the hyped companies. While the Securities Exchange Commission should have expanded its fraud enforcement efforts in response, it contracted them under the same political pressures. The Supreme Court apparently laid the foundation for the movement by eliminating the right of shareholders to name accountants, lawyers and bankers as aiders and abetters in fraud suits (Girion). These roughly simultaneous pro-hype policies rolled out a welcome mat for the predictable stock bubble that ensued.

More stock bubbles are very likely. The fraud law remains predictably lax and the redistributions we have recently experienced have nevertheless left a good part of the nation's common stock in the hands of the middle class. However, it takes quite a while for stock investors to regain their confidence in the market sufficiently to repeat their original, momentum-playing, errors. While the ruling class is waiting for this to occur, there are other markets to manipulate. In particular, even though their ideal time to create a real estate crash is not before the completion of the stock crashes, time preference may lead them to at least set up a real estate bubble while they are waiting for confidence to return to the stock market.

Indeed, it appears that a real-estate bubble is currently in the works. The unfortunate lack of a positive monetary response to the 2000 and 2001 recessionary aggregate-demand shocks created a three-year downward drift in real profit rates and long-term real interest rates[16] that complemented both earlier and later sequences of governmental finance policies making it increasingly artificially cheap for ordinary consumers to purchase a house. This sequence of positive shocks in the real estate market has created an artificial, government-induced, upward trend in real-estate prices relative to rentals and a corresponding entry of trend-following speculators. Thus, for example, although real residential real-estate prices should have fallen in response to the fitful increase in long-term interest rates from Summer 2003 to Summer 2004, these prices continued to rise. This reflects trend-following demand in the residential real estate market, evinced by the roughly 50% rise in real residential real estate prices over the past 10½ years (from CPI-deflating Freddie Mac's Conventional Mortgage Home Price Index for the second quarter of 2005 relative to the last quarter of 1994) viz-a-viz the relatively anemic 10% rise in real rents over this period (from the BLS real rental cost index for the second quarter of 2005 relative to it value in the last quarter of 1994) despite the essential constancy of the relevant long-term real interest rates over this period.[17] Thus, unless expected future US construction costs (including land prices) relative to present construction costs has inexplicably jumped, we are currently experiencing what must be

the end a real estate bubble, judging by the maximally generous, effectively 100%, house financing that is currently available.

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References

Abreu, D. and Brunnermeier, M. (2003) 'Bubbles and crashes'. *Econometrica*, Vol. 71, pp.173–204.

Aggarwal, R. and Wu, G. (2003) '*Stock Market Manipulation-Theory and Evidence*', Dartmouth WP, pp.1–41.

Ahn, D., Boudoukh, J., Richardson, M. and Whitelaw, R. (2002) 'Partial adjustment or stale prices: implications from stock index and future return autocorrelations', *Review of Financial Studies*, Vol. 15, pp.655–689.

Azariadis, Costas, (1981) 'Self-fulfilling prophesies', *Journal of Economic Theory*, Vol. 25, pp.380–396.

Allen, F. and Gale, D. (1992) 'Stock price manipulation', *Review of Financial Studies*, Vol. 5, 1992, pp.503–529.

Allen, F., Morris, S. and Postlewaite, A. (1993) 'Finite bubbles with short sale constraints and asymmetric information', *Journal of Economic Theory*, Vol. 61, pp.206–229.

Arrow, K. and Hurwicz, L. (1958) 'On the stability of competitive equilibrium', *Econometrica*, Vol. 26, pp.522–552.

Avery, C. and Zemsky, P. (1998) 'Multidimensional uncertainty and herd behavior', *American Economic Review*, Vol. 88, pp.724–748.

Back, K. and Baruch, S., (2004) 'Information in securities markets: kyle meets glosten and milgrom', *Econometrica*, Vol. 72, pp.433–465.

Bala, V. and Kiefer, N. (1994) 'On the existence of universally convergent mechanisms', *Journal of Economic Dynamics and Control',* Vol. 18, pp.299–316.

Benabou, R. and Laroque, G. (1992) 'Using priveledged information to manipulate markets: insiders, gurus, and credibility', *The Quarterly Journal of Economics,* Vol. 107, pp.921–958.

Bowden, C., *The Lion and the Throne*, Little Brown, Boston, 1957.

Carswell, J. (2001) '*The South Sea Bubble*', Sutton Publishing, Gloucestershire, p.178.

Cass, D. and Shell, K. (1982) 'Do Sunspots Matter?' *Journal of Political Economy*, Vol. 91, pp.193–227.

Chan, K. (1992) 'A further analysis of the cash market and stock index futures market', *RFS*, Vol. 5, pp.3–52.

Chan, K., Chan, L.K.C. and Karolyi, G. (1991) 'Intraday volatility in the stock index and stock index futures market', *Review of Financial Studies*, Vol. 4, pp.657–684.

Chandler, L. (1971) '*American Monetary Policy, 1928–1941*', New York, Harper and Row.

Cheung, Y. and Ng, L. (1992) 'Stock price dynamics and firm size', *Journal of Finance*, Vol. 47, pp.1985–1989.

Chancellor, E. (2005) '*A short history of the bear*', David W. Tice and Associates, LLC, http://www.prudentbear.com/press_room_short_selling_history.html

Copeland, T. and Friedman, D. (1991) 'Partial revelation of information in experimental asset markets', *The Journal of Finance*, Vol. 46, pp.265–295.

Davis, A.M. (1887) 'An historical study of law's system', *QJE*, Vol. 1, pp.299–300.

Ferguson, N. (2001) '*The Cash Nexus*', Penguin Press, London.

Foster F.D. and Viswanathan, S. (1994) 'Strategic trading with asymmetrically informed traders and long-lived information', *Journal of Financial and Quantitative Analysis*, Vol. 29, pp.499–518.

France, M. (2001) 'This crash won't make lawyers rich', *Business Week*, March 26.

Garber, Peter, 'Famous First Bubbles', *Journal of Economic Perspectives*, Vol.4, No. 2, Spring 1990, 35–54.

Glosten, L. and Milgrom, P. (1985) 'Bid, ask, and transaction prices in a specialist market with heterogeneously informed traders', *Journal of Financial Economics*, Vol. 13, pp.71–100.

Girion, L. (2001) '1995 Tort reform act said to provide safe harbor', *LA Times*, July 12.

Gould, J. (1954) 'The trade depression of the early 1620's', *Economic History Review*, Vol. 7, pp.81–90.

Harney, Kenneth',Condo Market is Hottest at Luxury and Entry Levels', *Miami Herald*, Aug. 31, 2003.

Harrison, Michael and Kreps, David., 'Speculative Investor Behavior in a Stock Market with Heterogeneous Expectations', *The Quarterly Journal of Economics*, 92, 2, May 1978, pp.323–336.

Hart, O. (1977) 'On the profitability of speculation', *Quarterly Journal of Economics*, Vol. 91, pp.579–597.

Jarrow, R. (1992) 'Market manipulation, bubbles, corners, and short squeezes', *Journal of Financial and Quantitative Economics*, Vol. 27, No. 3, pp.311–336.

Kyle, A.S. (1991) 'Continuous auctions and insider trading', *Econometrica*, Vol. 53, pp.1315–1335.

Kyle, A.S. and Vila, J.-L. (1991) 'Noisy trading and takeovers', *Rand Journal of Economics*, Vol. 22, pp.54–71.

Madhavan, A., Richardson, M. and Roomans, M. (1997) 'Why do security prices change?', *The Review of Financial Studies*, Vol. 10, pp.1035–64.

Melvin, M. and Tan, K.-H. (1996) 'Foreign exchange market bid-ask spreads and the market price of social unrest', *Oxford Economic Papers*, Vol. 48, pp.329–341.

Phelps-Brown, E.H. and Hopkins, S. (1957) 'Wage rates and prices: evidence for population pressure in the sixteenth century', *Economica*, Vol. XXIV, pp.289–306.

Saari, D. and Simon, C. (1978) 'Effective price mechanisms', *Econometrica,* Vol. 53, pp.1097–1125.

Samuelson, P. (1947) '*Foundations of Economic Analysis*', Cambridge, Mass, Harvard University Press.

Santos, M. and Woodford, M. (1997) 'Rational asset pricing bubbles', *Econometrica*, Vol. 65, pp.19–57.

Scott, W.R. (1968) '*The Constitution and Finance of English Scottish, and Irish Joint-Stock Companies to 1720*', Three Volumes, Peter Smith, Gloucester, Mass.

Scheinkman, J. and Xiong, W. (2003) 'Overconfidence and Speculative Bubbles;' *JPE*, Vol. 111, pp.1183–1219.

Smale, S. (1976) 'A convergent process of price adjustment and global newton methods', *Journal of Mathematical Economics*, Vol. 3, pp.107–120.

Simmons, E. (1947) 'The position of the treasury bill in the public debt', *JPE*, Vol. 55, esp. p.340.

Tilly, C. (1993) '*European Revolutions*', *1492–1992,* Blackwell, Oxford.

Theirs, A. (1859) '*The Mississippi Bubble: A Memoir of John Law*', Townsend and Co., esp. pp.167–89.

Thompson, E. (1966) 'A pareto optimal group decision process', *Public Choice*, Vol. 1, p.140.

Thompson, E. (1967) 'Debt instruments in both macroeconomic theory and capital theory', *AER*, Vol. 57, 1196–1210.

Thompson, E. (1995) 'The gold standard: causes and consequences', Encyclopedia of business cycles, David Glasner. (Ed.), Garland Publishing, pp.267–272.

Thompson, E. and Faith, R. (1981) 'A Pure Theory of Strategic Behavior and Social Institutions', *AER*, June, pp.366–80.

Thompson, E. and Faith, R. and Hickson, C. (2001) '*Ideology and the Evolution of Vital Institutions*', (2nd Ed.), Kluwer, Boston.

Tirole, J. (1982) 'On the possibility of speculation with rational expectations', *Econometrica*, Vol. 50, pp.1163–82.

Woodward, D. (1980) 'The background to the statute of artificers: the genesis of labour policy, 1558–1563', *Economic History Review*, Second Series, Vol. 33, pp.32–44.

Notes

[1]Although exogenous-bubbles are not genuine economic bubbles and imply no underlying inefficiency, to justify a claim that a price movement is basically exogenous, economists must identify the underlying exogenous shocks. An example of an exogenous-bubble is the US stock-market boom and bust that preceded our last Great Depression. We know this because we can easily identify the causative exogenous shocks: The shock precipitating the '28–'29 stock boom was Europe's resumption of convertibility of their various currencies into gold that occurred in the '25–'28 period (Chandler, 1971). The only way for the nations of European to acquire the gold necessary to make the conversion payments at their inflated post-1914 price levels was to induce the US, which held most of the world's gold after WWI, to run a cheap-money inflation, thereby inducing a large trade deficit and outflow of gold to Europe in the late '20's. The US was accommodating Europe in this regard through the wisdom and experience of Benjamin Strong, then the Chairman of the Board of Governors of the US Federal Reserve Bank. US profits, of course, increased, as wages lagged behind prices and a large stock boom was a therefore inevitable. When Strong died in the Spring of 1929, monetary policy was put in the hands of the President's pro-creditor cronies (an exogenous shock), who unfortunately deemed it a good idea to fight the boom by decreasing bank lending, thereby leaving the nations of Europe with no alternative but to deflate their price levels. Since the US government still held a lion's share of the world's gold and European monies were convertible into gold at their pre-WWI conversion rates, these deflations had to continue on to price levels that approximated their pre-WWI levels. To do this, prices had to fall by over 30%, which meant, again because of the wage lag, an even greater decrease in profits and stock prices (Thompson, 1995). Again, the reason this stock price pattern was not a genuine bubble is that the major movements are explainable by exogenous shocks whose significance was appreciated by many competing market professionals.

[2]Much of the literature on bubbles concerns infinite-horizon multiple equilibria (e.g. Azariadis, 1981; Cass and Shell, 1982) that are not true equilibria because they imply positive profits to setting-up private pension funds (Thompson, 1967). As these pension-fund profits are eliminated, the limits as time approaches infinity of the present values of time-t incomes are driven to zero (transversality). Santos and Woodford (1997) have shown that, under this condition, symmetric-information equilibrium bubbles are impossible; bubble-like price patterns are merely fluctuations in fundamental values (our 'exogenous bubbles'). We will generalize this result to symmetric-information disequilibria with rational learning.

Existing asymmetric-information bubble models, based on rational expectations equilibria, artificially restrict short-sales to create their bubbles (e.g. Harrison and Kreps (1978); Allen, Morris and Postlewaite (1993); Abreu and Brunnermeier (2003); Scheinkman and Xiong (2003)). In fact, short sales have been a common practice since the early 17th century (Chancellor, 2005).

Our asymmetric-information models – based on a weaker notion of rational learning instead of rational expectations – do not restrict short-sales but require what we call 'informational monopolies' to generate bubbles.

[3]This would be socially efficient because the prospective profit she otherwise sees is a resource-costly redistribution from less informed investors rather than a reward for producing socially valuable information. The social value of speculative information is virtually zero because of the highly temporary nature of the produced information advantages (Thompson, 1966). A law preventing orders that failed to reflect one's true demand – a law much different than observed, largely ineffective, laws discouraging manipulation and enforcing disclosure on large traders – would induce her to reveal her information. No market failure would arise. (Although a small government subsidy to producing price-relevant information would be a requisite complement in achieving a full Pareto optimum when the informed party would otherwise hold her information advantage for a significant length of time, disclosure of her trades would not be required until her number of trades became sufficiently large.) Nevertheless, this paper is chiefly concerned with actual markets, not optimal financial regulation.

[4]This manipulation ideally stops when the informational monopolist has created what Hicks called a 'zero elasticity of expectations', where future price expectations are insensitive to current price changes. Momentum traders, who have elasticities of expectation that exceed unity, are eliminated early in her manipulations.

Still ignoring transaction costs, it might appear advantageous for the manipulating monopolist to continue her price reversals until she induces negative elasticities of expectation (where a price change is expected to be more than fully reversed). However, such price patterns, which would reveal the presence of a true insider rather than an outsider-manipulator, are not sustainable because they would invite outsiders to, say, accumulate large positions in the asset at progressively lower prices and then wait, either for the informational monopolist to force prices back to their initial levels or for the end of the informational monopoly, when the expected price is equal to the initial price.

[5]Of course, this *ex-post* bubble pattern, like the *ex ante* bubble patterns we are about to discuss, would be insignificant if many, competing, adequately informed, economists were included among the market participants.

[6]Certain price information differences are implied by these, like other, business cycles. Here, if the public fully understood and thus anticipated the actions of the political leaders, wages would rise with prices and no real effects would follow. The real effects, of course, are that profits increase, which is easily observed by firms even before they show up on accounting statements, and that perceived wages rise, which is implied by the increase in employment during the temporary boom. So labor owners also feel benefited by the boom.

[7]Realistically, an objectivity-robbing ideology may capture an existing ruling elite and thereby lead them to make grossly inefficient social decisions, in which case, for a reason that differs from that discussed in this paper, a revolution may efficiently arise (Thompson-Hickson, 2001, Chs.1, 3, & 5). Hence, our present model does not apply to the ideology-based, institution-altering, 'social revolutions' of the 20th century. These revolutions were rational responses to foreign-imposed, ideologically 'rationalized', trade liberalizations largely unique to the economic-ideological warfare of the 20th century (ibid., Ch. 5, Part. I.G). In contrast, with a few exceptions such as the French Revolution (ibid., pp. 128–188), the pre-20th century revolutions to which our current theory applies were basically domestic, ideology-free, and reformed few if any domestic institutions.

[8]While irrational operation may make the government less valuable to the existing ruling elite than to the alternative one, the ideology responsible for the value differential would make it nearly impossible for the existing ruling elite to admit this reality. A social revolution would occur instead, as indicated in Note 7 above.

[9]The defenders of the existing ruling elite fight despite certain defeat because they are psychologically committed to do so (Thompson-Faith). A conceptually resource-costless revolution occurs when rebels simply buy-out the pained consciences of the disloyal military leaders of the existing ruling elite. With sufficient national debt, the rebels are willing to bid more for the psychologically costly support of the existing military than the existing rulers. Either form

of costly 'revolution' would rationalize the certainty model described in the text. More realistically, the military supporters of the existing ruling elite must be militarily defeated in an uncertain contest with the military supporters of the alternative ruling elites, the likelihood of success being appropriately determined by the relative financial contributions of the supporters. The uncertain war can be rationalised by recognising the natural uncertainty regarding the military productivity of the alternative leadership. That is, a society is generally better off if it waits to change its existing government until it has tested the military productivity of the alternative by pitting it against the old military in what the founders of the entire society would view as an efficient war. A more realistic model of this sort has been used elsewhere to explain the American Revolution (Thompson-Hickson, 2001 pp. 168n, 177n, and 217), a revolution that does not fit within our existing framework because it was a war of secession rather than a revolution to gain control over an existing government.

[10]In a model with realistic uncertainty with respect to the outcome of a revolutionary war, one might think that sufficiently punishing unsuccessful rebellion would suffice to efficiently deter revolution.

However, a relatively harsh monetary treatment of the losers of a revolutionary war, while decreasing the expected return to revolution, equally decreases the expected costs of revolution to the ruling elites because of the correspondingly lower expected monetary costs of revolution to the existing ruling elite. Such fines therefore have no systematic effect on the frequency of revolution. However, once a revolution has begun, a harsher monetary treatment of losers of a revolutionary war increases the returns to winning the war and therefore increases its intensity. The result is a prior legal commitment to a lenient post-war financial treatment of the losers of revolutionary wars. Although a harsher *military* treatment of the losers of a revolution always discourages revolution, such treatment also increases the intensity-of-effort once a revolution has begun. Hence, we cannot unambiguously evaluate the net benefit to the existing ruling class from adopting the rebellion–cost-affecting policy of applying harsh treatment to the losers of revolutions against its government.

To deal more generally with such ambiguities, we take a step back to see how the defense institutions that determine the costs of revolution were determined in the first place. Our underlying social theory tells us that the founders, or subsequent interactions between ruling elites and the potential rebels, determined these costs in prior, efficient, sequences of communications. Anticipating that revolutions should sometimes occur in the future, the cost of revolution was set at a non-prohibitive level. Anticipating also the subsequently excessive private return to revolution, the induced total costs of revolution were determined so as to create an efficient frequency of revolution. More specifically, in view of the excessive current (time-t) return to revolution, the founders (or deals between subsequent ruling elites and potential rebels) rationally induce future ruling elites to adopt revolution-deterring strategies that optimally complement their military strategies.

[11]The above discussion applies when there is only one potential revolutionary group, whom we take to be the members of the society who are neither ruling elites, their creditors, nor the military committed to defending these interests. When there are many potential revolutionary groups, a different theory social applies (Thompson-Hickson, Ch.5, Part I.B), one that would take us way beyond the European cultures examined in this paper.

[12]Although several of Tilly's 'revolutions' were actually secessions or the result of foreign attempts to gain control of the country and not relevant to the subject at hand, once these wars are removed from the list, there remain an extremely large number of 16th and 17th century revolutions.

[13]The King, in 1614, in the name of economic development, effectively rescinded the charter of the highly successful Merchant Adventurer Company by outlawing the export of undyed cloth and then, for about 1/3 of the profit, chartered a new company, called 'The New Company of Merchant Adventurers', promoted by his insider-associates led by one William Cockayne. The new company was to export the same cloth, as would the old, only dyed to fetch a higher price. The scheme was an immediate economic failure. However, the King then forced the old company to make huge informal payments to the court in order to restore their charter (Scott, Ch. VII.). The stock market decline unfolded in 1619 and 1620 as the details of the operation and the resulting decrease in profits of the Company became public information.

The possibly induced decline in investment cannot explain the strength of England's depression in the early 1620's. While there are several popular theories of the depression, various accounts (especially Gould (1954) and Scott, (1968) Ch IX) reveal only one, apparently ignored, rational sequence. It is that James had, in 1620, received a final, balloon payment on a previous loan of Queen Elizabeth to Holland. Raising the pounds necessary to make the payment caused the pound to appreciate relative to the Dutch Guilder, a Dutch export boom and a corresponding slump in England, lasting for several years because of the 1620 Dutch borrowing to finance the payment.

[14]The English Civil War thus began as a predictable revolution against a bankrupt government that had already exploited its bubble weapon. However, it became a social revolution with egalitarian implications with the re-emergence of a military technology, the 'New Model Army', in which ordinary citizens were once again significantly useful as soldiers.

[15]The negative real wage trend began in the US in the mid-1970s. Precipitating that shock was the loss of the War in Vietnam and corresponding switch away from a conscripted civilian army to an all-volunteer army. The correspondingly higher middle-class tax rates and reduction in expenditures on education and welfare reduced US wage rates. While the end of conscription may have compensated for this loss, nothing has compensated for the middle-class tax increases and corresponding real wage reductions we have seen since the end of the Cold War.

Also, the labor-intensive computer industry boom of the late 1990's, which turned into a bubble, created an extraordinary increase in demand for computer specialists that temporarily increased the US real wage level, which rose even further after the bubbles burst in 2000 because of the resulting recession and increased in the real wage rate. We regard these as temporary phenomena obfuscating the long-term downward trend in US real wages.

[16]Facilitating this movement toward lower interest rates was the Spring of '03 bond-market boom fueled by insider-promulgated rumors of impossibly low long-term interest rates that drew in an unprecedented number of non-professionals, innocent trend followers, into the bond market until the bubble burst in June, greatly enriching a large number of already-wealthy professional bond market traders and market executives.

[17]The relevant interest rate is the real long-term, insured, tax-exempt (municipal) bond rate. What makes this the relevant rate, although other rates are more typically employed to discount the value of housing services, is that it is the only rate that has the same tax treatment as housing investments. Like home ownership, municipal bonds do not have their income taxed, do have their capital gains taxed, and are typically held for several years.

Also, a more relevant house price-index, one reflecting the average quality of rental units rather than houses, is not the standard Freddie Mac Index reported above but a lower-house-quality index given by an index of condominiums. Available data from the National Association of Realtors (and that reported by Harney, 2003) indicates not only that have median condominium prices been increasing relative to house prices, but also that the prices of the lower-end condominiums have been increasing faster than median. So the numbers reported in the text above are conservative estimates of what appears to be a substantial real estate bubble.

Appendix I: The unsystematic convergence of competitive prices

Let $x_{it} \in R$ represent the excess demand for the good *i* in period *t*, where *i* runs from 1 to *n* and *t* from 0 to infinity. The underlying excess demand functions are stationary, the purpose of the time dimension being to allow for the consideration of disequilibrium behaviour. The excess demands are continuous functions, $x_i(P_t)$, of the prices of the first *n*-1 goods relative to the nth, whose price is unity, where $P_t \in R^{n-1}_{\geq 0}$ denotes the non-negative $n-1$ dimensional vector of these prices, $(p_{1t},...,p_{n-1,t})$, and X_t represents the corresponding vector of excess demands. A competitive equilibrium is achieved once

prices (from *t* onward) are such that $X(P_t) \leq 0$ and $x_{it} < 0$ implies $p_{it} = 0$. Since the nth good always has a positive price, Walras' identity (wherein the sum of the values of the excess demands in each period are identically equal to zero), assures us that $x_{nt} = 0$ in equilibrium. An equilibrium price vector, call it P^*, and the corresponding competitive equilibrium quantities, can always be found for such an ecnomy (Arrow-Hahn). We assume that these equilibrium prices and quantities are unique.

Individuals do not initially know the equilibrium prices. A price and corresponding excess demand path is said to converge whenever $\lim_{t\to\infty} X_t \leq 0$, and $\lim_{t\to\infty} x_{it} < 0$ implies $\lim_{t\to\infty} p_t = 0$. More specifically, what we want to prove here is that prices and corresponding excess demands unsystematically converge. This is stronger than convergence, or 'stability' (or 'uniform convergence' or 'asymptotic convergence') in that familiar stability concepts permit predictable booms and busts or secular price trends. Such continuous price adjustments create predictable price trends, which are inconsistent with rational speculation under symmetric information (or 'efficient' markets). Even the small price changes occurring close to equilibrium continue to jump to a common expectation of what would be market-clearing rather than following predictable trends.

Since our interest is in a single, possibly bubble-infected, market, we concentrate on a single market, say the market for good 1, relative to the numeraire, good *n*. The good's corresponding price movement is potentially an order-of-magnitude larger than that of other goods. Consequently, we simplify the dynamic analysis by assuming that other markets equilibrate around the market for good 1. In particular, for all *i*, $n > i > 1$, $P_t(p_{1t})$ varies so that, $x_i[P_t(p_{1t})] \leq 0$ and $x_{it} < 0$ implies $p_{it} = 0$, which implies that the sum of the values of these implicitly determined $n-2$ excess demands is equal to zero for any p_{1t}.

As explained in the text, we assume a discrete learning form, $p_{1t} = p_{1t-1} + f[x_1(p_{1t-1})]$, which is: (a) homogeneous so that $f[0] = 0$, (b) continuously differentiable, and (c) monotone increasing so that $f' > 0$. Note that once an equilibrium is reached, $X_t = X_{t+1} = X_{t+2} \ldots$.

Unsystematic convergence of the price of good 1 occurs because the successive price changes amount to ever-more refined Taylor approximations of the $f[x_1(P(p_{1t})]$ resulting from successive observations of points on the function. Thus, the initial period soon reveals an exact pair of points on the excess demand function, x_{10}, P_{10} (or $x_{10}, p_{10}, p_{20}(p_{10}), p_{30}(p_{10}), \ldots, p_{n0}(p_{10}))$ and $x_{11}, P_1(p_{11})$. From these, individuals can measure the first order effect of x_1 on its subsequent quantity as well as its price. Since higher order moments cannot be assumed *a priori* to be positive or negative, a linear approximation would furnish an unbiased estimate of f. If f were actually linear, then p_{12}, the linear extrapolation of the existing price-quantity observations to the point that $x_{12} = 0$, would exactly clear the markets in period 2. The subsequently observed price vector, P_2, and the $x_1, (P_2)$ that it actually generates, produces a third exact point on the

mutatis mutandis excess demand function from which to estimate the $f[x_1]$ function. Since higher order moments still cannot be assumed *a priori* to be positive or negative, the expected P_3 estimated from a quadratic approximations of *f* provides a second unbiased estimate of the price that will satisfy $x_1 = 0$. The subsequently observed p_3 and x_3 will provide a cubic approximation of f, *etc*.. This continual refinement of the estimation of f continues until the exact polynomials are the correct ones and the correspondingly observed x_{1t} values are the expected x_{1t} values for all goods or the process continues on forever coming closer and closer to the exact one. That is, since the resulting Taylor expansion of the function of the positively priced commodities around $x_1 = 0$ is convergent (e.g. Rosenlicht), the equilibrium is both stable and has the property that $E(P_t) = P_t$ for all *t*.

Related, but informationally more demanding, attempts to obtain a general convergence result, based on variants of Newton's less robust method of successive approximations rather than Taylor's Theorem, can be found in Smale (1976), Saari and Simon (1978), and, most pointedly, Bala and Keifer (1994). Although Bala and Keifer have shown, in essentially the same single-market setting as the above, that there is a generalisation of Newton's method that, like ours, leads prices to universally converge, the algorithm does not result from a successive application of individually rational, efficient-market, decisions.

Appendix II: Trading at false prices generates convergent martingales

Now let us allow sellers time to sell significant amounts at the initial prices. The resulting trading at 'false' prices creates income effects that shift the excess demand functions as trading proceeds. Hence, building upon the economic model of Appendix I, we now allow excess demands to depend upon previous unexpected price changes. Maintaining our special-purpose assumption that other prices equilibrate to p_1, this assumption simplifies the excess demand function to $x_{1t} = x_1(P_t(p_{1t}); \Delta P_t(p_{1t-1}), \ ..., \Delta P_1(p_{10}))$, where Δ is a first difference operator from the previous to the current period. The above continuity assumption is extended to the Δ variables because the redistributional effects and allocational losses created by trading at false prices shrink with the extent of the price changes. And, since these effects and losses cease once an equilibrium has been reached, the excess demand function is homogeneous in past price changes. In particular, $x_1(P_t(p_{1t}), 0, \ ...0, \Delta P_{t-s}, \ ..., \Delta P_1) = x_1(P_{t-1}(p_{1t-1}), \Delta P_{t-s}, \ ..., \Delta P_1)$, where *s* represents the number of consecutive prior periods that prices have not changed.

Price adjustment is, following the rational Walrasian form discussed in the text, described by $\Delta p_{1t} = g[x_{1t}(P_t(p_{1t})]$, where $g[\cdot]$ has the same homogeneity and monotonicity properties as $f[\cdot]$ above. Similarly, an equilibrium here is achieved once p_{1t} satisfies $x_{1t}(P_t(p_{1t})) = 0$, although there is generally an infinity of such p_{1t}'s given the infinity of possible, essentially random, distributional and allocational effects on the

dynamic path. In any case, from the homogeneity of $g[\cdot]$, once such a price is achieved, $\Delta p_{1t} = 0$, and it remains there in an equilibrium because of the homogeneity of $x_1(\cdot)$. Now, rational Walrasian price adjustment, from the text, is a martingale in that $E_{t-1}[p_{1t}] = E[p_{1t} \,|\, p_{1t-1}, ..., p_{10}] = p_{1t-1}$. But convergence is another matter. Random-walk prices, for example, are martingales. What will makes price converge here is that the allocational and distributional effects responsible for the random demand variations shrink as prices approach equilibrium levels.

From the law of large numbers, it is virtually certain that $|x_1(p_{1t})|$ will sometimes be less than a small positive number, say ε. Suppose that this occurs at time s_1. The false-trading-induced demand shifts have a zero mean and a variance that can then be represented as $v(s_1(\varepsilon))$, where $v'(\varepsilon) > 0$ and $v(0) = 0$. Continually linearly approximating the systematic part of the $x_1(p_{1t})$ function with the x_1, p_{1t} observations beyond s_1, justifiable because of the relatively small ε, yields a string of increasingly statistically significant estimates of this systematic part, and therefore smaller and smaller expected errors, in the continuing attempt to find a p_{1t} that will yield a zero error. Thus, although subsequently setting a tighter approximation band than ε, say ½ ε, will require an additional number of observations, $s_2(\varepsilon/2)$, to yield an excess demand within this tighter range, the probability of reaching $s_2(\varepsilon/2)$, increases over time at an increasing rate. This is not only because of the increasing efficiency of the estimator, but because the lower $v(\varepsilon)$ due to the decreased $|x_{1t}|$ increases the likelihood of randomly achieving such a low excess demand. This statistical variant of Newtonian approximation continues, ad infinitum if necessary, each 50% reduction in the approximation band again being achieved in decreasing expected time intervals because of the ever-smaller error variances as the excess demands are decreased. Even if x_{1t} does not hit zero in this entrapment process, in the above contraction process, $\lim_{t \to \infty} x_t = 0$. Thus, although p_{1t} is continually chasing a moving target, once it gets sufficiently close, convergence to an equilibrium occurs because the target approaches stationarity as p_{1t} closes in on it.