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AGGREGATE AND FIRM LEVEL VOLATILITY: THE ROLE OF ACQUISITIONS AND DISPOSALS.

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The purpose of this paper is to revisit an intriguing finding. Although over the last few decades leading up to the financial crisis there was a marked reduction in the volatility of aggregate output and inflation, there appears to have been a corresponding increase in the sales volatility of individual .rms. Here we argue that a significant reason for this apparent increase in firm level volatility was an increase in churning of firm activity through the acquisition and disposal of businesses. This created an increase in observed negative covariances between firms, so even if the volatility of underlying organic growth has also fallen, observed volatility has risen.

Aggregate and Firm level volatility: the role of acquisitions and disposals.

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Abstract

The purpose of this paper is to revisit an intriguing finding. Although over the last few decades leading up to the financial crisis there was a marked reduction in the volatility of aggregate output and inflation, there appears to have been a corresponding increase in the sales volatility of individual firms. Here we argue that a significant reason for this apparent increase in firm level volatility was an increase in churning of firm activity through the acquisition and disposal of businesses. This created an increase in observed negative covariances between firms, so even if the volatility of underlying organic growth has also fallen, observed volatility has risen.

JEL: D12, E52, E43.

Key-Words: Volatility, firm level growth.

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1 Introduction

A puzzle of the years before the financial crisis of 2008-9 was that, while aggregate volatility in both output and inflation had fallen to historic lows, there was an apparent rise in volatility at the firm level. Campbell, Lettau, Malkiel, and Xu (2001), amongst others, document increasing stock price volatility. A series of papers using the Compustat company accounting dataset report increasing sales growth volatility for public listed firms (Chaney, Gabaix, and Philippon, 2002, Comin and Philippon, 2005, Comin and Mulani, 2006). On the other hand, using the LBD database that contains plant level data on all US firms, private as well as public, Davis et al (2006) find that, overall, firm volatility has declined. They conclude that the increased volatility among public firms was overwhelmed by a fall in the volatility of private firms.

Comin and Philippon (2005) develop an explanation for the volatility puzzle in which the growing importance of proprietary assets such as R&D leads to increasing volatility at the firm level but falling covariance between firms.

Instead, in this paper, we argue that there is a simple data-consistency explanation why the observed volatility in sales growth in the Compustat population is a misleading correlate for US macroeconomic volatility. An increase in the churning of firm activity raises the reported sales of firms who acquire, and reduces the reported sales of firms that dispose of businesses. So, an active market for businesses creates an increase in negative covariances between firms, so that, even if the volatility of underlying organic growth had fallen during the great moderation, observed sales volatility in the population of quoted companies rose.

In other words, although in terms of GDP the acquisition or divestiture of firms in the economy is a neutral event (at least in the short run), it has a significant effect on the reported sales volatility of individual companies. Comin and Mulani (2006) recognize this problem but imply that the problem is with large takeovers and can be addressed by winsorizing at, say, sales growth rates above 50%. In fact, some firms do exhibit organic growth rates of this level. Relatively small business acquisitions and disposals generate significant churning in terms of observed sales growth. As we show, there are many such transactions.

In a later paper Comin et al claim to adjust for the effect of takeovers, but do not explain how they do it. It seems likely that they used Compustat variable 249, 'the effect of acquisitions on sales'. Unfortunately, although this field is available in Compustat, it is sparsely populated and is non zero in only a small fraction of cases where a firm was known to have acquired or disposed of businesses during the period.

In section 2 we revisit the volatility evidence and update the numbers to 2015, to include years after the financial crisis. In section 3 we develop a simple model of acquisitions and disposals and show that an increase in the market for businesses raises the volatility of firms but leaves aggregate volatility unchanged. In section 4 we combine the Compustat quoted company dataset with the SDC database of acquisitions and disposals. We show that the information on acquisitions and disposals in Compustat is incomplete and we identify a very large number of transactions from SDC. We note that, although SDC provides valuable information on the occurrence of an acquisition and a disposal it does not always give any information about the value of the transaction nor a direct measure of the effect of this activity on sales of the acquiring or divesting firm. In section 5 we turn to some estimation results. Section 6 concludes.

2 Firm and Aggregate Volatility

In this section we use Compustat company accounts data on individual firms to reprise and update the evidence on volatility in Comin and Philippon (2005) and Comin and Mulani (2006). While these papers report volatility data up to 1997, we use individual company data to 2015 that, allowing for the forward looking term, gives volatility measures to 2011.

We compute a measure of volatility of the *ith* firm as the moving average of the standard deviation of the growth of real sales, where nominal sales are deflated by the CPI[1]. $g_{i,t}$ is the ith firm's growth in period t:

$$\sigma_{i,t} = \sqrt{[\frac{1}{10}\sum_{k=-4}^{+5}(g_{i,t+k} - \tilde{g}_{i,t})^2]} \tag{1}$$

$\tilde{g}_{t,i}$is the mean of growth rates between $t-4$ and $t+5$. The weighted growth of the standard deviation of real sales is then:

$$\sigma^{w}_{i,t} = \sqrt{[\frac{1}{10}\sum_{k=-4}^{+5}\omega_{it}(g_{i,t+k} - \tilde{g}_{i,t})^2]} \tag{2}$$

The weight $\omega_{it} = S_{it}/\sum_{j=1}^{N} S_{jt}$, where N is the number of firms in any given year. The results are shown in Figure 1 below where we plot the median of the distribution in each year. The estimates are computed using data from 1950 to 2015.

Figure 1 captures the rising firm-level volatility, described by Comin and Mulani, to 1997. In fact, volatility continued to rise and peaked at about 2000. It declined thereafter, but by 2011 it was still at levels higher than in the first half of the 1990s.

[1] We exclude financial firms (standard industrial classification 6000-7000).

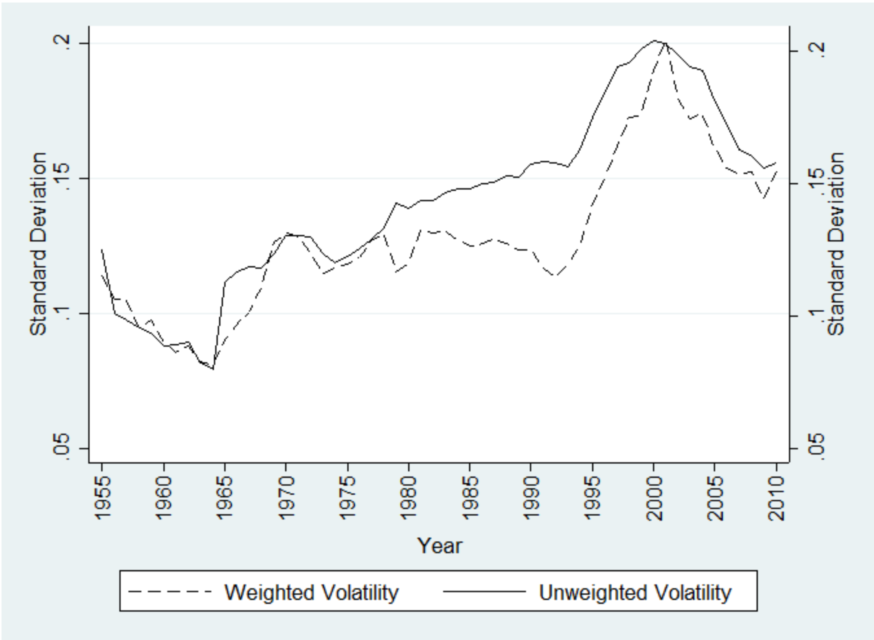

Figure 1. Firm Level Volatility.

Figure 2 reports the volatility of US annual GDP on the same basis as the 10 year $t-4$, $t+5$ moving average of the standard deviation of the growth of real GDP, and reveals the striking fall in macroeconomic volatility in the two decades before the financial crisis, in other words the period known as the 'great moderation'. From 2003 the forward-looking element kicks in with the financial crisis of 2008-9. Since the crisis there has been an increase in aggregate volatility.

In Figure 3 we treat data on individual firms in a different way. We first aggregate the real sales of firms, and then we calculate the moving average of the standard deviation of the growth in the aggregate, using equation (1). In this case we observe a decline in volatility during the great moderation and an increase thereafter. But the decline in firm volatility appears to start earlier than the decline in the volatility of GDP.

By summing sales of firms first rather than looking at the median of individual firms' sales volatility, the negative covariances between firms are largely cancelled out when we look at the aggregate figures. In the next section we provide a simple model where negative covariances between firms arise from the market for businesses in which firms acquire assets from other firms or dispose of assets by selling to other firms.

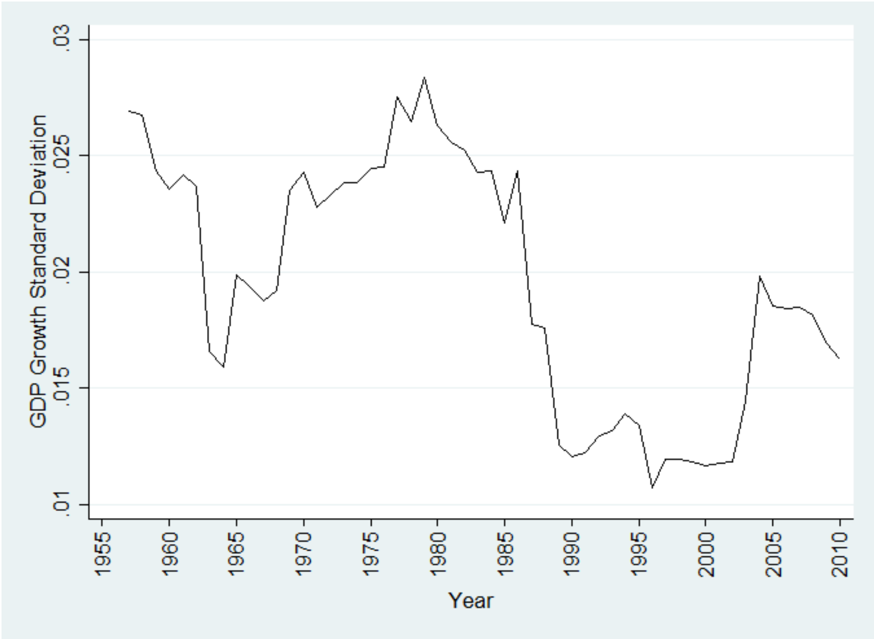

Figure 2: Volatility of real US GDP

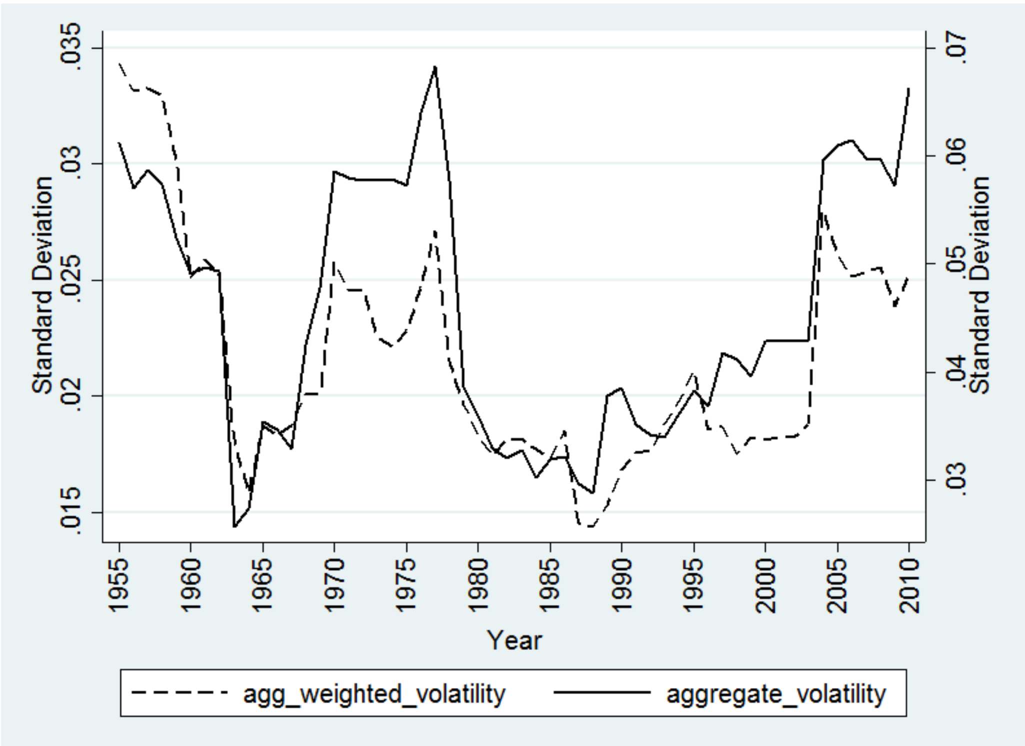

Figure 3: Volatility of aggregate real sales growth of public companies.

3 Model

In this section we develop a model in which there is a market for businesses. A firm can grow by purchasing another firm or parts of it, and can contract by selling off parts of its operations. If a firm acquires more assets its sales will rise, while if it disposes of assets, sales fall.

Consider a population of N firms. For simplicity the population of firms is constant, and there are no exits or entry. Let us assume, first, that firms do not sell or acquire other businesses. At any given time, t, each firm, $i \in \{1...N\}$, produces an output $y_{i,t}$. We assume that production follows a drift process:

$$y_{i,t} = \beta_i + +y_{i,t-1} + \zeta_{i,t} + \varepsilon_t \tag{3}$$

where $\zeta_{i,t} \sim iid\,(0, \sigma_i^2)$ represents a firm specific shock to output and $\varepsilon_t \sim iid\,(0, \sigma_\varepsilon^2)$ represents an economy wide, or sector specific shock to output. The drift parameter β_i is given exogenously. Production translates directly into sales, so inventories are not held.

Subtracting $y_{i,t-1}$, we can write each firm's *organic growth* (i.e., firms' growth without acquisitions and disposals) as:

$$g_{i,t}^o = \Delta y_{i,t} = \beta_i + \zeta_{i,t} + \varepsilon_t \tag{4}$$

The variance associated with this organic growth is then:

$$\sigma_{g_{i,t}^o}^2 = V_t\left[g_{i,t}^o\right] = \sigma_i^2 + \sigma_\varepsilon^2 + 2Cov\left(\zeta_{i,t}, \varepsilon_t\right) \tag{5}$$

Where firm specific, idiosyncratic shocks are uncorrelated with sector specific or aggregate shocks this simplifies to:

$$\sigma_{g_{i,t}^o}^2 = V_t\left[g_{i,t}^o\right] = \sigma_i^2 + \sigma_\varepsilon^2 \tag{6}$$

Consider the aggregate sales of all firms, $Y_t^a = N^{-1}\sum_{i=1}^N y_{i,t}$. The variance of this growth in aggregate sales is given by:

$$\sigma_{g_t^a}^2 = V_t\left[g_t^a\right] = \sum_{i=1}^N \sigma_{g_{i,t}^o}^2 + 2\sum_{i=1}^N \sum_{j=1}^i Cov\left(g_{i,t}^o, g_{j,t}^o\right) \tag{7}$$

where $Cov\left(g_{i,t}^o, g_{j,t}^o\right) = Cov\left(\zeta_{i,t}, \zeta_{j,t}\right) + Cov\left(\zeta_{i,t}, \varepsilon_t\right) + Cov\left(\zeta_{j,t}, \varepsilon_t\right) + \sigma_\varepsilon^2$. Since we assume firm-specific shocks are uncorrelated between firms:

$$Cov\left(g_{i,t}^o, g_{j,t}^o\right) = Cov\left(\zeta_{i,t}, \varepsilon_t\right) + Cov\left(\zeta_{j,t}, \varepsilon_t\right) + \sigma_\varepsilon^2 \tag{8}$$

Now let us suppose that firms can acquire or dispose of assets to other firms. Let ac_{ijt} denote the net acquisition of firm i from firm j at time t, and $ac_{it} = \sum_{j=1}^n ac_{ijt}$ denote firm i's total net acquisitions. Note that $ac_{ijt} = -ac_{jit}$, since a positive net acquisition by i from j must be associated with an identical net disposal by j to i,so the sum of all total net acquisitions must equal zero, $AC_t = \sum_{i=1}^n ac_{it} = 0$.

Assuming that acquisitions/disposals translate directly to output, we can now rewrite firms' production process:

$$y_{i,t} = a_i + y_{i,t-1} + ac_{it} + \zeta_{i,t} + \varepsilon_t \tag{9}$$

Subtracting $y_{i,t--1}$, firms now have *individual total growth* $g_{i,t} = \Delta y_{i,t} = g^o_{i,t} + g^{ac}_{i,t}$, which is composed of their organic growth, $g^o_{i,t}$, and their acquisition/disposal growth, $g^{ac}_{i,t}$. The variance in firms' total growth is:

$$\sigma^2_{g_{i,t}} = V_t \left[g^o_{i,t} + g^{ac}_{i,t} \right] = \sigma^2_{g^o_{i,t}} + \sigma^2_{g^{ac}_{i,t}} + 2Cov\left(g^o_{i,t}, g^{ac}_{i,t} \right) \tag{10}$$

where $Cov\left(g^o_{i,t}, g^{ac}_{i,t} \right) = Cov\left(ac_{it}, \zeta_{i,t} + \varepsilon_t \right)$. This gives us our first result:

Result 1: Acquisitions or disposals increase (decrease) the volatility of a firm's growth if and only if $\sigma^2_{g^{ac}_{i,t}} > (<) - 2Cov\left(g^o_{i,t}, g^{ac}_{i,t} \right)$. i.e., acquisitions/disposals increase volatility if they are positively related to or independent of organic growth.

We now consider aggregate sales, $Y_t = N^{-1} \sum_{i=1}^{N} Y_{i,t}$. Because total acquisitions sum to zero, it follows that the variance of aggregate total growth is exactly the variance of aggregate organic growth (i.e., $\sigma^2_{g_t} = \sigma^2_{g^o_t}$).

Result 2: Acquisitions or disposals have no effect on the volatility of aggregate growth.

4 Acquisition and Disposal in Compustat and SDC

In the this section we examine the empirical evidence on the relationship between the volatility of the growth of individual firms and acquisitions and disposals. In a real world setting the population of firms is not constant, there are exits through full acquisition and bankruptcy and new firms enter the population. The firms that we examine are quoted in the US, so if a firm is private it will not show up in the sample, and if US firms purchase foreign assets or dispose of assets abroad this will not enter the sample either.

There are other data-consistency explanations why the observed volatility in sales growth in the Compustat population is not a direct correlate for GDP volatility. There were significant compositional shifts in the Compustat population over the period under review that affected its measured volatility. Compustat was underweight in smaller public companies before 1970, but became complete thereafter. Subsequently, the profile of the quoted population itself changed when, in the technology boom of the 1990s, many very young and volatile firms were listed.

Firm-level studies focus on the volatility of sales, whereas GDP is a measure of value added. Sales is a component of value added, but even if an increase in sales volatility is demonstrated at the firm level, we need to understand how the firm's cost structure mitigates this to yield value added. Firms can hedge profit and cash flow, but the reported sales number is unhedged.

The reported sales and income of a multinational firm are the consolidated global sales of that firm and its subsidiaries, aggregated by converting the local results at the average exchange rate ruling during the period. The overseas element is not a component of US

GDP. Suppose a firm is growing at 5% and has half its sales overseas. A 10% decline in its local currency versus the $ over the year doubles the reported sales growth in the US.

Though it would be invaluable to observe the components of total sales growth, excluding acquisition and currency effects to reveal organic growth, this disclosure is not required by GAAP. Some, usually larger, firms do disclose this data, but this is not collected reliably by data providers.

The SDC Platinum database from Thomson Financial provides a record of M&A deals that is now widely used as the source for economic research into takeovers[2]. We use SDC data to identify whether each Compustat firm had either acquired, or disposed, of subsidiaries in each financial year. The accounting impact of an acquisition or disposal is recorded by the ultimate holding company or the buying or selling firm. By matching the cusip codes of SDC deal participants to the Compustat population we draw two, overlapping, sets of acquisitions and disposals: the population of acquisitions where the ultimate parent of the acquirer or seller was a US database[3] Compustat constituent. Acquisitions and disposals were excluded if they involved a purchase or sale of a stake but no change of control, since control is the criterion for the target firm's sales to be recognized or derecognized in the accounts of the ultimate parent company. The SDC 'effective date' was used to associate, possible multiple, acquisitions and disposals to Compustat financial years. Note that the financial year end varies between firms. It is important to understand how a single acquisition or disposal affects the reported sales growth of the companies involved over multiple periods. Suppose company A buys a division from company B halfway through year t, and for convenience suppose A, B, and the division all have the same underlying organic growth rate, g. In year t, A includes, and B excludes, just half of the division's sales for the year. In year t+1 A includes, and B excludes, a full year's sales from the division. In year t+2, the rate of sales growth returns to g. So in terms of annual growth rate in sales, company A experiences three inflection points and company B mirrors this. So in terms of observed company/year growth rates, one transaction generates six inflection points in the population.

SDC contains two promising fields, for the target's most recent sales, and for the transaction value. However the 'sales' field is only sparsely populated and, as other researchers have noted, the 'value' field is quite incomplete. Deal value is only available for slightly under half of transactions. Hence we generated two dummy variables, a 0/1 indicator of acquisition/disposal activity in each company year.

[2]See, for example, Harford (2005), Colak and Whited (2007), Dong et al (2006), Rhodes-Kropf et al (2005), and Warusawitharana (2007).

[3]Compustat has also a global database. We do not use this data because our primary interest is volatility in the US.

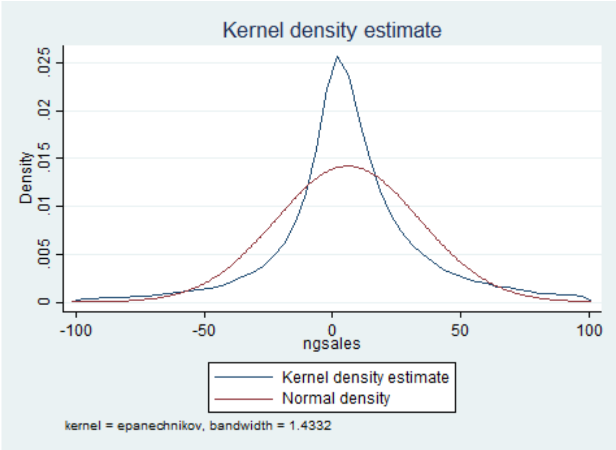

Figure 4: Kernal Density of All Firm's real sales growth. 1950-2015. Winsorized at ±100.

Using observations for 1982 to 2015 from Compustat we have 204,975 firm/years. Figure 4 plots annual growth in real sales for this population as a kernel density, winsorized at ±100%.Although the distribution is leptokurtic, with fat tails, it is symmetric with skewness of .0046, and standard deviation of 28.085. The mean is 5.99. So we are as likely to see a decline in sales as an increase.

4.1 Acquisitions and Disposals: The Market for businesses.

We use the SDC Platinum database to tabulate the extent of acquisition and disposal of businesses between 1982 and 2015. Maksimovic and Phillips (2001) report evidence for an earlier and overlapping period. They find that between 1974 and 1992 an average of almost 4 percent of large manufacturing plants changed ownership. There is a large literature on mergers and acquisitions involving the sale of entire organisations[4], and there is also a large and growing market for the partial disposal and acquisition of businesses. Figure 4 plots the total number of firms that acquired business assets among the quoted population (excluding financial firms) or divested of businesses. Note that in some cases these will involve multiple acquisitions or disposals.

[4]For some of this literature see Andrade et al (2001), Colak abd Whited (2007), Denis and Shone (2005), Golbe and White (1988), Graham et al (2002), Harford (2005), Ming et al (2006), and Rhodes-Kropf et al (2005).

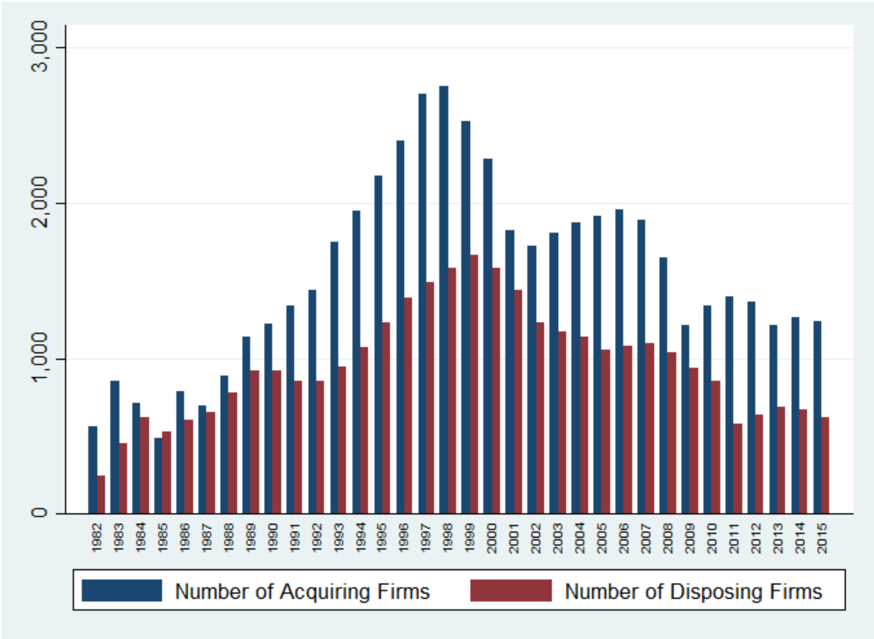

Figure 5: Number of firms that acquire and divest.

Figure 6 plots the proportion of firms that were involved in acquisitions or disposals. At the peak of each merger cycle more than 20 percent of US quoted companies were involved in acquisition each year.

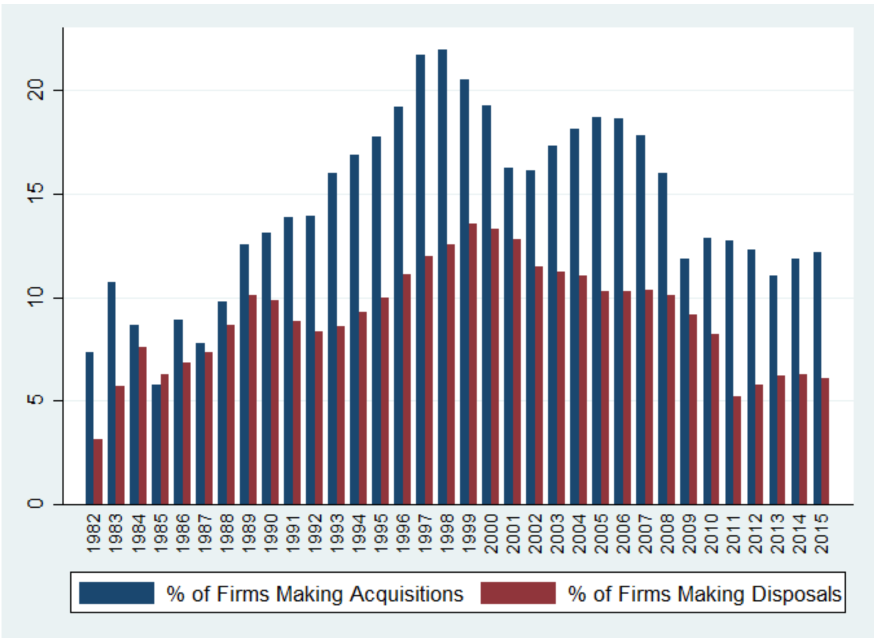

Figure 6: Percentage of firms acquiring or disposing of businesses.

The actual numbers in each year after combining Compustat and SDC are shown in

Tables 1 and 2. The second column reports the total value at current prices (when we actually know the value). This peaks in 2000 at the height of the IT stock market boom and a merger and acquisitions upswing. The third column gives the total number of transactions and column 4 the number of firms involved in each year. Around the IT peak of 2000 about 20% of quoted firms were involved. In Table 2 we report divestitures. As with acquisitions divestitures peaked in 2000 with about 13% of firms involved. These tables draw attention to the enormous amount of churning in the corporate asset market as firms (often simultaneously) both acquire and divest assets.

Table 1: **Acquisitions: 1982 - 2015.**

Year	**Total Value (£Mil)**	**Transactions**	**Number of Firms**	**% of Firms**
1982	24397.02	796	559	7.35
1983	39773.06	1208	852	10.72
1984	53796.97	1009	710	8.68
1985	73845.87	664	489	5.80
1986	95481.14	1218	785	8.93
1987	79233.27	1041	695	7.81
1988	133440.4	1405	888	9.81
1989	142644.7	1881	1138	12.53
1990	77278.81	2036	1221	13.14
1991	72323.33	2208	1341	13.89
1992	66840.64	2412	1436	13.95
1993	107521.7	3154	1753	16.01
1994	178705.5	3767	1952	16.85
1995	293645.1	4178	2174	17.72
1996	317162.1	5115	2403	19.21
1997	564571.3	6579	2702	21.71
1998	892973.8	6773	2756	21.92
1999	971370.9	5665	2530	20.50
2000	1182243	4650	2287	19.26
2001	589560.1	3314	1821	16.23
2002	362108.7	3019	1728	16.11
2003	297232.4	3398	1808	17.28
2004	452812.4	3568	1874	18.13
2005	667705.2	4038	1919	18.72
2006	888904.8	4201	1959	18.65
2007	878743.5	4184	1887	17.83
2008	616574.3	3522	1652	16.00
2009	409811.3	2186	1215	11.88
2010	532224.6	2746	1340	12.85
2011	642470.9	3104	1400	12.74
2012	651370.1	2945	1366	12.31
2013	565934.9	2445	1212	11.01
2014	680298.6	2694	1264	11.83
2015	954938.1	2584	1243	12.18

Table 2: **Divestitures: 1982 - 2015.**

Year	**Total Value (£Mil)**	**Transactions**	**Number of Firms**	**% of Firms**
1982	28598.64	240	240	3.16
1983	19805.15	452	452	5.69
1984	53396.29	619	619	7.57
1985	62217.52	531	531	6.30
1986	75120.41	603	603	6.86
1987	71531.29	655	655	7.36
1988	99389.76	782	782	8.64
1989	89590.68	918	918	10.11
1990	91037.89	918	918	9.88
1991	38968.57	852	852	8.82
1992	38858.23	857	857	8.33
1993	49583.25	943	943	8.61
1994	98366.38	1073	1073	9.26
1995	132996.7	1227	1227	10.00
1996	227043.8	1392	1392	11.13
1997	319510.7	1491	1491	11.98
1998	574480.1	1580	1580	12.57
1999	647861.6	1669	1669	13.52
2000	759025	1582	1582	13.32
2001	705797.8	1437	1437	12.81
2002	247267.7	1234	1234	11.51
2003	224488.9	1174	1174	11.22
2004	276094.3	1140	1140	11.03
2005	564740.9	3641	1056	10.30
2006	825383.6	3748	1082	10.30
2007	993851.8	3708	1099	10.38
2008	734776.4	3317	1040	10.07
2009	652001.6	3021	938	9.17
2010	504353.8	2763	857	8.22
2011	199861.8	963	576	5.24
2012	224535	1084	639	5.76
2013	284210.1	1115	684	6.22
2014	304278.4	1170	670	6.27
2015	402129.8	1104	623	6.10

4.2 Growth in Sales

In this section we compare the rate of growth of real sales by those firms who acquired or disposed of businesses in any given year compared to those firms that did not. The results for acquisitions and disposals are shown in Tables 3 to 6. Table 3 reports the median of real sales growth for acquiring and non-acquiring firms, where the acquisition took place in the current year. Column 2 shows average (nominal) sales in each year for all firms. Column 3 shows average growth rates of sales when the acquisition is in the current year. Column 4 shows the average growth of firms that did not make an acquisition in the current year. The differences in rates of sales growth between acquirers and the firm average are shown in columns 5 and 6. There is a clear tendency for those firms that have made an acquisition in the current year to grow significantly faster than those firms that have not made an acquisition in the current year. A similar exercise for Disposals is shown in Table 5. Here sales growth rates for firms disposing of assets is significantly less than the firm average.

However, in itself this is not necessarily evidence against the Comin/Mulani model since it may be that firms who are growing rapidly for other reasons are in a better position to make acquisitions, or firms that are in trouble may wish to divest assets[5]. We conduct the same exercise for the relationship between acquisitions and disposals in the previous year in Tables 4 and 6. Again the same pattern emerges. There are a number of firms that simultaneously acquire firms and divest in the same year, as they rationalise their businesses or sell on unwanted, acquired assets.

5 Estimation Results

We regress the rate of growth of real sales against various measures of corporate asset market operations in a panel with fixed effects. In Table (7) two dummy variables are used. dv_t^{acq} takes a value of 1 if the firm acquired another firm in that year - whatever the actual value of the transaction - and zero otherwise. dv_t^{dis} takes a value of 1 if a firm divests - whatever the value of the transaction - and zero otherwise. Although there is a large amount of noise with a very low R^2, acquisitions are correlated with larger growth with real sales and disposals are correlated with lower growth. The first column includes firms for which we have at least 2 years of data. We include up to 2 lags in acquisitions and disposals, as we argued earlier that the effects are spread over three years.

The next columns increase the minimum number of firm years to at least 30, which we still have data for on more than 2000 firms. Using OLS with a lagged dependent variables comes up against the Nickell bias, even as the number of cross section units goes to infinity the OLS estimates are still inconsistent when the number of years is small (Nickell,1981), however, when the number of years exceeds 30 the bias disappears[6].

[5] Denis and Shome (2005) find that operating performance at the firm and industry levels are negatively related to asset disposals and asset disposals are positively related to the firm's debt ratio and its level of diversification. Empirically they study 130 publicly traded firms that each reduce their book value of assets by at least 25% in one fiscal year between 1985 and 1994.

[6] Alternatively we could have used the Arellano–Bond (1991) estimator.

Table 3: **The effect of acquisition on Sales Growth in current time period.**

	Median Sales Growth (%)			Deviation	
Year	All Firms	Acquirers	Non-Acquirers	Acquirers	Non-Acquirers
1982	-2.93	0.11	-3.21	3.04	-0.29
1983	4.41	8.44	3.86	4.03	-0.54
1984	7.83	12.40	7.45	4.57	-0.38
1985	2.52	7.47	2.24	4.95	-0.28
1986	4.42	9.27	3.93	4.85	-0.49
1987	6.58	12.41	6.08	5.83	-0.50
1988	6.53	11.71	5.81	5.18	-0.72
1989	2.77	7.82	1.99	5.05	-0.78
1990	0.49	6.59	-0.59	6.09	-1.09
1991	-1.38	3.09	-2.15	4.47	-0.77
1992	2.86	7.73	2.05	4.87	-0.82
1993	5.23	9.64	4.35	4.41	-0.87
1994	9.11	15.48	7.50	6.37	-1.61
1995	9.18	14.67	7.62	5.48	-1.57
1996	9.16	17.19	7.32	8.03	-1.84
1997	9.30	18.91	6.83	9.61	-2.47
1998	7.85	17.15	5.36	9.29	-2.50
1999	8.57	17.56	6.64	9.00	-1.92
2000	8.95	17.49	7.03	8.54	-1.92
2001	-0.83	4.28	-1.90	5.10	-1.07
2002	-0.69	3.30	-1.49	3.99	-0.80
2003	5.12	9.09	3.77	3.97	-1.35
2004	9.22	12.60	8.00	3.38	-1.22
2005	7.42	11.54	6.13	4.12	-1.29
2006	7.86	9.92	7.12	2.06	-0.74
2007	6.38	9.45	5.37	3.07	-1.01
2008	3.31	5.85	2.41	2.54	-0.90
2009	-6.46	-3.87	-7.09	2.58	-0.63
2010	7.52	9.49	7.01	1.98	-0.51
2011	6.11	9.56	5.05	3.45	-1.06
2012	2.14	4.74	1.52	2.60	-0.63
2013	3.30	5.32	2.81	2.03	-0.49
2014	4.59	6.46	4.02	1.87	-0.57
2015	1.31	3.68	0.75	2.37	-0.56

Table 4: **The effect of acquisition on Sales Growth in the previous time period.**

	Median Sales Growth (%)			Deviation	
Year	All Firms	Acquirers	Non-Acquirers	Acquirers	Non-Acquirers
1982	-2.93	0.41	-3.02	3.34	-0.10
1983	4.41	8.22	4.11	3.81	-0.30
1984	7.83	13.78	7.32	5.95	-0.51
1985	2.52	6.66	2.19	4.14	-0.32
1986	4.42	10.91	3.97	6.50	-0.45
1987	6.58	14.14	5.72	7.57	-0.85
1988	6.53	12.70	5.88	6.18	-0.65
1989	2.77	8.92	2.12	6.16	-0.64
1990	0.49	6.59	-0.46	6.09	-0.96
1991	-1.38	3.80	-2.07	5.18	-0.70
1992	2.86	8.86	1.92	6.00	-0.94
1993	5.23	10.47	4.42	5.25	-0.81
1994	9.11	16.31	7.83	7.20	-1.29
1995	9.18	16.59	7.44	7.41	-1.74
1996	9.16	16.44	7.64	7.28	-1.52
1997	9.30	18.80	7.31	9.50	-1.99
1998	7.85	18.39	5.32	10.53	-2.53
1999	8.57	14.62	6.72	6.06	-1.84
2000	8.95	15.08	7.23	6.13	-1.72
2001	-0.83	3.92	-1.98	4.75	-1.15
2002	-0.69	4.01	-1.61	4.71	-0.92
2003	5.12	10.19	3.70	5.06	-1.43
2004	9.22	14.56	7.77	5.34	-1.44
2005	7.42	12.11	6.10	4.69	-1.31
2006	7.86	9.70	7.32	1.84	-0.54
2007	6.38	8.29	5.75	1.91	-0.64
2008	3.31	5.90	2.35	2.59	-0.96
2009	-6.46	-5.09	-6.88	1.37	-0.42
2010	7.52	9.95	7.06	2.43	-0.46
2011	6.11	9.48	5.11	3.37	-1.00
2012	2.14	4.31	1.62	2.17	-0.52
2013	3.30	5.38	2.81	2.08	-0.48
2014	4.59	6.22	4.07	1.63	-0.52
2015	1.31	2.81	0.92	1.50	-0.40

Table 5: **The effect of disposals on sales growth in the current year.**

	Median Sales Growth (%)			Deviation	
Year	All Firms	Disposers	Non-Disposers	Disposers	Non-Disposers
1982	-2.93	-6.63	-2.84	-3.70	0.09
1983	4.41	-0.14	4.60	-4.54	0.20
1984	7.83	2.65	8.14	-5.18	0.31
1985	2.52	-4.24	2.74	-6.76	0.23
1986	4.42	-1.59	4.74	-6.00	0.32
1987	6.58	2.90	6.80	-3.68	0.23
1988	6.53	3.88	6.82	-2.64	0.29
1989	2.77	0.77	3.10	-2.00	0.34
1990	0.49	-1.20	0.78	-1.70	0.28
1991	-1.38	-4.57	-1.00	-3.20	0.38
1992	2.86	-0.96	3.44	-3.82	0.58
1993	5.23	-0.30	5.98	-5.52	0.75
1994	9.11	3.61	9.79	-5.51	0.67
1995	9.18	4.40	9.86	-4.79	0.68
1996	9.16	2.97	9.85	-6.19	0.69
1997	9.30	4.44	9.94	-4.85	0.64
1998	7.85	3.37	8.49	-4.48	0.63
1999	8.57	3.42	9.28	-5.15	0.71
2000	8.95	3.75	9.58	-5.20	0.64
2001	-0.83	-4.82	-0.15	-3.99	0.68
2002	-0.69	-6.11	-0.15	-5.42	0.55
2003	5.12	1.41	5.51	-3.71	0.39
2004	9.22	4.78	9.81	-4.44	0.59
2005	7.42	2.17	8.14	-5.25	0.72
2006	7.86	3.77	8.52	-4.09	0.66
2007	6.38	3.15	7.12	-3.23	0.74
2008	3.31	-0.03	3.76	-3.34	0.45
2009	-6.46	-11.29	-5.91	-4.83	0.55
2010	7.52	3.87	8.00	-3.65	0.48
2011	6.11	3.53	6.40	-2.59	0.29
2012	2.14	-0.64	2.31	-2.78	0.17
2013	3.30	1.00	3.44	-2.30	0.14
2014	4.59	2.00	4.86	-2.59	0.27
2015	1.31	-4.96	1.84	-6.27	0.52

Table 6: **The effect of disposals on sales growth in the previous year.**

	Median Sales Growth (%)			Deviation	
Year	All Firms	Disposers	Non-Disposers	Disposers	Non-Disposers
1982	-2.93	-5.85	-2.91	-2.92	0.02
1983	4.41	2.01	4.42	-2.39	0.02
1984	7.83	4.97	7.89	-2.86	0.06
1985	2.52	-1.92	2.72	-4.44	0.21
1986	4.42	-0.10	4.61	-4.51	0.19
1987	6.58	4.45	6.68	-2.13	0.10
1988	6.53	4.58	6.68	-1.94	0.16
1989	2.77	1.29	2.90	-1.47	0.13
1990	0.49	0.20	0.59	-0.29	0.09
1991	-1.38	-4.45	-1.03	-3.07	0.35
1992	2.86	0.61	3.22	-2.25	0.36
1993	5.23	0.66	5.68	-4.57	0.46
1994	9.11	4.72	9.67	-4.40	0.55
1995	9.18	6.10	9.60	-3.08	0.42
1996	9.16	4.82	9.73	-4.34	0.58
1997	9.30	3.85	9.98	-5.45	0.68
1998	7.85	4.80	8.28	-3.06	0.43
1999	8.57	4.33	9.14	-4.24	0.57
2000	8.95	4.00	9.55	-4.95	0.60
2001	-0.83	-4.37	-0.36	-3.54	0.47
2002	-0.69	-3.70	-0.26	-3.01	0.44
2003	5.12	2.70	5.34	-2.43	0.21
2004	9.22	6.99	9.61	-2.23	0.39
2005	7.42	4.08	7.81	-3.34	0.39
2006	7.86	4.35	8.34	-3.51	0.48
2007	6.38	4.15	6.83	-2.24	0.45
2008	3.31	1.27	3.64	-2.04	0.33
2009	-6.46	-9.45	-6.09	-2.99	0.37
2010	7.52	5.02	7.85	-2.50	0.33
2011	6.11	4.55	6.41	-1.57	0.29
2012	2.14	0.51	2.28	-1.63	0.14
2013	3.30	1.66	3.41	-1.63	0.11
2014	4.59	1.53	4.92	-3.06	0.33
2015	1.31	-5.41	1.90	-6.73	0.59

There still remains a possible problem with endogeneity. In Table (8) we report a reduced form estimate of the model. These are consistent estimates and suggest that the dummy variable for acquisitions has a positive effect on sales growth and the dummy variable for disposals has a negative effect. In column 2 we control for firm-specific factors - Tobin's Q[7] , Q_t, and the change in the rate of profit, $\Delta\rho_t$, (ebitda divided by sales). In column 3 we control for some common macroeconomic factors: the growth in real GDP, Δy_t, the inflation rate, π_t, the short term, rs_t, and long term, rl_t, interest rates and the real exchange exchange rate, rex_t, (export prices divided by import prices). In column 4 we control both for firm-specific and common factors. Finally, in column 5 we estimate the reduced form for the model of column 4, treating the 2 dummy variables as endogenous.

5.1 Goodwill, Total Assets, Acquisitions and Disposals.

So far we have used a simple dummy variable to capture the way in which acquisitions and disposals affect sales growth. However, US GAAP (generally accepted accounting principles) determines which asset are included on the balance sheet of a company. We now exploit the balance sheet accounting that accompanies acquisitions and disposals. Typically, home grown intangible assets such as brands and patents are written off and do not appear in the balance sheet (Higson, 2012). However, if a company acquires another company this is recognised in the balance sheet and total assets should change to reflect the acquisition/disposal of assets.

The acquisition of a business brings some mix of tangible assets (property, plant and equipment), inventory, loans, assets, other long-term assets, and intangibles, and, finally, goodwill which is the residual item measuring the difference between the price paid for an acquisition and the carrying values of the identifiable assets and liabilities acquired. The acquired net assets are added to/subtracted from total assets in the balance sheet. However, some part of an increase in total assets will also reflect the underlying organic growth of the company. US companies do now report a breakdown of the acquired/disposed assets, but this has only started to appear in Compustat since 2010.

In Table (9) we add the change in the log of real total assets, Δta_t. This turns out to be a highly significant addition to the model with the overall R^2 increasing to over 37 percent, compared to the results in Tables (7) and (8). The inclusion of real total assets reduces the size and the significance of the 2 dummy variables for acquisitions and disposals. In the second equation in Table (9) we drop the dummy variables entirely, reducing the R^2 only very slightly.

5.2 Endogeneity

In this section we try to take account of possible endogeneity of sales growth and acquisitions and disposals. In Table (10), we use the panel of (2177) firms that have more than

[7] We use the Tobin's Q constructed by Peters and Taylor (2017) for both tangible and intangible investment. We are grateful to Ryan Peters for making the data and definitions available .

Table 7: **Fixed Effects Panel Model**

	All years	10 years +	20 years +	30 years +
	Δs_t	Δs_t	Δs_t	Δs_t
Δs_{t-1}	-0.0742***	-0.0412***	-0.0133***	0.00922**
	[0.00206]	[0.00218]	[0.00260]	[0.00332]
DV_t^{acq}	6.714***	6.222***	4.296***	2.842***
	[0.319]	[0.310]	[0.298]	[0.310]
DV_{t-1}^{acq}	8.678***	7.738***	6.152***	5.270***
	[0.325]	[0.318]	[0.307]	[0.321]
DV_{t-2}^{acq}	-2.950***	-2.962***	-2.612***	-2.418***
	[0.328]	[0.320]	[0.310]	[0.325]
DV_t^{dis}	-11.82***	-11.11***	-9.546***	-7.753***
	[0.401]	[0.387]	[0.367]	[0.365]
DV_{t-1}^{dis}	-6.440***	-5.527***	-4.253***	-3.582***
	[0.416]	[0.400]	[0.378]	[0.377]
DV_{t-2}^{dis}	-3.964***	-3.705***	-3.314***	-2.590***
	[0.424]	[0.406]	[0.381]	[0.378]
intercept	4.173***	4.122***	4.305***	4.079***
	[0.106]	[0.104]	[0.103]	[0.107]
N	258051	223597	151529	93717
overall R^2	0.0062	0.009	0.0109	0.0119

Standard errors in brackets
* p<0.05, **p<0.01, *** p<0.001

Table 8: **Fixed Effects Panel Model. Firm specific and common aggregate controls.**

		30 years +			
	Δs_t	Δs_t	Δs_t	Δs_t	Δs_t
Δs_{t-1}	0.0121***	0.0823***	-0.0057	0.0677***	0.0706***
	[0.00333]	[0.00411]	[0.00332]	[0.00411]	[0.00412]
DV_t^{acq}		2.320***	4.220***	3.182***	
		[0.229]	[0.310]	[0.229]	
DV_{t-1}^{acq}	5.208***	4.604***	6.529***	5.458***	5.756***
	[0.310]	[0.237]	[0.320]	[0.236]	[0.233]
DV_{t-2}^{acq}	-2.806***	-2.133***	-1.129***	-1.259***	-1.243***
	[0.318]	[0.241]	[0.324]	[0.240]	[0.239]
DV_t^{dis}		-4.989***	-6.822***	-4.544***	
		[0.275]	[0.362]	[0.271]	
DV_{t-1}^{dis}	-4.908***	-2.246***	-2.512***	-1.569***	-2.144***
	[0.369]	[0.283]	[0.373]	[0.279]	[0.276]
DV_{t-2}^{dis}	-3.432***	-1.749***	-1.070**	-0.706*	-1.030***
	[0.374]	[0.284]	[0.376]	[0.281]	[0.281]
Q_t		0.687***		0.789***	0.795***
		[0.0727]		[0.0712]	[0.0715]
Q_{t-1}		0.957***		0.700***	0.718***
		[0.0797]		[0.0784]	[0.0787]
$\Delta\rho_t$		6.673***		6.016***	5.982***
		[0.183]		[0.180]	[0.180]
$\Delta\rho_{t-1}$		3.069***		2.617***	2.653***
		[0.184]		[0.180]	[0.181]
Δy_t			142.3***	141.1***	142.0***
			[6.544]	[6.162]	[6.186]
Δy_{t-1}			-15.55**	-22.36***	-23.18***
			[5.815]	[5.266]	[5.286]
π_t			56.53***	64.68***	64.28***
			[11.94]	[10.84]	[10.87]
π_{t-1}			-61.21***	-48.41***	-48.00***
			[10.19]	[9.191]	[9.219]
rs_t			0.646***	0.249*	0.246*
			[0.125]	[0.103]	[0.103]
rs_{t-1}			-0.173	-0.427***	-0.409***
			[0.126]	[0.106]	[0.106]
rl_t			-0.136	-0.1	-0.123
			[0.214]	[0.173]	[0.173]
rl_{t-1}			-0.19	0.507***	0.503***
			[0.171]	[0.146]	[0.146]
rex_t			-10.03*	-26.06***	-25.86***
			[4.291]	[4.318]	[4.335]
rex_{t-1}			29.24***	39.26***	38.54***
			[4.271]	[4.027]	[4.042]
intercept	4.024***	2.696***	-2.228***	-5.292***	-5.020***
	[0.104]	[0.113]	[0.592]	[0.609]	[0.600]
N	93717	58145	93717	58145	58145
overall R^2	0.007	0.073	0.038	0.107	0.100

Standard errors in brackets

* p<0.05, **p<0.01, *** p<0.001

Table 9: **Fixed Effects Panel Model. Firm specific and common aggregate controls and change in real total assets.**

	Δs_t				Δs_t		
					30 years +		
Δs_{t-1}	-0.104***	rs_t	-0.284**	Δs_{t-1}	-0.104***	rs_t	-0.316***
	[0.00416]		[0.0873]		[0.00416]		[0.0874]
DV_t^{acq}	-0.520**	rs_{t-1}	-0.0459	DV_t^{acq}		rs_{t-1}	-0.0276
	[0.196]		[0.0897]				[0.0893]
DV_{t-1}^{acq}	2.508***	rl_t	0.148	DV_{t-1}^{acq}		rl_t	0.199
	[0.202]		[0.147]				[0.147]
DV_{t-2}^{acq}	-0.345	rl_{t-1}	-0.0778	DV_{t-2}^{acq}		rl_{t-1}	-0.131
	[0.205]		[0.124]				[0.123]
DV_t^{dis}	-2.420***	rex_t	-14.95***	DV_t^{dis}		rex_t	-14.25***
	[0.230]		[3.675]				[3.682]
DV_{t-1}^{dis}	-0.115	rex_{t-1}	21.18***	DV_{t-1}^{dis}		rex_{t-1}	20.39***
	[0.236]		[3.431]				[3.432]
DV_{t-2}^{dis}	0.454	Δta_t	50.72***	DV_{t-2}^{dis}		Δta_t	51.12***
	[0.239]		[0.381]				[0.376]
Q_t	0.242***	Δta_{t-1}	25.36***	Q_t	0.233***	Δta_{t-1}	25.95***
	[0.0611]		[0.433]		[0.0613]		[0.430]
Q_{t-1}	-0.0372	Δta_{t-2}	-1.933***	Q_{t-1}	-0.0334	Δta_{t-2}	-2.044***
	[0.0679]		[0.370]		[0.0681]		[0.367]
$\Delta \rho_t$	3.968***	intercept	-2.959***	$\Delta \rho_t$	3.910***	intercept	-2.834***
	[0.154]		[0.519]		[0.155]		[0.470]
$\Delta \rho_{t-1}$	0.890***			$\Delta \rho_{t-1}$	0.838***		
	[0.155]				[0.156]		
Δy_t	102.5***			Δy_t	102.0***		
	[5.242]				[5.253]		
Δy_{t-1}	-14.02**			Δy_{t-1}	-13.07**		
	[4.485]				[4.493]		
π_t	90.57***			π_t	89.95***		
	[9.215]				[9.206]		
π_{t-1}	-42.80***			π_{t-1}	-42.23***		
	[7.828]				[7.817]		
N	57619				57619		
overall R^2	0.3753				0.3725		

Standard errors in brackets

* p<0.05, **p<0.01, *** p<0.001

30 years of data over the period 1982 to 2014 using a GMM estimator with fixed effects. In the first column of results we endogenise only real total assets.[8] and use firm-level Tobin's Q and the change in real profitability as well of exogenous aggregate variables as excluded instruments. The IV coefficient of $\Delta\rho_t$ is much larger than the OLS estimate in Table (10), nevertheless, some overall tests of the model are not particularly good. There is a significant reduction in R^2, and while the Anderson LR statistic rejects the null that the excluded instruments are not relevent, the Cragg-Donald F statistic rejects a test for weak instruments. The Sargan test is a test of overidentifying restrictions. The joint null hypothesis is that the instruments are valid instruments, uncorrelated with the error term, and that the excluded instruments are correctly excluded from the estimated equation.

The second column of estimates includes the firm-level Tobin's Q and the change in profitability. The Craig-Donald F Statistic does not now reject the null, at least for the case if we set the maximum acceptable bias to 0.05 (i.e. we tolerate a bias of 5% relative to OLS). However, the Sargan test suggests that we should also include (some or all) of the aggregate variables. In column 3 we include aggregate growth, inflation and the lagged short term interest rate. The model now comfortably passes all of the tests.

6 Conclusion

We provide evidence to suggest that the apparent increase in the volatility of individual firms during a period of lessening volatility at the aggregate level can be directly related to the market for corporate assets with many firms acquiring or divesting businesses, sometimes at the same time.

First, we replicate and update the work of Comin and Philippon (2005) and Comin and Mulani (2006) using the Compustat accounting dataset. The median volatility of the sales growth of individual firms peaked in about 2000, but still remained at higher levels than in the mid-1990s. However, when we sum the real sales of all quoted companies the volatility of the aggregate behaves in a similar why to the volatility of GDP, declining during the great moderation and rising after 2007. This suggests negative covariances between individual firms that cancelled out in the aggregate.

We propose a simple model in which these negative covariances reflect activity in the market for corporate assets, in which some firms acquire the assets and thus the sales of businesses, and other firms disposed of the assets and sales of businesses. Compustat over most of the sample period was incomplete in recording acquisitions and disposals. We use the SDC Platinum dataset to collect data on the year a firm acquired or disposed of businesses. Firms that grew more rapidly than the average tended to have acquired businesses, while those growing more slowly than average had disposed of businesses.

We also report estimation results which reinforce these findings. The change in the total assets of the firm do reflect acquisitions and disposals indirectly and we find a strong relationship between the growth of the firm and the change in total assets, controlling for the endogeneity between growth, acquisitions and disposals.

[8] We use the IVREG28 code of Baum, Schaffer and Stillman (2007).

Table 10: **Fixed Effects, GMM, IV Panel Model.**

	Δs_t	Δs_t	Δs_t
Δs_t	-0.105***	-0.0923***	-0.106***
	[0.00795]	[0.0118]	[0.0245]
Δta_t	103.9***	67.21***	139.0***
	[2.012]	[5.735]	[23.01]
Δta_{t-1}	20.53***	26.90***	9.473*
	[0.823]	[1.671]	[3.920]
Δta_{t-2}	-2.746***	4.880***	-17.20***
	[0.587]	[1.136]	[4.133]
Q_t		-19.78***	-9.976
		[1.371]	[5.552]
Q_{t-1}		14.06***	5.098
		[1.168]	[3.537]
$\Delta \rho_t$		34.69***	-76.95***
		[3.216]	[19.99]
$\Delta \rho_{t-1}$		9.956***	-23.68***
		[1.063]	[5.968]
Δy_t			146.8***
			[29.03]
Δy_{t-1}			-115.0***
			[29.03]
π_t			153.4***
			[28.75]
π_{t-1}			-119.0***
			[27.49]
rs_{t-1}			-0.614***
			[0.115]
N	56534	56070	56534
R^2	0.15	na	na
Anderson canon. corr. LR statistic	2953.8	202.8	17.7
Chi-sq P-val	0	0	0
Cragg-Donald F statistic	189.555	16.924	3.55
5% maximal IV relative bias	21.3	17.8	9.5
10% maximal IV relative bias	11.5	10	6.6
Hansen-Sargan J statistic	1472.2	201.8	1.92
Chi-sq(15) P-val	0	0	0.383
Endogeneity test	764	1179.3	206.3
Chi-sq P-val	0	0	0
Instrumented	Δta_t	$\Delta ta_t, Q_t, \Delta\rho_t$	$\Delta ta_t, Q_t, \Delta\rho_t$
included instruments	$\Delta ta_{t-1}, \Delta ta_{t-2}$	$\Delta ta_{t-1}, \Delta ta_{t-2}$ $Q_{t-1}, \Delta\rho_{t-1}$	$\Delta ta_{t-1}, \Delta ta_{t-2}$ $Q_{t-1}, \Delta\rho_{t-1}$ $\Delta y_t, \Delta y_{t-1},$ $\pi_t, \pi_{t-1}, rs_{t-1},$
excluded instruments	$\Delta y_t, \Delta y_{t-1},$ $\pi_t, \pi_{t-1}, rs_t,$ $rs_{t-1}, rl_t, rl_{t-1},$ rex_t, rex_{t-1}	$\Delta y_t, \Delta y_{t-1},$ $\pi_t, \pi_{t-1}, rs_t,$ $rs_{t-1}, rl_t, rl_{t-1},$ rex_t, rex_{t-1}	$rs_t, rl_t, rl_{t-1},$ rex_t, rex_{t-1}
Standard errors in brackets	* p<0.05, **p<0.01,	*** p<0.001	

The theoretical literature on the role of mergers and acquisitions is comparatively thin. On the theoretical side there is Gort (1969) and more recently Xu (2017) and on the empirical side Andrade et al (2001), Andrede and Stafford (2004), Doytch and Uctum (2011), Maksimovic and Phillips (1998, 2002), Schoar (2002) and Warusawitharana (2007). Buying another firm may is a way of acquiring a patent or technology rather than investing directly in R&D, as in the work of Xu (2017).

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