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A test of "turbulent arbitrage"

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A test of "turbulent arbitrage"

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Abstract

Anwar Shaikh's theory of turbulent arbitrage predicts that incremental profit rates will tend to equalize across sectors, albeit in a noisy and turbulent fashion. He supports the claim with plots of time series of average and incremental profit rates for US sectors. This paper applies a Kolmogorov-Smirnov two-sided test to pairs of sectoral profit rate time series, drawing on Shaikh's data. The results support Shaikh's claim.

1 Introduction

Among several mechanisms proposed in his sweeping book *Capital*, Anwar Shaikh presents a theory of "turbulent arbitrage" (Shaikh, 2016, pp. 66 ff. and chapter 7). Shaikh's core argument has classical roots: that the pursuit of financial returns leads investors to shift funds towards more profitable industries. As those industries expand, prices fall, thereby squeezing profits; the opposite happens in industries with lower investment and slower rates of expansion. The result is a noisy process that tends towards, but never reaches, equal profit rates across industries. Crucially, the mechanism applies to *new* investment, so the relevant profit rate is the incremental rate: that is, the change in profits relative to recent investment.

The predictions of the theory of turbulent arbitrage appear to be borne out in fact, as can be seen from data provided by Shaikh (2016, Appendix 7.1).[1] Incremental profit rates for different industries in the US are plotted in Fig. 1. As the theory anticipates, between-sector differences in incremental profit rates, calculated as the annual change in gross profits divided by previous-year investment, do not persist. In contrast, as shown in Fig. 2, average profit rates, which are not subject to turbulent arbitrage, exhibit persistent differences.

While Figs. 1 and 2 are compelling, it cannot be ruled out that incremental profit rates differ between sectors in ways that are not evident in the plotted time series. The mean values of industry incremental profit rates might not differ systematically, as they do for average profit rates, but the distributions might differ systematically in other ways. This paper applies a statistical test and reconfirms the prediction of the theory of turbulent

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[1]Data are from http://realecon.org/data/, 7.2 Data Tables. The data was used to construct Shaikh's Figs. 7.15 and 7.17.

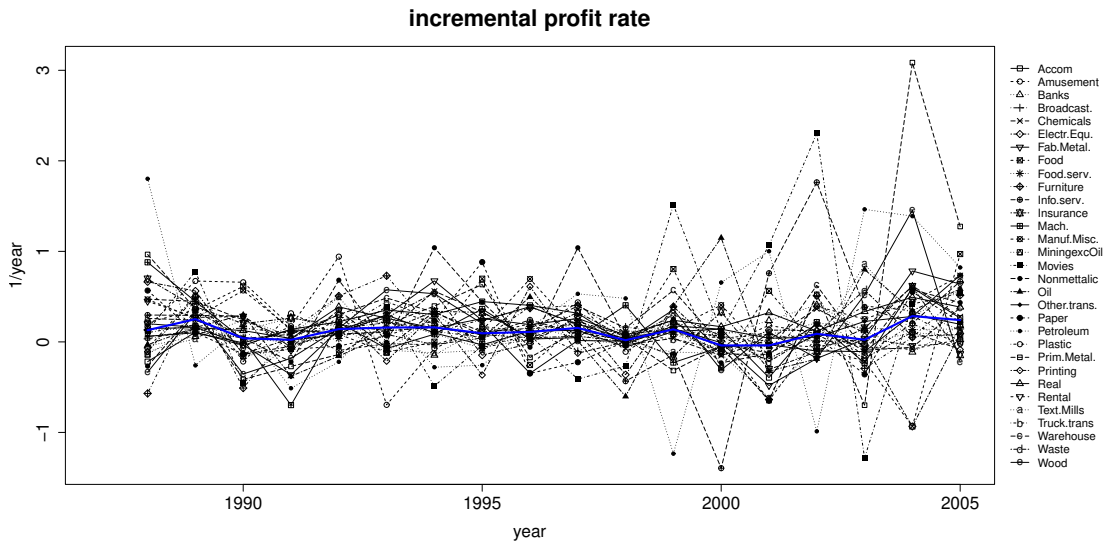

Figure 1: Incremental profit rate over time for 19 sectors, US industries, 1988-2005 (blue line is the median)

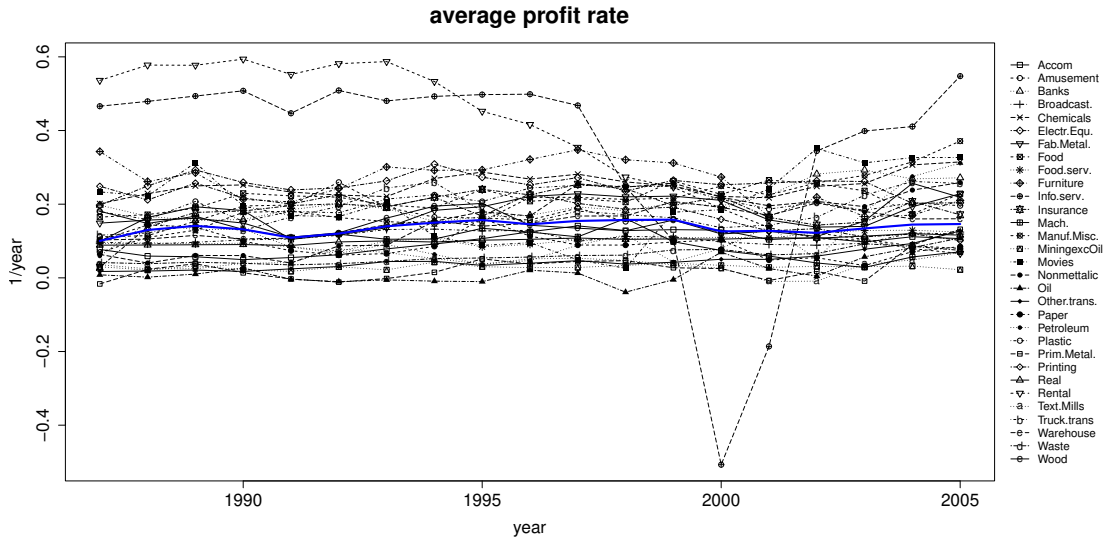

Figure 2: Average profit rate over time for 19 sectors, US industries, 1987-2005 (blue line is the median)

arbitrage. While a few sectors appear to be outliers, the distributions of incremental profit rates for most sectors are statistically similar to those of other sectors.

One positive implication for post-Keynesian theory is that aggregation across sectors may be justified in models where the incremental profit rate drives investment behavior. In contrast, in conventional one-sector neo-Kaleckian or Kaldorian models – at least those with a profitability-dependent investment function – investment is a function of the average profit rate (e.g., see Lavoie, 2014; Hein, 2014). If the single sector is conceived of as the aggregate of a multi-sector economy in which average profit rates differ widely between

sectors, then the use of a single expected or target profit rate is problematic. However, to avoid tying the empirical results of this paper to a specific and debatable model, the implications for modeling are left to future work.

The rest of the paper is organized as follows. Section 2 critically evaluates Shaikh's arguments for turbulent arbitrage and suggests some modifications. Section 3 explains the statistical test and presents results. Section 4 concludes.

2 Background

Shaikh (2016, chapter 7) justifies the theory of turbulent arbitrage within a larger theory of "real competition." In particular, Shaikh (2016, pp. 265 ff.) assumes price equalization within industries as determined by a price leader employing the "regulating conditions of production." The regulating conditions of production are defined as "the ones with the lowest reproducible (quality-adjusted) costs in the industry," and the corresponding rate of profit is the regulating rate. The underlying assumption appears to be that different firms within an industry produce nearly identical outputs and compete largely on the basis of cost, an assumption familiar from the theory of capital (e.g., see Harcourt, Cohen, and Mata, 2022). However, outside of industries with highly standardized products, prices can differ widely due to non-price competition and market segmentation (e.g., through so-called "value innovation": see Kim and Mauborgne, 2004). Pricing decisions are informed by many factors in addition to competitive pressures (Lee, 1999, p. 213), which can lead to substantially different prices for nearly identical products (Barsky et al., 2003).

That is not to say that price competition does not matter – it does – and many industries feature market leaders. But different firms within an industry can charge quite different prices for apparently similar goods, and market leaders may hold their position through means other than low cost. Moreover, "quality", a somewhat elusive concept, cannot explain the differences. In fact, the empirical literature suggests that causal influences flow in the opposite direction – price and brand name affect *perceived* quality (Rao and Monroe, 1989), while the link between perceived and objective quality is weak at best (Gerstner, 1985; Lichtenstein and Burton, 1989). Indeed, the causal link appears to be so strong that consumers have more positive experiences of identical goods when they pay more for them (Shiv, Carmon, and Ariely, 2005).

Fortunately, the theory of turbulent arbitrage does not rest on the details of the theory of real competition. Unlike goods and services, which vary across multiple dimensions, investment opportunities are frequently evaluated along two axes – risk and return. Expected returns on potential investments are used by financial officers for capital budgeting decisions, whether in form of the internal rate of return (IRR), net present value (NPV), hurdle rate, or payback period (Graham and Harvey, 2002). Lenders ask whether anticipated cash flows are likely to be forthcoming and, if they are, will be sufficient to repay the loan (Minsky, 2008, pp. 212 ff.). Financial investors ask whether adding a potential investment to their portfolio could contribute to meeting their investment goals. The commodity-like nature of financial investments tends to generate a common minimum level for expected returns from new investment. Moreover, even in industries where barriers to entry are high, they are not zero, placing a weak upper limit on profit margins (Lee, 1999). It is thus not necessary to posit a regulating rate of return for an industry in order to anticipate convergence.

A widely-shared benchmark rate of return is the key to turbulent arbitrage. Shaikh (2016) argues that investor arbitrage should drive finance towards profitable enterprises

and away from less profitable ones. The influx of investment funds expands supply in profitable sectors, thereafter driving prices and profits downward, while the opposite happens in less profitable sectors. Yet, other dynamics are possible. A further mechanism could be increased demand for inputs in the expanding sectors – particularly labor inputs – driving up costs and again squeezing profits. Yet another is high profits drawing in new firms, who then seek to expand market share by offering lower (but still profitable) prices. Low profits can lead some firms to exit or, if firms are otherwise healthy, enable mergers and acquisitions. Regardless of the precise mechanism, the result is turbulent arbitrage.

Because the theory of turbulent arbitrage does not depend on the details of the theory of real competition, it should be possible to incorporate it into a variety of theoretical traditions, including post-Keynesian. While Shaikh (2016, pp. 361-363) argues that his theory of real competition is inconsistent with post-Keynesian theory because of its claims of "turbulent equalization of long-run rate rates of return of the price leaders, and turbulent fluctuations of actual capacity utilization rates around normal rates," only turbulent equalization of the incremental profit rate is necessary for turbulent arbitrage. What is more, equalization of the profit rate does not appear to be inconsistent with post-Keynesian price theory (Coutts and Norman, 2013; Lavoie, 2022, p. 130). As those authors note, the essence of post-Keynesian pricing is that firms set prices through a markup applied to unit costs, regardless of the degree of competition. While post-Keynesian models do not, at present, assume equalization of incremental rates of profit, there is no fundamental reason they could not do so.

3 Testing turbulent arbitrage

The central prediction of the theory of turbulent arbitrage is that, while incremental profit rates of different sectors can differ widely at any given time, when taken as a whole, the time series of incremental profit rates do not systematically differ between sectors. No such prediction holds for average profit rates.

As shown in Fig. 1, incremental profit rates do vary over an extremely wide range – much wider than the average profit rates in Fig. 2 – and differ between sectors in any given year. Moreover, the patterns vary over time; the distribution was apparently narrower prior to around 1999 than subsequently, and the annual median across sectors varies considerably, from -4%/year to 28%/year. However, sectors do not obviously perform differently relative to another.

To test whether the time series of sectors do differ, this paper treats them as samples from a distribution of incremental profit rates. The two-sample Kolmogorov-Smirnov (K-S) test can then answer whether the time series of pairs of sectors were drawn from different distributions. The null is that the samples are drawn from the same distribution, so rejecting the null means that they are different.

To display the results in a single plot, the p-values from pairwise two-sample K-S tests were rescaled such that a p-value of 0.05 maps to a value of 0.50. Specifically, p-values were raised to the power $\ln(0.50)/\ln(0.05) = 0.231$. The rescaled p-values were then plotted on a heatmap, shown in Fig. 3. The colors were chosen such that orange, yellow or white means that the null (identical distributions) was not rejected, whereas red means that the null was rejected. The scores were then clustered, in order to group sectors exhibiting similar patterns.

The results Fig. 3 show that for most pairs of sectors, the null hypothesis that the distri-

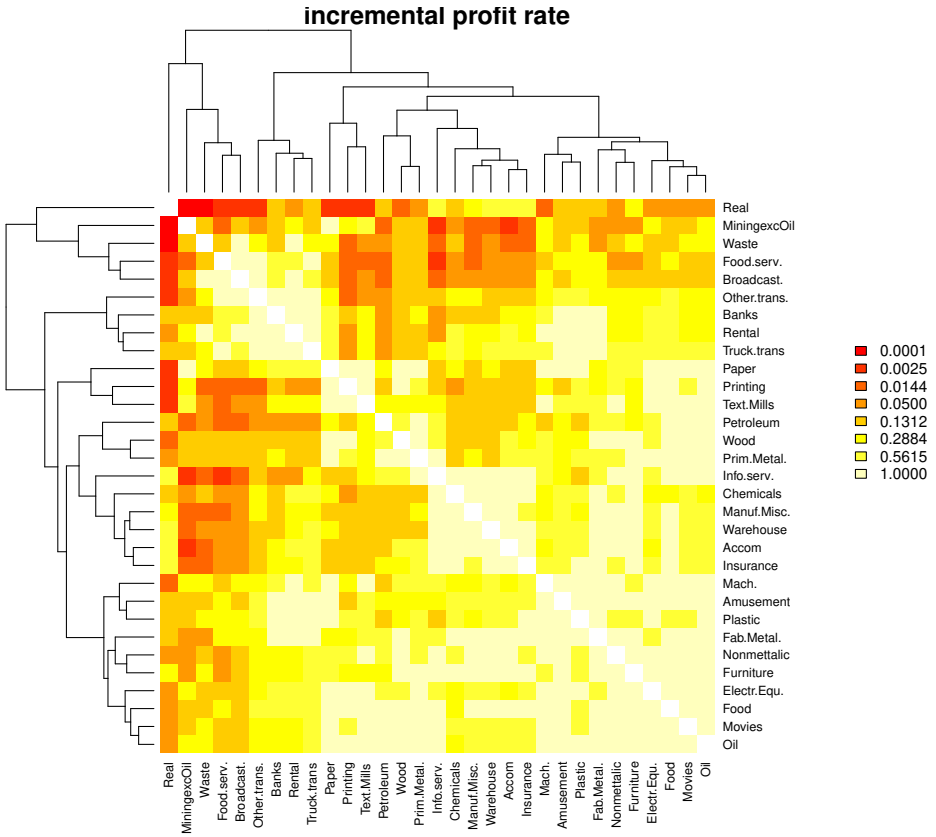

Figure 3: Sector-by-sector results for the 2-sample Kolmogorov-Smirnov test on sectoral incremental profit rates (redder shade means the null hypothesis that the distributions are the same is rejected; p-values are shown in the legend)

butions of incremental profit rates are identical cannot be rejected. Thus, the results largely support the prediction of the theory of turbulent arbitrage. In contrast, the distributions of average profit rates are distinctly different, as shown in Fig. 4.

A few sectors exhibit incremental profit rates that do differ systematically from other sectors. Those exceptions are clustered at the top and left in Fig. 3: Real estate, Mining excluding oil, Waste, Food service, and Broadcasting. Real estate in particular stands out. It is worth noting that profits in that sector were adjusted by removing the imputed value of owner-occupied housing (Shaikh, 2016, p. 857), so it is possible that the difference is an artifact introduced either by the U.S. Bureau of Economic Analysis (BEA) when they prepared the data or through the subsequent adjustment.[2]

4 Conclusion

The empirical results in this paper reinforce Shaikh's claim that fluctuations in incremental profit rates appear to show similar patterns in different sectors (Shaikh, 2016). This stands in sharp contrast to the behavior of average profit rates, which exhibit persistent differences

[2]The possibility that the different pattern for real estate was related to the incipient 2007/8 housing bubble was explored by the author by restricting the data to an earlier time period. The result was qualitatively similar, suggesting that the distinct features of the real estate sector are persistent.

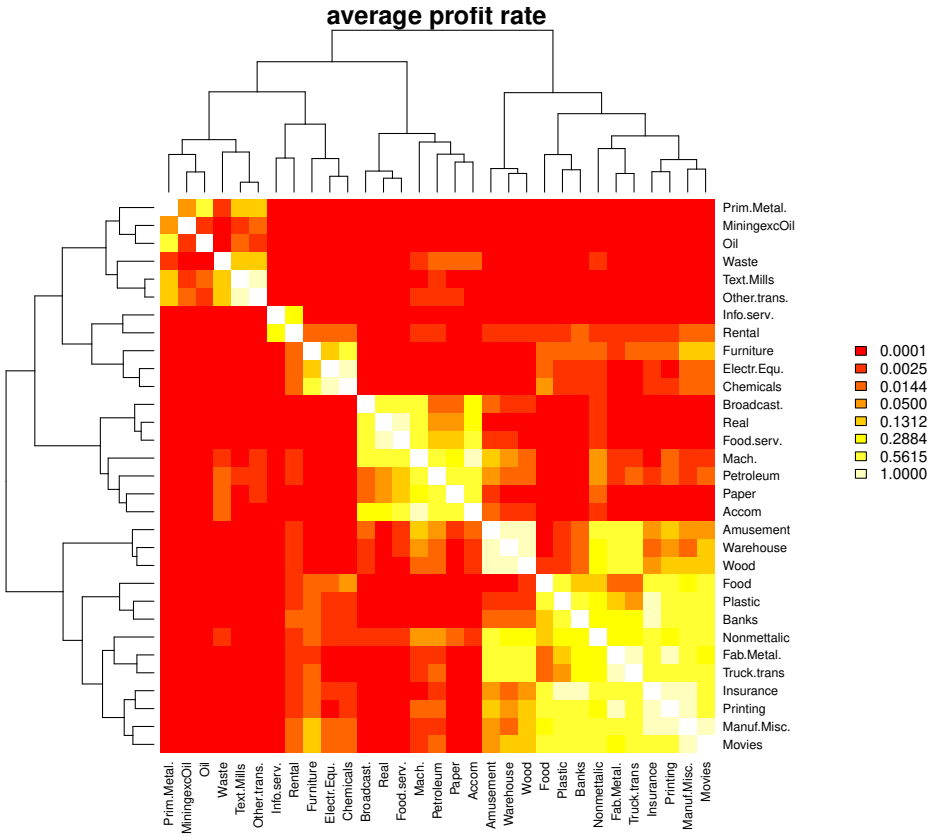

Figure 4: Sector-by-sector results for the 2-sample Kolmogorov-Smirnov test on sectoral average profit rates (redder shade means the null hypothesis that the distributions are the same is rejected; p-values are shown in the legend)

across sectors. Shaikh argues that cross-sector similarity of incremental profit rates is a consequence of "turbulent arbitrage," in which investments flow to profitable opportunities and away from unprofitable ones, with the consequence that incremental profit rates in different sectors repeatedly overshoot and undershoot a central tendency.

A corollary to this finding is that marginal profit rates should be robust to aggregation across sectors. If, as Fig. 3 suggests, the distribution of incremental profit rates within any given sector is similar to that in other sectors, then the central tendency characterizes the aggregate across the sectors. This conclusion can apply to a wide range of models, including those informed by post-Keynesian theory. In advancing this claim, the present paper diverges from Shaikh, who seeks to differentiate his theory from that of post-Keynesians. This paper argues that the concept of turbulent arbitrage does not depend on the details of Shaikh's theory of real competition and is, moreover, not obviously incompatible with post-Keynesian price theory as presented by, for example, Coutts and Norman (2013) and Lavoie (2022).

While we argue that Fig. 3 supports the theory of turbulent arbitrage when interpreted as a strong tendency, it also shows that some sectors depart from the pattern. This finding is new. Further investigation – for example, over different time periods and for different countries – could show whether those departures are systematic or specific to the US between 1988 and 2005. Systematic departures could have implications for theory in cases where

atypical sectors play a large role, such as a housing bubble.

Finally, we note that the magnitude of shifts in the median line in Fig. 1 are left unexplained. The post-Keynesian theories of the firm and of interest rate determination (Lavoie, 2022, chaps. 3-4), suggest mechanisms for setting target marginal profit rates.

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