MERGERS AND TECHNOLOGICAL CHANGE: 1885-1998

by

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Abstract

We analyze mergers over the past century in a growth model that emphasizes technological change. We explain the positive relation between mergers and stock prices, the positive relation between internal growth of firms and their acquisitions, and the positive relation of mergers with other measures of reallocation such as entry and exit. More broadly, mergers help us to reallocate assets more smoothly, thereby raising returns to investment and the growth rate. We also find that merger waves are shorter when technological change is more dramatic, when the capital of other firms is less costly to transfer, and when entry and exit are a smooth reallocation mechanism. This last result underscores that entry and exit on the one hand and mergers on the other are substitute means of reallocation.

1   Introduction

The stock market is a market for claims to income streams, and it is, at the same time, a market for corporate control. Manne (1965) argued that mergers are a way to get resources into the hands that can manage them best. The stock price of a badly managed firm will be low, argued Manne, and the firm will be an attractive target to those who can manage it better. Moreover, Manne argued that mergers play the same economic role as entry and exit – that of asset reallocation – and that they often do it more cheaply and effectively.

The view that mergers represent reallocation suggests that merger waves should occur when there is major technological change. Our theory of merger waves extends some arguments of Gort (1969). When a major new technology arrives, many firms will not easily be able to adapt to it, perhaps because their managers and workers have the wrong skills. Such firms become takeover targets for those firms that can

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take advantage of the new technology. The merger wave simply reallocates the assets to those firms that can most efficiently operate the new technology. The wave dies down when the reallocation is complete.

We find that merger waves will be shorter when technological change is more dramatic, when the capital of other firms is easier to adapt to one's own purposes, and when entry and exit are a smooth reallocation mechanism. This last result underscores that entry and exit on the one hand and mergers on the other are substitute means of reallocation.

2 Facts on mergers

Merger waves tend to occur during stock-market booms. The first merger wave took place at the turn of the 20th century, the second in the 1920's, the third in the late '60's, and the fourth in the '80's. We are now in the midst of a fifth wave that started around 1993. The merger waves coincide with periods of high price-earnings ratios on the stock market. Figure 1 shows total merger capitalization by year since 1885 as a percentage of GDP,[1] and contrasts this with total stock market capitalization,

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[1] Our time series for merger capital draws from six sources and has an important change in methodology and coverage in 1926. For 1926-98, the University of Chicago's Center for Research on Securities Prices (CRSP) file identifies 7,455 firms that exit the stock market by merger, but links only 3,488 of them to acquirers. Using the *Directory of Obsolete Securities* and *Predicasts F&S Index of Corporate Change,* however, we found acquirers for 3,646 (91.9%) of the unlinked mergers, of which 1,803 were in CRSP. We include in Figure 1 the market values of CRSP firms, both acquirers and targets, at the end of the year before the merger. This restricts the merger series to include NYSE-listed firms from 1926, AMEX-listed firms from 1962, and Nasdaq firms from 1971.

For 1920-25 we include mergers in the manufacturing and mining sectors from Eis (1968, Table 3-1, p. 40), and for 1895-1920 we include those from Nelson (1959, Table 14, p. 37). Both Eis and Nelson measured firm size by the value of gross assets, outstanding capital, or authorized capital based on data availability. One would suspect today that book values might understate the market value of merging entities, yet around 1900 firms commonly overstated their size with an inflated authorized capital that was not fully paid in. Despite these deficiencies, the use of gross assets or authorized capital to approximate market value is preferable to counting only those firms which, by virtue of exchange listing, have price data available. This is particularly true for the pre-CRSP period, during which much merger activity occurred between unlisted firms or for whom consolidation was a precursor to exchange listing. Indeed, by comparing the mergers listed on the handwritten worksheets of both Nelson and Eis to the NYSE listings from the *Commercial and Financial Chronicle,* we found that only 2,768 of 7,761 (35.7%) acquirer-target combinations (with each target firm in a consolidation counted separately) involved at least one NYSE-listed firm, and that the listed firm was acquirer in 98.1% of these cases. Only 166 (2.1%) of the bilateral combinations involved two NYSE-listed firms. Since most capital involved in mergers was listed on an exchange by the end of our study (according to CRSP and the *Flow of Funds* files virtually all outstanding equity capital was listed on an exchange in 1985 and over 85% is listed today), our restriction of the sample to exchange-listed firms after 1925 becomes less important with time, especially given that merger activity was virtually absent during the 1932-41 period (see Nelson, p. 122). In fact, the total merger capital from our NYSE-listed sample in 1926 exceeds that for the entire manufacturing and mining sectors from Eis. We do not attempt to join these two segments

also as a percent of GDP,[2] and with firm size as measured by the average number

in 1926.

To measure merger capital prior to 1895, we use the number of combinations exceeding $1 million in value compiled by Conant (1901) for each year between 1885 and 1894, and multiply by the average size of a merged entity from Nelson (Table 32, p. 60).

The GDP figures that we use to normalize both the merger and stock market capitalization series are from the Bureau of Economic Analysis for 1929-1998, and from Balke and Gordon (1986) for earlier years.

[2]To estimate the market value of outstanding corporate equity, we extend the *Flow of Funds* series (Table L.4) backward using the available data on capitalization for the NYSE, the regional exchanges, and the over-the-counter (OTC) markets. We work backward not from 1945 (which is when the *Flow of Funds* begin), but rather from 1949 because the closest overlapping observations of OTC activity are for 1949.

The *Flow of Funds* reports $117 billion for outstanding corporate equities in 1949, which we divide into the value of NYSE-listed firms, the value of firms listed exclusively on AMEX and the regional exchanges, and the value of firms traded exclusively in OTC markets. Friend (1958) estimates the sum of NYSE and regional capital in 1949 at $95 billion. We know from CRSP that NYSE capitalization was $68 billion. This implies a regional capitalization of $27 billion and OTC capital of $22 billion in 1949. Assuming that the capitalizations of NYSE and regionally-listed firms are proportional to their transaction values, which are available from the *Annual Reports* of the Securities and Exchange Commission for 1935-49, we multiply NYSE capital by the ratio of regional to NYSE transactions to approximate movements in capitalization on the regional exchanges. We then adjust the resulting regional series to match the $27 billion that we estimate for 1949. To estimate regional capital for 1920-34, we observe that the ratio of regional to NYSE transaction value was steady at 0.18 for 1935-50 and assume that it was the same for 1920-34. We can then multiply NYSE capital by 0.18 for these years.

The OTC market presents a double-counting problem. Friend estimates that, in 1949, 25% of quoted OTC issues were also listed on a registered exchange. Our measure of OTC capital must exclude such firms. To derive estimates for 1920-49, we use Friend's counts of the number of OTC-quoted firms over a 3-month window surrounding three benchmark dates in 1949, 1939 and 1929. There were 5,300 such OTC firms in 1949, of which 75% were not listed on registered exchanges. The median market value of these unlisted firms was $2.4 million. Therefore, we approximate exclusive OTC capital at $9.54 million (.75*5300*$2.4) in 1949. Assuming that the real median size of unlisted OTC firms did not change over 1920-49, we next use the GDP deflator to convert the median size into nominal terms at the other benchmark dates. Next, we observe that the $9.47 million for 1949 is too small by a factor of 2.3 given our comparable estimate from the *Flow of Funds*, and adjust the OTC benchmark estimates by this factor. Finally, we interpolate between the benchmarks to obtain an annual OTC series for 1929-49.

To obtain OTC capital for 1920-28, we continue to assume that capital on the exchanges is proportional to relative transaction values. Since we know NYSE capitalization and now have estimates for the regional and OTC markets in 1929, we can estimate of the share of the OTC in total market value in 1929. Since Friend (p. 109) provides us with this share for 1926, and 1920, we can use them to estimate OTC capital for these years given the values of NYSE capitalization from CRSP and our earlier estimates of regional capital. We interpolate between the benchmarks once again to obtain OTC capital for 1920-29.

By adding NYSE, regional and OTC capitalizations, we obtain a series for total market value for 1920-49 that is consistent with the *Flow of Funds* in the sense that the two segments coincide in 1949. Our final estimates of equity capital outstanding, displayed in Figure 1, are obtained by splicing our series with the *Flow of Funds* in 1945. Since we wish to show market value from 1885,
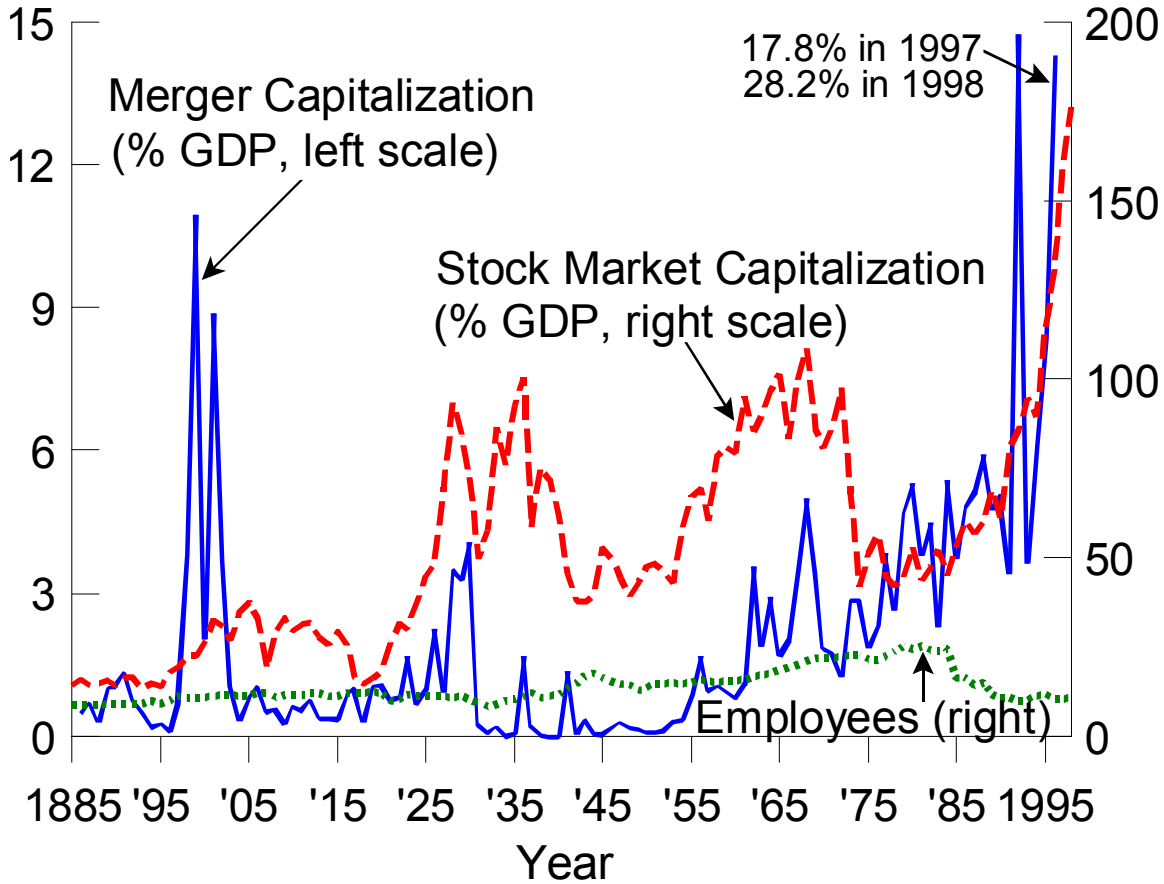
Figure 1: Total merger and stock market capitalization as percentages of gross domestic product, and the average number of employees per business concern, 1885-1998.

of employees per business concern.[3] Our model of mergers will generate waves that look strikingly like those in Figure 1 with respect to both length and timing patterns. As we would also expect, merger activity is highly correlated with the size of the stock market, with a correlation coefficient (ρ) of .574. Interestingly, the scale of production, as measured by number of employees per concern, is unrelated to merger activity ($\rho = .029$), although employees per business is weakly correlated with market size ($\rho = .216$).

The series in Figure 1 thus raise the suspicion that scale economies, and perhaps even market power, are not the primary motivations for mergers. Indeed, Jensen

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we ratio splice the value of NYSE capital 1885-1920 (obtained from individual issues of the *The Annalist, The Commercial and Financial Chronicle, The New York Times,* and *Bradstreet's*) to our result for 1920-98.

[3]Data on employment and the number of business concerns are from the *Historical Statistics of the United States* and various issues of the *Statistical Abstract of the United States.*

(1988) reports that mergers raise the combined market asset value of the bidding and target firms by about eight percent, but that these gains do not seem to come from the creation of market power. These findings favor Manne's hypotheses. So does common sense: Not every failing firm's assets should disperse and seek employment elsewhere individually. Bankruptcy and direct asset sell-offs usually entail the selling of the company's assets in pieces and not the replacement of the defective parts.[4]

So much of the discussion of mergers centers around two correlates of mergers, namely antitrust policy and regulation policies and, more recently, "globalization". Before getting into our model we shall first say a few words about why these other explanations cannot explain the bulk of the merger activity and the waves we have seen over the past century

2.1   Shifts in antitrust policy

A merger wave may occur after an easing of antitrust policy. The idea would, presumably, be that the desire of firms to merge with one another is somehow bottled up, and that a more permissive antitrust stance lets the merger genie out of the bottle. But the data do not really support this view. Instead, they suggest that antitrust policy itself responds to technology, but far more sluggishly than mergers do.

Antitrust activity starts at the end of the 19th century as a response to the growth in the power of the large corporation which, in turn, occurs because of innovations in communication and transportation technologies that enabled the organization of a larger body of assets located over a larger geographical area. The antitrust stance of the courts became gradually more activist after the Sherman Act of 1890, peaked in the 1940's and '50's, and has declined steadily since. Figure 2 reflects this inverted U-shape, where antitrust stance is measured as the number of cases initiated by the

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[4]We should admit that there are some offsetting advantages, however. Fraser (2001) notes that buyers may prefer to buy assets directly (assets include hard assets – buildings, machinery, real estate, furniture – as well as intangibles, such as intellectual property, client lists and goodwill) rather than the company's stock because this gets them the most desirable parts of the firm without its disclosed and undisclosed liabilities – environmental liabilities, upcoming lawsuits, or even unpaid tax bills. For instance, the firm *Bid4Assets.com*, an online auctioneer of high-value, distressed assets from financial, government and bankruptcy sources, was in mid-2000 listing more than $1 billion worth of assets for sale. The items were in in four primary asset categories: financial instruments, real estate, intangible property and personal property. They seem to have created a centralized market from what was once a fragmented set of public outcry auctions and private deals. The asset-sale market is still not that large, however, and the market for bankruptcy claims was in mid-2000, for instance, estimated at around $30 billion per year (New Generation Research, 2000). This is dwarfed by the nearly two trillion dollars' worth of assets involved in mergers and acquisitions during the year 2000. Still, it is a growing market and companies like E-bay are now auctioning expensive high-end equipment (like Sun servers) at bargain zero prices. This is weakening demand for the next generation of equipment that has similar features but is more expensive. This is an example of the sort of competition between new and used capital that arises in our model, but we shall simply assume (and the facts bear this out) that all used capital trading is in the form of mergers and acquisitions.
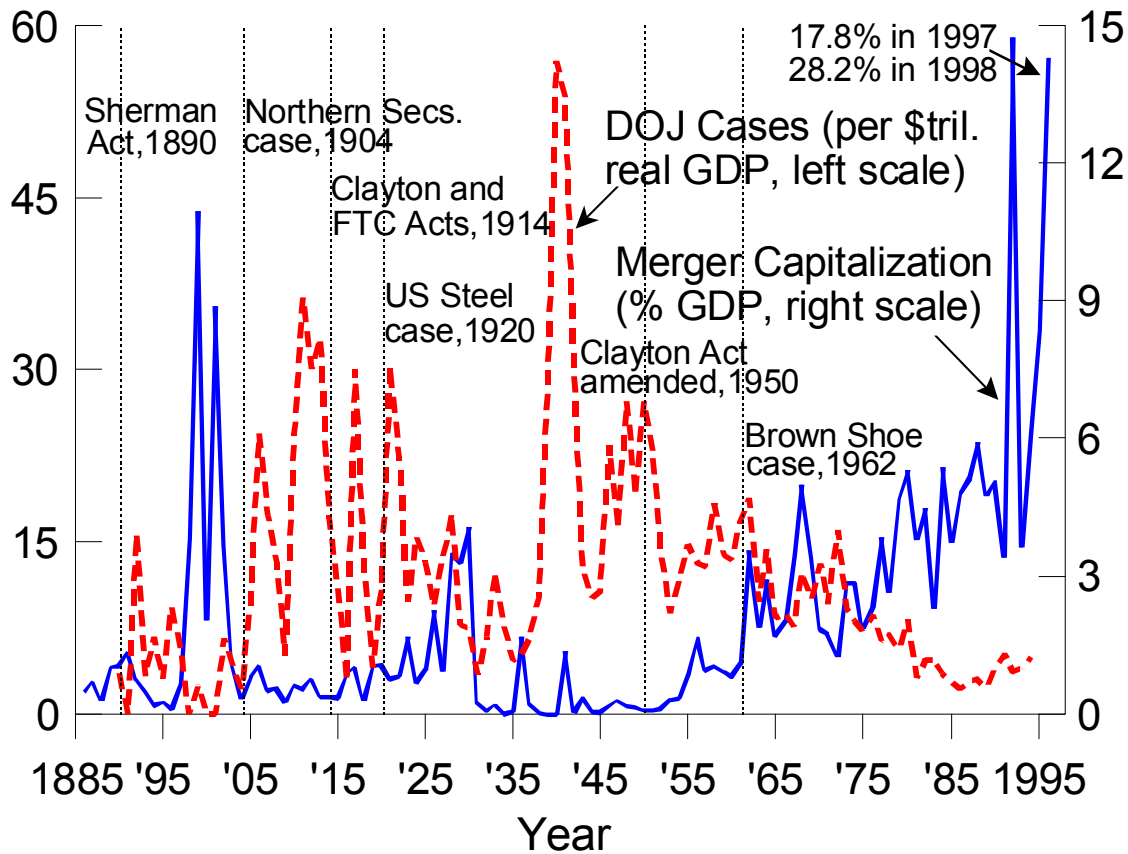
Figure 2: Antitrust stance and merger activity, 1885-1998.

Department of Justice per trillion dollars of real GDP.[5] The figure also marks a few milestones in antitrust history.[6] In contrast, the ratio of merger capital to GDP

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[5] The number of antitrust cases is from Posner (1970, Table 1, p. 366) for 1890-1954, and from worksheets underlying Ghosal and Gallo (2001, Figure 1, p. 36) for 1955-94.

[6] The Sherman Act of 1890 declared illegal every contract, combination (in the form of trust or otherwise) or conspiracy in restraint of interstate and foreign trade, and authorized the federal government to institute proceedings to dissolve trusts. The Act was rarely enforced by the courts until 1904, when the dissolution of the Northern Securities Company marked the start of a less tolerant stance towards trusts that was reaffirmed with the dissolution of the Standard Oil trust in 1911, the passage of the Clayton Act in 1914, and the establishment of the Federal Trade Commision as an enforcement agency in the same year. The refusal of the courts to dissolve the U.S. Steel Trust in 1920 marked a swing in the pendulum towards a more lenient stance, which persisted until 1936 and the passage of the Robinson-Patman "anti-chain store" Act. Antitrust enforcement became even more vigorous when the Sherman Act was clarified and strengthened in 1950. The case of the Brown Shoe Company in 1962 is one in which a merger was disallowed that would have secured only 6 percent of the footwear industry for the acquirer. There have been a number of high profile cases more recently, such as the AT&T divestiture in 1982 and the current Microsoft case, but the

ratio does have a U-shape. At low frequencies, then, antitrust stance is negatively correlated with merger intensity. Even the contemporaneous correlation between the series is -.384. We argue here that the relation is not causal, but rather that both series move in response to technology. When major new technologies appear – like electricity and the internal combustion engine at the turn of the 20th century and information technology at the turn of the 21st century – assets need to be reallocated smoothly, inventors of new technologies need to be compensated, and these considerations should override measures to protect the consumer from excessive market power of firms. Moreover, given the costs of invention, allowing innovators to have some degree of market power is one way to reward them.[7] On the other hand, when technology is more static, as was perhaps the case in the middle of the century, it becomes optimal for the government to worry about monopoly.

2.2   Shifts in regulation policy

In theory, at least, deregulation works very much like the arrival of a new technology because it allows the set of input-output combinations to expand. Some mergers, such as those of some banks after the 1933 Securities Act, are explicitly prohibited by law. In other markets, such as those of utilities and airlines, the actions of firms were constrained by regulation. After the wave of deregulations that started in the late 1970s, some reallocation of ownership over assets was possible, and many firms elected to take advantage of the new freedom. This is the view that has led many to describe the current merger wave as the result of deregulation.

Figure 3 contrasts merger activity with an index of the degree of government regulation over the past century. The index, based upon data from worksheets underlying Mulligan and Becker (1999), uses the number of pages in the *Federal Register* for 1935 to 1994, the number of pages in the *U.S. Code of Federal Regulations* for 1925-34, and the size of Congressional staffs (from Bibby et al., 1980, pp. 69-71) for 1890-1925. All segments are first normalized by the level of real GDP and then spliced together and adjusted to set 1936=1. The index rises gradually from 1891 through 1945, falls for the next five years, and then commences upon another gradual rise to a high-water mark in 1980. It falls by 48 percent between 1980 and 1986, but has been once again on the rise since. Only between 1980 and 1986 does the series appear to be negatively correlated with merger activity. In fact, the correlation between the two series over the full 1890-1994 period is .483. This relatively large and positive correlation suggests that regulatory theories of merger activity are not well-supported by the available *aggregate* measures of regulatory stance.[8]

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number of cases initiated by the Department of Justice has fallen off dramatically in recent years with respect to the size of the nation's economy.

[7]Posner (1970, section 7) finds that the identity of the political party in power was not correlated with the number of antitrust cases instituted by the Department of Justice in the period 1890-1969.

[8]Becker and Mulligan present other series of government regulation in addition to those that we
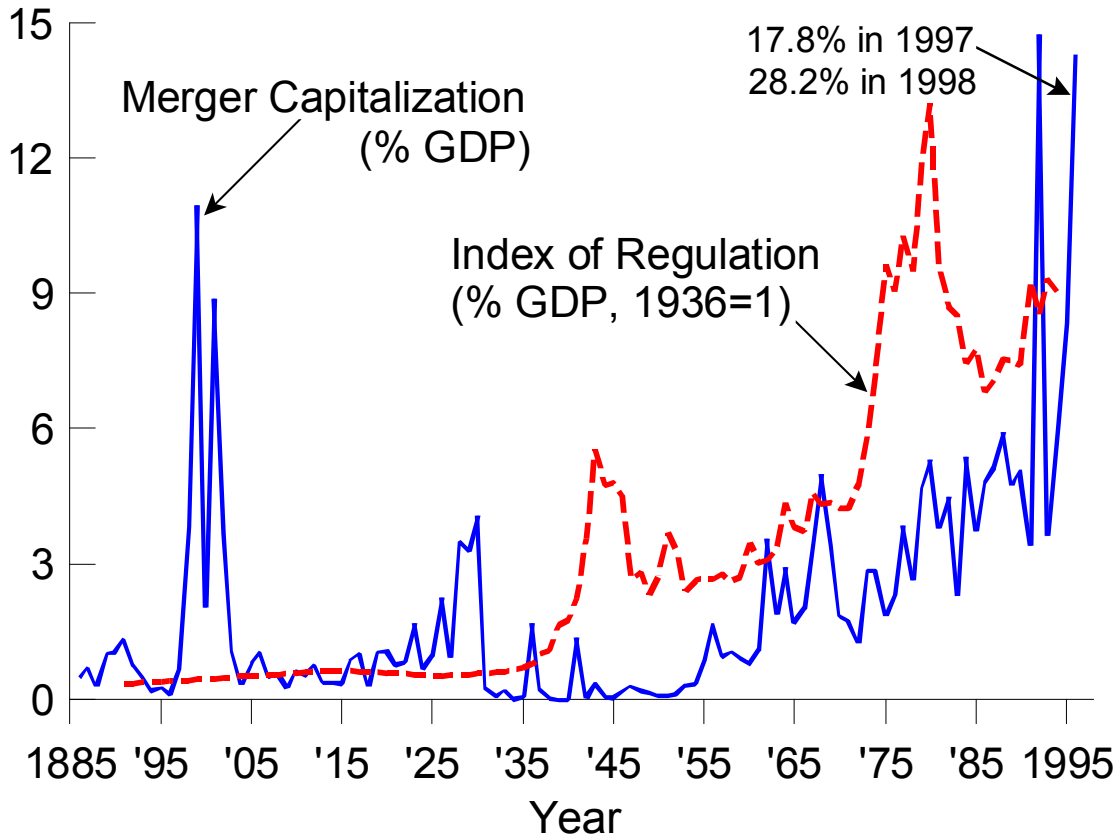
Figure 3: Index of government regulation and merger activity, 1885-1998.

Regulation has responded to technology. The technologically relatively tranquil period of the mid-20th century produced a rise in antitrust activity as it became less important to create a friendly environment for the process of creative destruction, and more important to protect the consumer from established businesses engaged mainly in the refinement of technologies and products that already existed. As creative destruction of technologies returned thirty years ago with the arrival of the microprocessor and the accompanying rise in product innovations, many sectors – airlines, telecommunications, etc. – were deregulated in the U.S. and elsewhere.

use to construct our 104-year index. In particular, they find similar time patterns in the number of U.S. District Civil Court cases from 1960-94 and the size of Congressional member staffs from 1930-94. The ratios of both total government spending (1890-94) and federal government spending (1900-94) to GDP also trend gradually upward throughout the century, with the exception of sharp spikes during the World Wars. When normalized by population rather than real GDP, they also find a gradual upward trend in the number of civil employees.

2.3 Globalization

Measures of trade in goods and assets move too sluggishly to be of help in explaining merger waves. Moreover, the waves occur even if one excludes – as we do throughout – any acquisitions by foreign-based firms. Mergers that involve foreign firms have been rising sharply, but the wave of the 1990s is still the largest of them all even if we restrict mergers only to U.S.-based companies. To be sure, relative to GDP, gross flows of capital across borders are now much larger than they were in 1900, although the net flows have not changed much. Some of these flows may involve foreign capital in the reallocation of capital among managers in the U.S., but this should count as direct foreign investment, and this has not increased much, standing at less than one percent of GDP in 1995. The effect of increased trade has, however, caused (or should have caused) the Government to loosen its antitrust stance.[9] The growth of foreign competition means that we can now allow more mergers without creating monopoly power.

3 Model

This will be an endogenous growth model of the 'Ak' type in which a better ability to reallocate capital raises the growth rate by raising the rate of return to investment. We model a closed economy with a single consumption good and a representative agent. The representative agent has no labor endowment. His income derives from his ownership and trade in the shares of firms. For the final-good producers we combine some features of the models in Lucas and Prescott (1971) and Hopenhayn (1992). That is, we assume that firms face costs of rapid adjustment of the capital stock, and we assume that they can exit. We also allow firms to expand and contract by participating in the merger market. Our firms have constant average cost curves and, hence, no limit to size, but they cannot grow infinitely fast because of costs of rapid adjustment of the capital stock. Firms' efficiencies differ and we interpret these as arising from the quality of their managements.

3.1 Final-goods producers

If a firm's state of technology is z and its capital is k, its output is zk. The firm-specific shock has the Markov transition law

$$\Pr\left\{z_{t+1} \leq z' \mid z_t = z\right\} = F\left(z', z\right).$$

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[9]The share of foreign trade (the sum of imports and exports) to GDP stood at 19% percent in 1890, which was the heyday of what has come to be known as the "golden age of globalization." The World Wars disturbed this pattern of capital market integration, with trade accounting for 9.3%, 9.5%, 9.7% and 11.4% of GDP in 1940, 1950, 1960, and 1970, respectively (Mitchell, 1998, Table E-1, pp. 429-41). The share of trade rose dramatically in the '70's, however, reaching over 21% by 1980 and maintaining this level thereafter.

Evolution of k: The firm can buy capital on the new-capital market, on the used-capital market, or both. Assume that X is the firm's investment in new capital and that Y is its investment in acquired capital (i.e., capital acquired through merger)

$$k' = (1 - \delta) k + X + Y. \tag{1}$$

A firm buys X from capital-goods producers and Y directly on the merger market

Internal costs of adjustment: Let $\hat{C}(k, X, Y)$ be the adjustment cost, assumed homogeneous of degree 1 in k, X, and Y so that we can write

$$\hat{C}(k, X, Y) = k\hat{C}\left(1, \frac{X}{k}, \frac{Y}{k}\right) \equiv kC(x, y).$$

where $x = X/k$ and $y = Y/k$. We shall assume that $C(0,0) = 0$, that C is differentiable, increasing and convex in (x, y), and that it is defined only for nonnegative x and y.

Profits: The price of new capital is unity, and the price of used capital is q. The firm's profit,

$$(z - C(x, y) - x - qy) k,$$

is paid out to shareholders as a dividend.

The optimal investment mix: The cheapest way to accumulate a given amount of capital will, in general, lead a firm to purchase both x and y. More precisely, suppose that a firm wishes to raise its capital stock from k to sk, where $s \geq (1 - \delta)$. The minimized cost of growth, $h(s)$, solves the problem:

$$h(s) \equiv \min_{x \geq 0, y \geq 0} \{C(x, y) + x + qy\} \tag{2}$$
$$\text{s.t. } s \leq 1 - \delta + x + y.$$

The first-order conditions collapse to just one restriction

$$1 + C_1(x, y) = q + C_2(x, y). \tag{3}$$

That is, the firm will invest internally until the marginal cost of internal adjustment equals the price of used capital q. Equations (2) and (3) allow us to solve uniquely for the optimal investment rules $x(s)$ and $y(s)$. Moreover, $h(s)$ is increasing and convex.[10]

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[10] Only the convexity of h is perhaps not obvious. Take two values of s – say s_1 and s_2. Let (x_i, y_i) $i = 1, 2$ be the optimal decisions for the cost-minimization problems indexed by those two parameters. Now from (1) we see that the convex combination

$$(\theta x_1 + (1 - \theta) x_2, \theta y_1 + (1 - \theta) y_2)$$

is feasible when $s = \theta s_1 + (1 - \theta) s_2$. From here, convexity of C leads directly to the convexity of h.

Market value: A firm's market value depends on its capital stock and on the quality, z, of its management. Since all profits go to shareholders, the firm's market value satisfies the Bellman equation

$$V\left(k,z\right) = \max_s \left\{ zk - h\left(s\right)k + \frac{1}{1+r} \int \max\left\{qsk, V\left(sk, z'\right)\right\} dF\left(z', z\right) \right\},$$

which has a solution the form

$$V\left(k,z\right) = v\left(z\right)k,$$

with $v\left(\cdot\right)$ satisfying

$$v\left(z\right) = \max_s \left\{ z - h\left(s\right) + \frac{s}{1+r} \int \max\left\{q, v\left(z'\right)\right\} dF\left(z', z\right) \right\}. \tag{4}$$

This is the firm's value per unit of capital, and it is increasing in z.

Growth: The optimal growth factor

$$s = g\left(z\right)$$

solves the first-order condition[11]

$$h'\left(s\right) = \frac{1}{1+r} \int \max\left\{q, v\left(z'\right)\right\} dF\left(z', z\right). \tag{5}$$

Since h is convex, and since v is increasing, we find that more productive firms grow faster:

Proposition 1 *If F is stochastically increasing in z, $g\left(z\right)$ is an increasing function.*

And, since high-z firms will tend to be larger, we have.

Corollary 2 *Large firms tend to grow faster than small firms.*

3.2   Capital-goods producers

This sector makes new capital and recycles old capital. Capital-goods producers sell capital to final-goods producers – incumbents and entering firms. They can produce capital with one of two constant-returns technologies:

1. A technology that transforms goods into capital one-for-one. Assuming that entry of producers is free, when this technology is in use, the price of new capital that is sold to the consumption-producing sector must be unity.

2. A technology that transforms used capital into new capital as follows: $k_{NEW} = \gamma k_{OLD}$ where $\gamma \leq 1$. This is the recycling technology and here, too, entry of producers is free. Since new capital sells at a price of unity, the price for old capital, at which the capital-goods firms demand it infinitely-elastically, is γ. Therefore a *final goods* producer who scraps his capital and sells it to a capital-goods producer for recycling will receive γ per unit of capital scrapped.

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[11]This condition is similar to the optimal investment condition in Lucas and Prescott (1971). It equates the marginal cost of investment to next period's average Q.

3.3 The market for corporate control

Sellers on this market can be viewed as takeover targets, and buyers can be viewed as acquirers. In this market, the price that a buyer pays per unit of capital will be denoted by q.[12]. Now, if there are any transactions in this market, they must occur at a price q at least as high as γ, or else the targets of the takeover would rather disband than place their capital on this market. On the other hand, if q were ever to exceed γ, no firm would ever disband and exit on its own. Our steady state analysis assumes that mergers and exits are both positive and that, therefore,

$$q = \gamma.$$

The transitional dynamics of the next section will not maintain this assumption

3.3.1 Entry and exit

Exit: A firm can cease to exist in one of two ways. It can sell its capital to capital-goods firms at a price of γ per unit of capital. Its other option is to place its capital on the merger market. The least-productive firm is indifferent between continuing and shutting down, and its efficiency, z_e, satisfies

$$v\left(z_e\right) = q. \tag{6}$$

Since the firm's survival depends on z but not on k, we have the testable proposition:

Proposition 3 *The probability of surviving does not depend on firm size if we control for z*

Entry: The process of entry and exit recycles z too. Re-entering capital carries with it a z that is probably higher than the z of the firm that released it. An entering firm draws z from the distribution $G\left(z\right)$, but, before it does so, it *first* chooses k.

An entering firm that chooses k and then draws z at the start of the next period starts to produce or, if it does not like the z that it has drawn, exits or offers its capital up for sale on the merger market. Entering capital takes a period to become active and, being supplied infinitely elastically, it must earn a zero rent:

$$\frac{1}{1+r} \int \max\left\{q, v\left(z'\right)\right\} dG\left(z'\right) = 1. \tag{7}$$

Therefore entering size k is indeterminate. Only the mass of the entering capital will be determined in equilibrium. Let $A\left(k\right)$ be the cumulative distribution of capital among entrants. and let n_E be the number of entrants. Since entering capital-levels

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[12]Prescott and Boyd (1987) discuss a potential market of this type but then they make assumptions on their model so that no transactions in this market will take place.

k are independent of the subsequent draw of z, the joint distribution function among them is $G(z) A(k)$. The total mass of entering capital is

$$X_{ENTER} \equiv n_E \int k dA(k),$$

and the total mass of capital disappearing because of exit or merger is

$$X_{EXIT} + X_{MERGE} \equiv \int_0^{z_e} k d\Gamma(z, k).$$

. Hopenhayn treats G as exogenous, and so shall we. We shall also treat A as exogenous.

3.3.2 Resource constraints

- *Income identity*: Aggregate output equals consumption plus investment:

$$\int \{z - h[g(z)]\} k d\Gamma(z, k) = c + I. \tag{8}$$

- *Constraint in the market for new capital*: Unconsumed output plus recycled exiting capital must equal capital absorbed by entrants plus new capital demanded by incumbents

$$I + \gamma X_{EXIT} = X_{ENTER} + \int_{z_e} x[g(z)] k d\Gamma(z, k), \tag{9}$$

  where X_{EXIT} is the mass of exiting capital.

- *Constraint in the market for used capital*:

$$\int_{z_e} y[g(z)] k d\Gamma(z, k) = X_{MERGE}. \tag{10}$$

These three resource constraints could be used to eliminate I and n_X and get to a single resource constraint.

3.3.3 Optimal savings

Each consumer has the utility function

$$E\left\{\sum_{t=0}^{\infty} \beta^t U(c_t)\right\}.$$

We do not allow aggregate risk, and we look only at steady state growth. Shocks to dividends will be independent and, since agents hold the market portfolio and have

no labor income, each agent's consumption is a deterministic sequence. The only assets that individuals can hold are shares of "firms" as in Lucas (1978b).

The consumer maximizes utility subject to a wealth constraint. Let

$$U(c) = \frac{c^{1-\rho}}{1-\rho}.$$

The consumer maximizes discounted utility $\sum_{t=0}^{\infty} \beta^t U(c_t)$ subject to the constraint that $\sum_{t=0}^{\infty} c_t / (1+r)^t$ not exceed his wealth. The first-order conditions for an optimum reduce to

$$\frac{\beta U'([1+\theta]c)}{U'(c)}(1+r) = \beta(1+\theta)^{-\rho}(1+r) = 1,$$

so that the discount factor is

$$\frac{1}{1+r} = \frac{\beta}{(1+\theta)^\rho}. \tag{11}$$

3.3.4 Law of motion for $\Gamma(\cdot)$

Fix (z,k). That firm's capital stock next period is

$$k' = \begin{cases} kg(z) & \text{if } z \geq z_e, \\ 0 & \text{if } z < z_e, \end{cases}$$

and its next-period draw of z' has the C.D.F. $F(z',z)$. Therefore, a firm that today is of size k will tomorrow have a capital stock of at most k' as long as its productivity today satisfies the inequality

$$z \leq g^{-1}\left(\frac{k'}{k}\right).$$

Therefore the number of today's incumbents that will have next period's shock and capital not exceeding z' and k' is

$$\int_{k=0}^{\infty} \int_{z=z_e}^{g^{-1}\left(\frac{k'}{k}\right)} F(z',z)\, d\Gamma(z,k).$$

Now if y measure of firms enter, they add $yG(z')$ to the CDF. Thus a constant growth equilibrium requires that there exist a growth-rate θ such that

$$\Gamma(z',[1+\theta]k') = n_E G(z') A(k') + \int_{k=0}^{\infty} \int_{z=z_e}^{g^{-1}\left(\frac{k'}{k}\right)} F(z',z)\, d\Gamma(z,k), \tag{12}$$

and such that n_E grows at the rate θ.

When (12) holds, the distribution of capital expands at the rate θ. The number of firms of type (z,k) today is $\Gamma_{1,2}(z,k)$. The number of firms of type $(z,[1+\theta]k)$ tomorrow is $\Gamma_{1,2}(z,[1+\theta]k)$. And that is what happens when (12) holds.

4   A merger wave

So far we have an economy in a constant growth equilibrium in which a constant fraction of firms is merging. To get a wave we need a shock. The shock that does this is a technological improvement that rearranges comparative advantage. We shall illustrate the full dynamics with a special case that begins with a constant growth path on which there are no mergers and no exits. Then we shall subject the economy to a technological shock that calls for reallocation and therefore sets off both exits and mergers along the transition path to the new and higher constant growth path that, once again, does not involve exits or mergers.

4.1   Before the shock

Suppose that the economy is on a constant-growth path before the shock. Let $\delta = 0$ and let $F(z', z)$ be such that z never changes, or, rather, that no one expects it to ever change, and suppose that somehow the economy finds itself in a situation where all firms are at z^0. Moreover, assume that $G(z)$ also puts all of its mass at z^0. There are no mergers and no exit because firms are homogeneous. All growth in capital and output thus takes place through entry. This is because entrants are of the same quality as incumbents and pay the same price for their capital as incumbents (i.e. unity) yet do not have to pay the adjustment cost of internal growth. If k is capital per head, we have

$$c + I = z^0 k,$$

$$k' = k(1 - \delta) + I$$

so that the growth factor is

$$1 + \theta = \frac{k'}{k} = 1 - \delta + \frac{I}{k} = 1 - \delta + z^0 - \frac{c}{k},$$

the consumption to income ratio is

$$\frac{c}{z^0 k} = \frac{z^0 - \theta - \delta}{z^0},$$

and the consumption to capital ratio is just $z^0 - \theta - \delta$. Now in (4) since incumbents do not invest, $s = 1 - \delta$ and

$$
\begin{aligned}
v\left(z^0\right) &= z^0 + \frac{1 - \delta}{1 + r} v\left(z^0\right) \\
&= \frac{1}{1 - \frac{1 - \delta}{1 + r}} z^0 \\
&= \frac{1 + r}{r + \delta} z^0.
\end{aligned}
$$

Using (7) and the fact that

$$\int \max \{q, v(z')\} \, dG(z') = v\left(z^0\right) = \frac{1+r}{r+\delta} z^0,$$

the condition governing optimal investment through entry is

$$\frac{1}{1+r} v\left(z^0\right) = \frac{z^0}{r+\delta} = \frac{z^0}{\frac{(1+\theta)^\rho-\beta}{\beta}+\delta} = 1$$

because from (11)

$$r = \frac{(1+\theta)^\rho - \beta}{\beta}.$$

Therefore the growth rate of the economy is

$$\theta = \left[\beta\left(1 + z^0 - \delta\right)\right]^{1/\rho} - 1 \tag{13}$$

which, as we would expect, increases in β, z^0, and (as long as growth is positive) decreases in δ and in the curvature parameter ρ.

Because no reallocation takes place in equilibrium, the reallocation costs $C(\cdot)$ and $1-\gamma$ do not affect long-run growth. This result is special; in general a lower $C(\cdot)$ or a higher γ should raise long-run growth.

4.2   After the shock

Let us suppose that we get a shock at date 0 that permanently raises the support of G from z^0 to z^1. This represents the arrival of a new technology. We also allow a small fraction μ of incumbents to experience a jump from z^0 to z^1. The presence of these enlightened incumbents ensures that the acquisitions market opens as soon as the shock occurs.[13]

4.2.1   The equilibrium adjustment path:

Let us describe the equilibrium in words before constructing it formally.

- If γ is relatively high, some of the incumbents exit immediately, at date 0. No further exit occurs after that. If γ is low and, in particular, if $\gamma = 0$, no firm ever exits.

- If μ is vanishingly small, no incumbents are taken over at date 0 because the efficient firms have not yet had time to enter.

---

[13]Radically new technologies are usually brought in by new entrants. Such was the case with electricity – GE and Westinghouse (IPO'd in 1892) – and with the microcomputer – Microsoft and Apple (IPO'd in 1986).

- At date 1, the first efficient entrants arrive carrying z^1. They immediately start taking over the remaining z^0 firms.

- When all of them are gone, the economy is again on a steady-state growth-path but with a higher rate of growth, $\theta = [\beta(1+z^1)]^{1/\rho} - 1$, the ratio of consumption to output is

$$\frac{c}{z^1 k} = \frac{z^1 - \theta - \delta}{z^1},$$

and the consumption to capital ratio is $z^1 - \theta - \delta$.

In the remainder of this section superscripts denote types while subscripts denote time subscripts or partial derivatives. Let v_t^i $(i = 0, 1)$ be the value of capital in firms with efficiency z^i. As we noted, $x = 0$ for all incumbents because entrants can bring capital in at a cost of unity whereas incumbents face an additional internal adjustment cost. On the other hand, a z^1 incumbent can buy a z^0 incumbent and absorb his capital.

The value functions For a z^1 firm the growth factor is

$$s = 1 - \delta + y,$$

its investment costs per unit of capital are

$$h(1 + y) = q_t y + C(0, y),$$

the unit value of its capital is

$$v_t^1 = \max_{y \geq 0} \left\{ z^1 - q_t y - C(0, y) + \frac{1 - \delta + y}{1 + r_t} v_{t+1}^1 \right\}, \tag{14}$$

and its capital acquisition, y_t, solves

$$q_t + C_2(0, y) = \frac{1}{1 + r_t} v_{t+1}^1. \tag{15}$$

Since all entering firms are of type z^1, for profits to entry to be zero we must have

$$\frac{1}{1 + r_t} v_{t+1}^1 = 1. \tag{16}$$

Then, (15) simplifies to

$$C_2(0, y_t) = 1 - q_t, \tag{17}$$

and (14) simplifies to

$$\begin{aligned} v_t^1 &= \max_{y \geq 0} \left\{ z^1 - q_t y - C(0, y) + 1 - \delta + y \right\} \tag{18} \\ &= 1 + r_{t-1} \end{aligned}$$

in view of (16). This equation must hold whenever the acquisitions market is active, which will be the case for a finite number of periods, $t = 0, 1, \ldots T$.

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Deriving the q_t sequence A z^0 firm will invest neither in x nor in y. Suppose that some mergers take place in each of T periods after the shock. Then the z^0 incumbents are, at each t, indifferent between selling out and continuing another period. In this case

$$v_t^0 = q_t = z^0 + \frac{1-\delta}{1+r_t} q_{t+1}.$$

for $t = 0, 1, 2, ... T - 1$. Then $(q_t)_{t=0}^{\infty}$ satisfies the difference equation

$$q_{t+1} = \frac{(1+r_t)}{1-\delta} \left(q_t - z^0 \right). \tag{19}$$

Now solve (17) for y_t in terms of q_t, and call the result $y_t = D(q_t)$. Then we can combine (19) with (18) to obtain

$$q_{t+1} = \frac{(1 + z^1 + (1 - q_{t+1}) D(q_{t+1}) - C(0, D(q_{t+1})))}{1 - \delta} \left(q_t - z^0 \right).$$

If we assume that $C(0,y) = y^2/2\alpha$, then $D(q_t) = \alpha(1 - q_t)$ and $C(0, D(q_t)) = \alpha(1 - q_t)^2/2$ so that

$$q_{t+1} = \frac{\left(1 + z^1 + \frac{\alpha}{2} (1 - q_{t+1})^2 \right)}{1 - \delta} \left(q_t - z^0 \right)$$

or

$$q_t = z^0 + \frac{(1-\delta) q_{t+1}}{\left(1 + z^1 + \frac{\alpha}{2} (1 - q_{t+1})^2 \right)}. \tag{20}$$

Observe that the right-hand side is monotonically increasing in q_{t+1} on the region $q_{t+1} \in [0, 1]$. If, as is likely, q_t is an increasing sequence, and if exit does take place at date zero, then $q_0 = \gamma$ is our initial condition, and we can solve this difference equation for q_t uniquely. From there we can use (19) to calculate the sequence (r_t) and solve for entry and exit by consulting the laws of motion and income identities. A merger wave ends when all old capital vanishes either through exit or merger.

Note also that period T is the first period in which there are no z^0 incumbents left. The adjustment cost $C_2(0,0) = 0$, which means that the demand price for merged capital is 1, and so if we were to require that the $T - 1$ merged exits are indifferent between exit at $T - 1$ and T, we would have the condition

$$q_T = 1. \tag{21}$$

It is helpful to maintain this condition for the time being; it is sufficient but not necessary, as we shall see presently.

As mentioned above, the sequence of q_t values that renders the participating firms indifferent between the various merger dates, including the date T, is precisely the backward recursion

$$q_t = z^0 + \frac{(1-\delta) q_{t+1}}{1 + z^1 + \frac{\alpha}{2} (1 - q_{t+1})^2} \equiv \Phi(q_{t+1}) \tag{22}$$

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for $t = T - 1, T - 2, ...,$ with (21) as the initial condition. Further, if

$$\frac{(1 - \delta)}{1 + z^1} + z^0 < 1$$

$\Phi(1) < 1$. Moreover, $\Phi'(q) > 0$, which means that the iterates of Φ generated backwards from unity will be decreasing or, what is the same thing, the sequence of q's thus generated will be increasing in t.

Now we explain why (21) is only sufficient, and we derive the sufficient conditions. Equilibrium allows that all surviving z^0 firms strictly prefer exiting at date $T - 1$ to exiting at date T. Therefore, also admissible are paths for which (22) holds for $t = T - 2, T - 3, ...,$ and for which

$$1 \geq q_{T-1} \geq z^0 + \frac{1 - \delta}{1 + z^1}.$$

All sequences (q_t) that satisfy this pair of inequalities at $T - 1$ and that also satisfy (22) meet the requirement that z^0 firms are indifferent about when they exit for $t < T$, and that they prefer (possibly weakly) any date earlier than T. When the right-hand inequality binds, the firms are indifferent between exit at $T - 1$ and T.

Lemma 4 *Any parametric change that reduces $\Phi(q)$ for all $q \in [0, 1]$ means that the iterates of Φ decline more sharply, and that the sequence (q_t) ascends more steeply in t. And this means, in turn, that there will be fewer consecutive dates, t, for which $q_t \in [\gamma, 1]$.*

Together with the observation that for all $q \in (0, 1)$

$$\frac{\partial \Phi}{\partial z^0} > 0, \frac{\partial \Phi}{\partial \delta} < 0, \frac{\partial \Phi}{\partial z^1} < 0 \ \text{and} \ \frac{\partial \Phi}{\partial \alpha} < 0,$$

and we end up with

Proposition 5 *The period of time during which mergers are the reallocation mechanism is increasing in z^1, α, and δ, and it is decreasing in z^0 and γ.*

Some comments on this result:

1. The bigger is z^1 relative to z^0, the bigger the return from reallocating capital from the low-z to the high-z firms, and the quicker this will be accomplished according to the proposition.

2. The higher is γ, the more efficient is the entry-exit mechanism of reallocation, and the less need there is for mergers.

3. The bigger is δ, the less inefficient capital survives, and, hence, the quicker the reallocation process is completed.

4. The higher is α, the cheaper it is to absorb the capital of other firms, or the more adaptable it is.
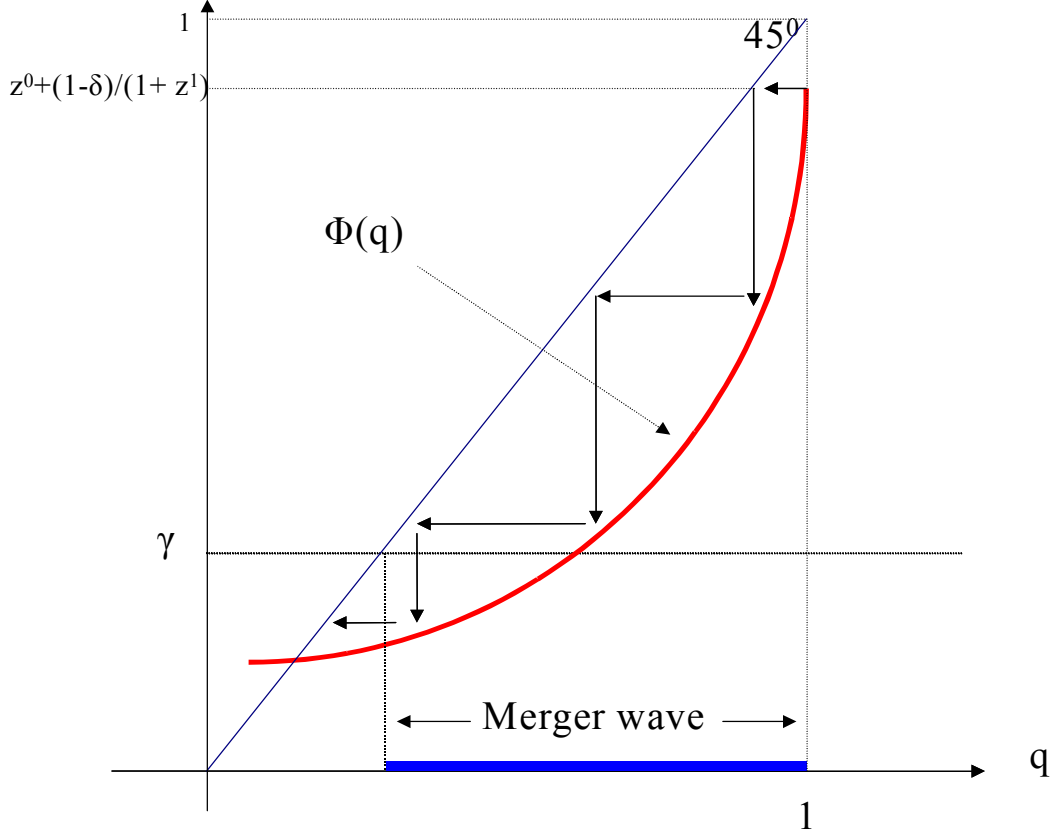
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Figure 4: How the length of a merger wave is determined.

Identities and Simulation results: Let k_t^i denote the measure of capital in firms of type $i \in \{0, 1\}$. Consumption, c_t, plus investment, X_t^{ENTRY}, must equal aggregate output plus capital released by exits, X_t^{EXIT}:

$$c_t + X_t^{ENTRY} = z^0 \left(k_t^0 - X_t^{EXIT} \right) + \left[z^1 - C\left(0, y_t\right) \right] k_t^1 + \gamma X_t^{EXIT}. \qquad (23)$$

Moreover, the two categories of capital evolve as follows

$$k_{t+1}^1 = k_t^1 \left(1 - \delta + y_t\right) + X_t^{ENTRY} \qquad (24)$$

and

$$k_{t+1}^0 = k_t^0 \left(1 - \delta\right) - y_t k_t^1 - X_t^{EXIT} \qquad (25)$$

where X_t^{EXIT} satisfies

$$\left\{ \begin{array}{l} X_t^{EXIT} > 0 \Longrightarrow q_t = \gamma, \text{ and} \\ \quad q_t > \gamma \Longrightarrow X_t^{EXIT} = 0. \end{array} \right. \qquad (26)$$

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Finally, if the date-zero capital stock is k_0,

$$k_0^0 = (1 - \mu) \, k_0 \quad \text{and} \quad k_0^1 = \mu k_0.$$

All variables will be proportional to k_0, and if we assume that $k_0 = 1$, then

$$k_0^0 = 1 - \mu \quad \text{and} \quad k_0^1 = \mu.$$

On the last date of the merger wave we revert to balanced growth. Let T be the first date when k^0 becomes zero. We then have the additional restriction that

$$c_T = \left(z^1 - \theta - \delta \right) k_T^1.$$

This restricts r_{T-1} to satisfy

$$
\begin{aligned}
1 + r_{T-1} \;&=\; \frac{1}{\beta} \frac{c_T}{c_{T-1}} = \frac{1}{\beta} \frac{\left(z^1 - \theta - \delta \right) k_T^1}{z^0 k_{T-1}^0 + \left[z^1 - C\left(0, y_{T-1} \right) \right] k_{T-1}^1 - X_{T-1}^{ENTRY}} \qquad (27) \\[2mm]
&=\; \frac{1}{\beta} \frac{\left(z^1 - \theta - \delta \right) k_T^1}{z^0 k_{T-1}^0 + \left[z^1 - C\left(0, \frac{k_{T-1}^0}{k_{T-1}^1} \right) \right] k_{T-1}^1 - X_{T-1}^{ENTRY}}
\end{aligned}
$$

because in the next-to-last period all remaining capital is acquired:
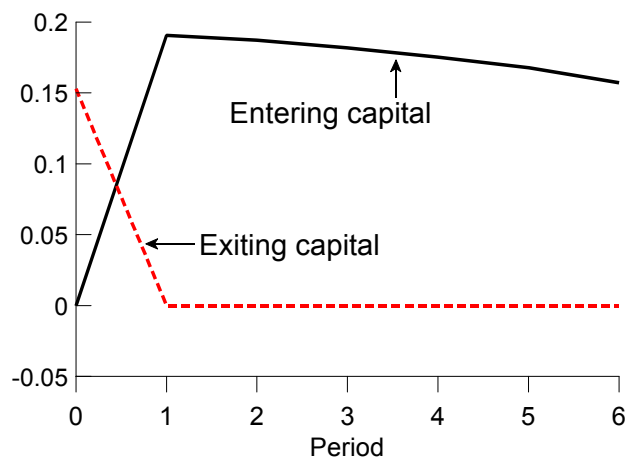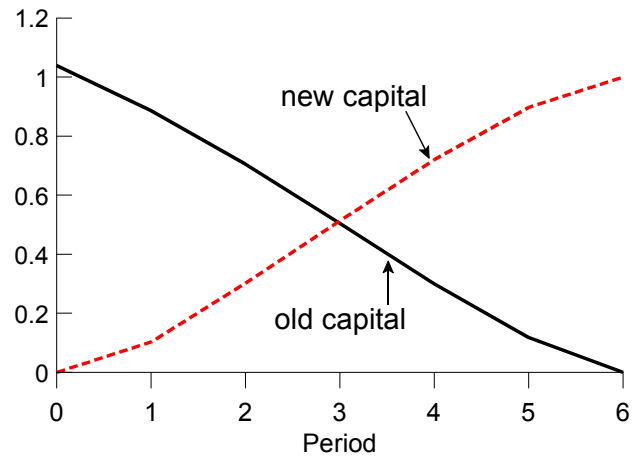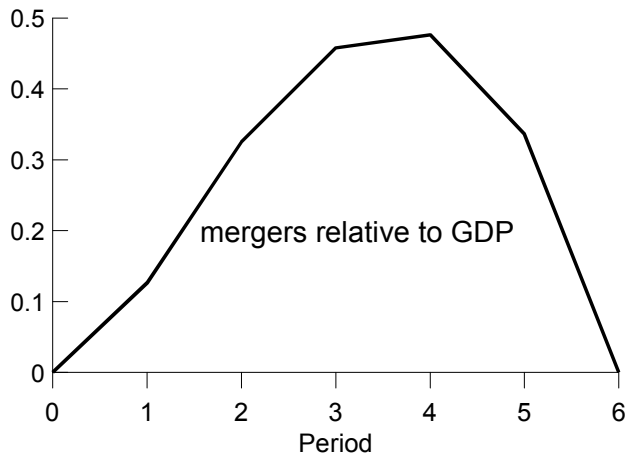
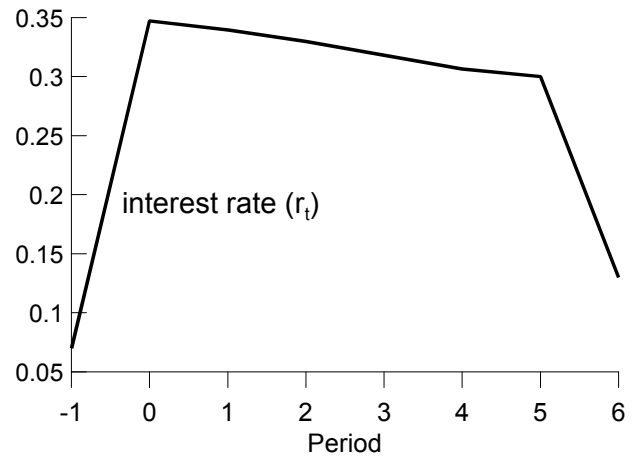$$y_{T-1} k_{T-1}^1 = (1 - \delta) \, k_{T-1}^0$$
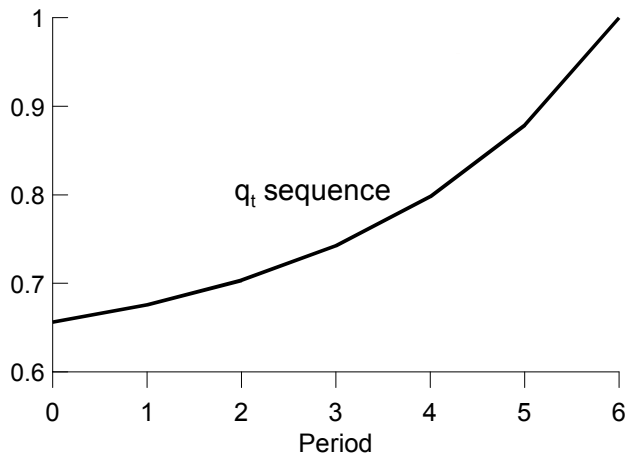
so that

$$y_{T-1} = (1 - \delta) \frac{k_{T-1}^0}{k_{T-1}^1}.$$

Working backwards, we can write (27) as

$$
1 + r_{T-1} = \frac{1}{\beta} \frac{\left(z^1 - \theta - \delta \right) \frac{k_T^1}{k_{T-1}^1}}{z^0 \frac{k_{T-1}^0}{k_{T-1}^1} + \left[z^1 - C\left(0, \frac{k_{T-1}^0}{k_{T-1}^1} \right) \right] - \frac{X_{T-1}^{ENTRY}}{k_{T-1}^1}}
$$

Now we have 2 unknowns: $\frac{k_T^1}{k_{T-1}^1}$ and $\frac{X_{T-1}^{ENTRY}}{k_{T-1}^1}$. But from (24),

$$\frac{k_T^1}{k_{T-1}^1} = (1 - \delta + y_t) + \frac{X_{T-1}^{ENTRY}}{k_{T-1}^1} \qquad (28)$$

Figure 5. Simulated transitional dynamics.

Model settings:
$z_0 = 0.24$, $z_1 = 0.30$,
$\gamma = 0.66$, $\alpha = 0.90$,
$\delta = 0.17$, $\beta = 0.96$,
$k_0 = 1$, $\mu = 0$,
$r_0 = 0.07$, $r_1 = 0.13$.

This allows us to compute the ratios in question and, since we also know k_T^1, we can figure out k_{T-1}^1, k_{T-1}^0 and X_{ENTRY}. At that point, we iterate on (27) using the denominator as the numerator for the next iteration, updating the subscripts in the denominator to those of the preceding period, and using the laws of motion as before. When q reaches γ, we have reached the point of the initial shock, and can now use the laws of motion and γ to compute the amount of capital that exits with the shock and re-enters as new capital during the first period.

Figure 5 illustrates the transitional dynamics of the system for a choice of parameter settings. We choose $\gamma = 0.9$ to generate exit in the period that the shock arrives and, by setting $\mu = 0$, force entrants to be the only acquirers. Given that the capital stock includes both physical and human capital and that output in the initial steady state is $z^0 k_0$ with $k_0 = 1$, we set $z^0 = 0.24$. When the technology shock hits, we assume that z rises by 25 percent so that $z^1 = 0.30$.

The upper left panel shows the evolution of q_t over six periods following the technology shock from its initial value, γ, up to unity. Incumbents rise in value as the merger wave proceeds. In this simulation, then, the merger wave happens while the stock market is rising on its way to a new high.

The upper right panel shows the time-path of the interest rate. It pre-shock value is 7 percent, and it then jumps sharply to nearly 35 percent before falling gradually to its new, and higher steady state level of 13 percent. The interest rate along the transition path is computed using (19).

The center left panel shows the ratio of merger capital to output as the wave progresses. The ratio rises gradually at first and then more sharply, leveling off to a peak after 4 periods. The ratio then quickly drops off. This pattern matches the merger waves of the late '20's, '60's, and '80's that we depict in Figure 1 remarkably well, and fits the approximate length of all four merger waves, including that of the turn of the 20th century. The center right panel shows the evolutions of the stocks of old and new capital. Old capital is depleted at first by exit as the $z-$shock arrives, and then declines more gradually through merger until it is extinguished completely. Thus, after six periods the merger wave ends and the economy achieves the new and higher steady-state growth path. New capital rises gradually throughout the model's time horizon. The lower panel depicts entry and exit in the model, with all exit occurring in the first period and entry falling off gradually after a sharp initial rise.

5   Other Properties of the model

The premise of the model – that mergers are caused by technological change –   is supported by cross section analysis. The two most recent merger waves were clearly concentrated in the high-tech sectors, and so was some earlier merger activity. Using Ralph Nelson's data that cover the 1895-1920 period, Telser (1987, ch. 8) finds that mergers were more intense in rapidly growing industries. Similarly, for the 1951-59

period, Gort (1969) finds that mergers were more intense in sectors that hired more technically trained personnel.

The model has no span of control limitations. A large firm grows as easily as a small one. Its growth depends only on its z. There is no optimal firm size, only optimal growth.[14]

5.0.2 The positive relation between mergers and stock prices

Figure 1 shows the positive relation between mergers and stock prices. The model explains this if merger waves occur after major technological change. The first panel of Figure 5 shows that the model generates a positive relation between mergers and stock prices: as mergers pick up, the stock price of the date-zero incumbents rises.

The model has just one kind of output. Because of this – and in contrast to the models of Greenwood and Jovanovic (1999) and Hobijn and Jovanovic (forthcoming) – in this model the arrival of the new technological vintage is good news for incumbents. Even the inefficient incumbent will enjoy a rise in value: The new technology has produced a new generation of high-valued entrants who bid up the values of the inefficient incumbents as they gobble them up.

5.0.3 The empirical distribution of market-to-book values, $v(z)$

If k is measured properly by book value, $v(z)$ is the firm's market-to-book value and, since there are no inventories, it is the firm's average and marginal Q. Thus, although the distribution of firm size is indeterminate, the model has a unique prediction about the cross-section distribution of market-to-book values. An empirical cross-section distribution of $v(z)$ is plotted in Figure 6 using the COMPUSTAT data in 1998.[15]The highly skewed nature of the distribution reflects, we think, the fact that some firms' k's are not on the books but are in the form of intangibles. Other measures for a firm's $v(z)$ will be needed.

A rise in the dispersion of stock prices per unit of capital invested probably signals some technological event, as Gort (1969) argued. Therefore we shall need to get snapshots of the distribution of the $v(z)$'s at earlier dates as well. According to our

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[14]Jovanovic (1993) considers the case in which a loss of control arises in a larger or a more diversified firm and derives conditions under which larger firms will also be more diversified.

[15]Figure 6 is the frequency distribution of market to book values for all 6,051 firms listed in the combined CRSP and Compustat files in 1998 that include a book value suitable for computation. Market values represent common equity only, while book values correspond to the firm's residual claim. The residual book claim is the sum of common shares valued at par and any premia on stock, surplus, retained earnings, and net undivided profits that might appear on the firm's consolidated balance sheet. We omitted firms with negative values for net common equity from the plot since they imply negative market to book ratios. We also excluded firms with market to book ratios that exceeded 100, since our "residual" definition of book equity could at times be negligible even though the firm's total liabilities were quite large.
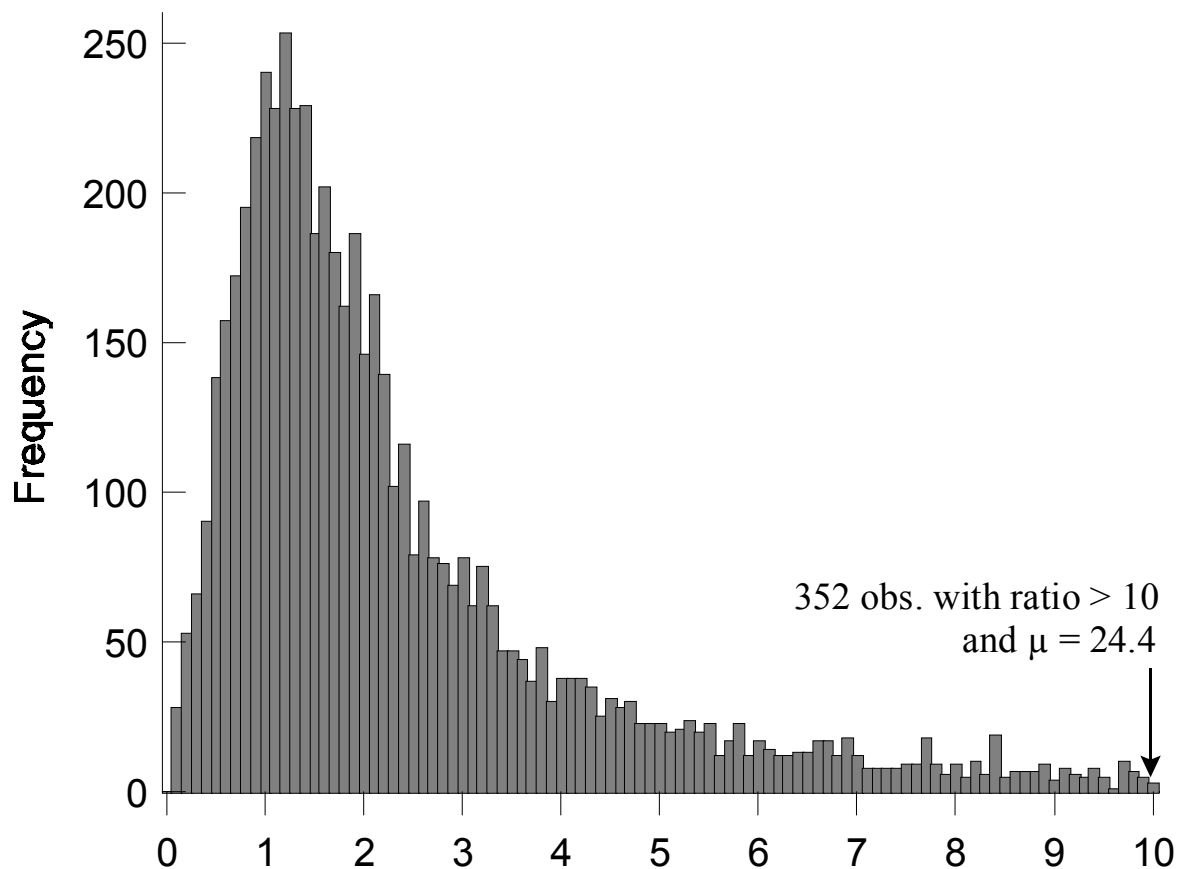
Figure 6: Market to book ratios for 1998 CRSP/Compustat firms.

model, a rise in the dispersion of these values should signal the onset of a merger wave.

If a firm experiences a rise in z, it will grow. It can use both margins to do so – internal investment and the acquisition of external capital, and the two types of growth (internal and external) are positively related. Acquirers should have higher productivity (z) than the targets. Lichtenberg and Siegel (1987) find that the TFP of targets was low, and at least 4 percent lower than that of other firms in the same industries. Elsewhere they show that leveraged buyouts lead to higher-than-average productivity growth. Also, Andrade and Stafford (2000) find that merger and non-merger investment are positively related to the Tobin's q of the acquirer.

5.0.4 Mergers, entry and exit

Exit and entry are less efficient a recycling tool than are mergers, for the following two reasons:

1. Exiting capital is taxed, as it were, before it can re-enter. The effective "tax" on the re-entry of capital is $1 - \gamma$. If the economy can reallocate capital through mergers, it can escape this tax.

2. Incumbents know their z, and they can choose how much capital to buy on the retired capital market. Entrants, on the other hand, do not know their z, and have to choose their entering capital before they know it. Therefore mergers reallocate capital more efficiently in the sense that they serve comparative advantage better.

Mergers have an offsetting disadvantage, however, in that they impose adjustment costs on incumbent firms qualitatively similar to the adjustment costs that the purchase of new capital imposes on them. Since the adjustment cost function is convex, we can hope for an equilibrium in which both types of adjustment are positive. To see what it might take to get such an outcome, consider two extreme cases:

- CASE 1: $\gamma = 0$. In this case $q > \gamma = 0$, no firms exit and all reallocation occurs through mergers.

- CASE 2: $\gamma = 1$. Now the price of merged capital would be the same as the price of new capital, but some mergers would still take place unless the adjustment cost were of the extreme form $C(x + y)$, in which case the division of capital between exits and merger would be arbitrary.

If we were to write $C(x, y) = C(x + y)$, used capital would have to trade at the same price as new capital. This implies that q (which we shall define presently) would have to equal unity at all times.

Since it takes one period to reallocate capital and make it productive somewhere else, z must be autocorrelated in order for reallocation to take place. That is,

Proposition 6 *If z is not serially correlated $X_{MERGE} = 0$. That is there are no mergers. If, in addition, $\theta > 0$, then $X_{MERGE} = X_{EXIT} = 0$ – there is no exit.*

PROOF: If z is uncorrelated, the right-hand side of (5) does not depend on z. In other words, $g(z)$ is then a constant and all firms have the same s. Now, the cost-minimization problem defined in (2) and leading to condition (3) does not involve z. Therefore neither x nor y depend on z.

A central implication is that mergers should be related to *gross* entry and exit of firms because these are two substitute ways of reallocating resources to the best managers, and substitute ways of recycling the stock of organization capital. On the other hand, mergers should not be related to *net* entry except perhaps (and this remains to be proved) when adverse aggregate shocks cause consolidations. The logic works, at least, when net entry is positive: If an aggregate shock raises the return to
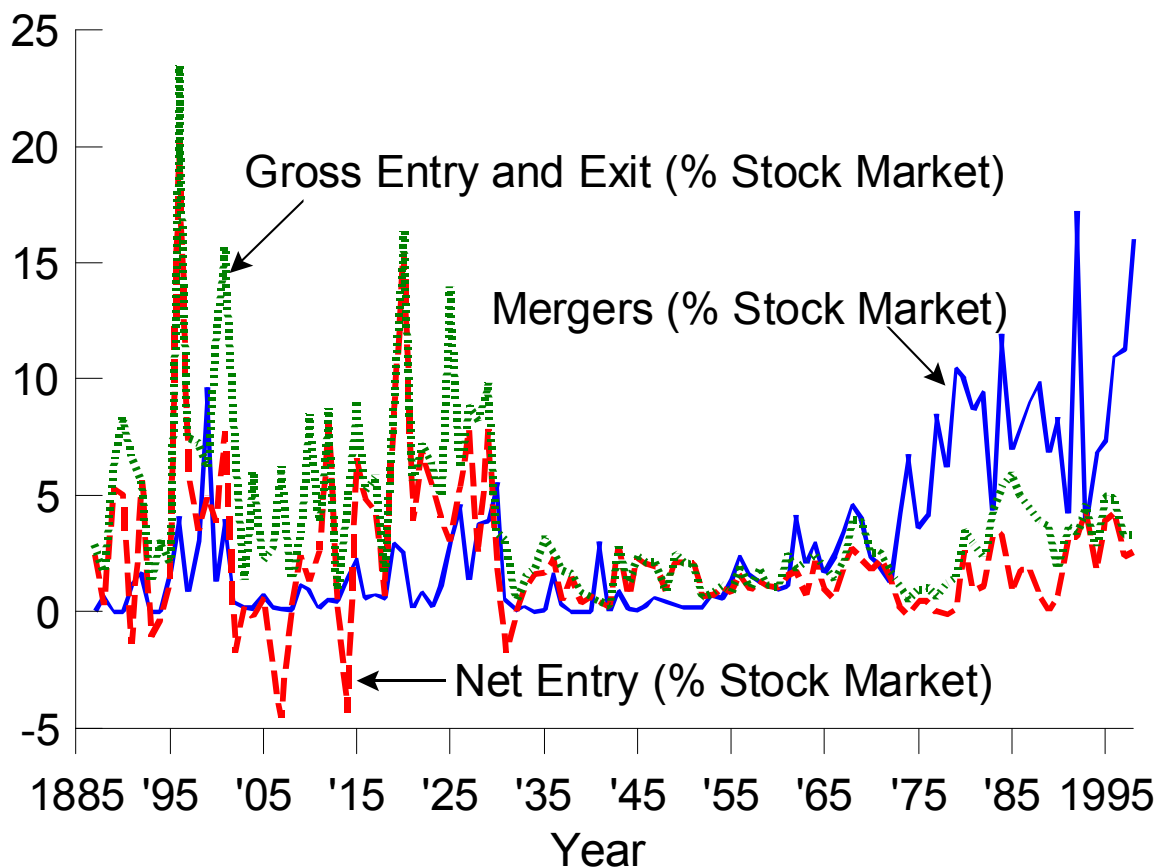
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Figure 7: Mergers and net entry capital for exchange-listed firms as shares for stock market capitalization, 1885-1998.

investment, we should have more capital and therefore we should have more entry, but this does not call for reallocation.

Figure 7, which depicts the capital involved in mergers, net entry of capital (entry less exit), and gross entry and exit (entry plus exit) for exchange-listed firms as percentages of total stock market capitalization in each year, confirms these implications of the model resoundingly – mergers are highly correlated with gross entry and exit activity but far less correlated with net entry. Table 1 shows the correlations of the series after detrending, and includes both the entry and exit components as well. Since firm entries and exits are restricted to exchange-listed firms, we restrict the merger totals also to include only those that involve listed firms.[16] The exit component of

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[16]We obtained information on individual mergers from worksheets underlying Nelson (1959) and Eis (1968) for the 1895-1925 period, which restricts the sample further to include only manufacturing and mining firms in those years. For 1885-94, we collected information on mergers from the financial news section of weekly issues of the *Commercial and Financial Chronicle.* See footnote 1 for sources

our series excludes firms that de-list due to acquisition by other listed firms.

Table 1 –Correlations of Mergers, Firm Entry and Exit, 1885-1998

	Mergers	Entry	Exit	Entry+Exit	Net Entry
Mergers	1				
Entry	.361	1			
Exit	.260	.125	1		
Entry+Exit	.412	.944	.445	1	
Net Entry	.259	.934	-.239	.763	1

Note: the table includes correlations of series that are expressed as
percentages of total stock market capitalization and then detrended.

We can summarize the implications for the growth and exit of firms as follows A large firm grows as easily as a small one. Its growth depends only on its z. There is no optimal firm size, only optimal growth because the model has no span of control limitations. [17] Since the firm's survival depends on z but not on k, we have the testable proposition:

Proposition 7 *The probability distributions of growth and of survival do not depend on firm size if we control for z*

6 Conclusion

Entry and exit is one recycling mechanism for capital and mergers and acquisitions are another. An advantage of economies that are financially developed and that, in particular, have a liquid stock market, is that they can discipline poor management and restructure failing companies more easily than can economies that do not have these means at their disposal. This was the implicit message in Manne (1965), and we have modelled things that way. New capital and acquired capital are two ways to grow. In response to some shocks, firms will move the same way along both margins; in response to others, they will utilize one margin at the expense of the other.

One thing that writers have stressed is that mergers and acquisitions are a less painful way to restructure assets than entry and exit. Transactions on the used capital market escape the "restructuring tax" $1 - \gamma$. The higher is γ, the greater the social benefit that mergers offer.

But this is only one part of the gain to mergers. When an economy can more easily cleanse its capital stock, the incentive to create new capital will rise. Cross-country evidence on financial development has shown (e.g., Atje and Jovanovic 1993; Rousseau and Wachtel 2000) that financial development, including that of a stock

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of merger data for 1926-98.

[17]Jovanovic (1993) considers the case in which a loss of control arises in a larger or a more diversified firm and derives conditions under which larger firms will also be more diversified.

market, is positively related to growth. Traditionally, one thinks of this fact as the result of looser financial constraints. What we show here is that the recycling role of stock markets may be a second, competing explanation for the positive relation between finance and growth.

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