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Abstract Financial engineering is an art, not a science. The core of the subject is how to camouflage increases in leverage as the source of raised earnings on equity capital. This article explores how and why demand for financial engineers grows globally under the influence of inflationary U.S. monetary policy and how a boom in their profession contributes importantly to the potentially devastating effect of monetary inflation on economic prosperity. It proceeds to consider the extent to which foreign countries, large or small, would take steps to counter their vulnerability to the financial engineers, with particular reference to the case of the emerging markets and Japan who have experienced at times the maximum impact. Of course, the most effective defense is monetary, but for many reasons detailed here, this has rarely been implemented.

Keywords Financial engineering · Irrational forces · Transactions costs · Cycles in leverage · Private equity bubble · Equity buy back boom · Corporate leverage · Convergence · Emerging markets · Carry trades

JEL B53 · E43 · E44 · E58 · F31 · F34 · G12 · G13 · G15 · G32 · G41

Financial engineers strive to add to shareholder value by working on the capital structure of the firm, equivalently changing the mix of outstanding securities (including bank loans). It is not their job to find or exploit investment opportunity as that is for the entrepreneur. They may be able to increase the potential capital available for a given opportunity set of projects via skillful design of securities. The main job of the financial engineer, within this specification, is to explore alternative ways of altering the leverage ratio (mixture of debt and equity finance) of the business in question and identify which can best fit the given purpose.

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In the idealized setting described in corporate finance theory, the financial engineer would find all efforts futile. According to the so-called Modigliani-Miller theorem, changes in the leverage ratio or any other type of change in the mix of securities outstanding cannot alter the total market value of the firm (the sum of all its securities, whether debt or equity) (Modigliani and Miller 1958; Miller 1988; Titman 2001). The key insights here are that the individual investor could have replicated on his own any change in leverage or more generally capital structure that the company could achieve. If markets for contingent income in different states of the world are near-complete, then re-packaging income among different securities would not alter the total value of the mix. There is no reward for the corporate financial engineer's work. For example, instead of the firm increasing leverage, individuals could reduce the share of safe bonds in their portfolios or increase the amount of personal borrowing against it but the end result would be the same.

In the real world, a whole host of factors could rescue the financial engineer's work mission. As some debt securities outstanding may have imperfect seniority covenants, introducing more debt may lower their value to the benefit of pre-existing equity holders. The securities may be so complex in nature, though attractively packaged, that the engineer might be able to fool one group of investors or lenders to the benefit of another group, most importantly the equity owner. Alternatively, there may be substantial costs of going through the bankruptcy process. In that case, the engineer should calculate the optimal leverage ratio which would reduce costs in actuarial terms to the most efficient level from the viewpoint of the equity holders assessing trade-offs between risks and potential returns. In this regard, an increase in the leverage ratio might allow the entrepreneur to maintain a controlling equity ownership, saving on the alleged costs of public ownership and the associated short-term reporting requirements. Finally, there are the tax aspects, that are less clear than at first glance.

According to the standard presentation, interest cost is deductible from profit before taxes, providing an incentive to increase leverage to the point at which other costs of leverage (e.g., potential bankruptcy costs) increase into equivalence with the present value of the tax saved (calculated at the margin). In this argument, however, the focus is exclusively on taxation of income generated by the corporation (calculated before deduction of interest) while still upstream (in particular corporation tax). However, one should also take into account the tax on income as it proceeds downstream from the original gross profit source to cash or wealth gain in the hands of stakeholders (debt and equity holders) whether categorized as, for example, interest income, capital gains, or dividends. That part of profits which turns into interest income on the way to the respective stakeholder is subject (at the level of individual taxation) to potentially high marginal rates of tax, an offset to the fact that at the source, this may not be subject to the basic corporate tax rate. By contrast taxation of dividends might be at a much lower rate than interest income (specifically for the effective rate on real income adjusted for inflation). Capital gains tax may be low especially with respect to non-realized gains. Even so, the complexity of taxation systems and the heterogeneity of investors with respect to tax treatment (both within the U.S. and globally) should provide some scope for financial engineers to use their skills.

Irrational Forces Increase Scope for Financial Engineering

After allowing for irrational market forces, the scope for financial engineering increases substantially. This is where monetary inflation comes into our discussion. Monetary

inflation strengthens irrational forces in various ways in the financial marketplace. For example, insofar as the effect on return to safe assets is often compression into negative territory, inflation may encourage irrational behaviour of the form analysed by Kahneman (2011) in his development of prospect theory.

Specifically, if you offer someone the choice between certain loss and a bad bet (the expected utility value of a bad bet is more negative than for certain loss), most choose the bad bet. In the context of monetary inflation where real returns from safe investments (e.g., government bonds and fiat money) are negative (the likely denouement of high inflation), investors might adopt a range of strategies for adding to risk despite rationally assessed returns (demonstrating a normal healthy scepticism towards speculative narratives) being unsatisfactory. Alternatively, even when safe returns are not obviously depressed, but the central bank is, e.g., leaning against high rates in line with an abnormally high neutral level as during a period of rapid growth in economic prosperity, a capital gains bonanza can fuel positive feedback loops stimulating irrational exuberance. (Brown 2017)

How do these strengthened forms of irrationality provide new scope for the financial engineer? Hypothetically, financial engineers could focus on finding where the irrational forces are causing misaligned prices between debt and equity or between other pairs of securities (including cross-currency comparison) and take advantage of this for the shareholders they ultimately serve. If debt has become over-priced relative to equity, then the engineer should boost debt and reduce equity outstanding, but there are three problems with this answer. First, by what objective measures can the engineer assess mispricing? Second, even if there is mispricing, how can the engineer have any confidence that a correction will occur within the near future and not grow into even greater mispricing? Third, if shareholders are able to act on their own to account for perceived mispricing, why would there be any reward for the financial engineer's efforts?

For example, the engineer may determine that, in areas of business activity where he focuses attention, interest rates as presently manipulated by central banks are unusually low relative to expected rates of return to entrepreneurial investment. Issuing debt to buy back equity is something that shareholders can do on their own (whether by taking on debt or reducing the share of safe bonds in their portfolio). Equity prices presumably already reflect artificially low interest rates. If equity does fall towards a fundamental value, a firm in which financial engineers had been active during the hot phase of asset inflation in issuing debt to retire equity could find itself heading towards legal jeopardy as its leverage ratio jumps reflecting the fall in equity values, re-doubling the fall in equity price.

Engineers Save on Transaction Costs but Are Not Good Gamblers

Finance 101 suggests that the debt position of corporation X is equivalent to holding riskless debt plus writing a put option (at a low striking price) against the hypothetically unleveraged equity of a given corporation (Black and Scholes 1972). Income from the put option provides extra interest. Given the hunger for yield, the prices of the put options are depressed far below fundamental value relative to equity value, as depicted in low derived estimates of volatility based on the Black-Scholes formula. In principle, arbitragers could buy puts whilst selling equity, but transaction costs and calculation costs (imprecisions) would be considerable.

The corporation may have an advantage in being able to scoop up arbitrage profits by issuing corporate debt to the yield-hungry investors, effectively buying puts at depressed prices as a component of this process and buying back some equity. The corporation could offset the boost to leverage implicit in such arbitrage, at least to some degree, by running down bank loans. Overall transaction cost considerations of these operations might justify the company having a higher leverage ratio than otherwise, which shareholders can offset as they choose. All of the foregoing is subject to not incurring a serious increase in risk of bankruptcy when asset inflation eventually moves into the end phase. Equity markets could collapse and the exposed leverage ratio calculated at market values could increase.

In broad terms, financial engineers may facilitate arbitrage as described. In fact, they are not bold gamblers against irrational market value disparities. Quite the opposite is true. In their search for big time reward, they play on the phenomena of irrational markets, which includes excessive expectations of returns from carry trades in various forms (whether seeking currency risk premium, illiquidity risk premium, or term risk premium), the dropping of normal cynicism about speculative hypotheses, and the momentum following and unusual blindness to, clever disguises of leverage, all to increase prospective rates of return to equity shareholders as long as the “bubble music” continues. Momentum-following involves gaining from positive feedback loops related to investors’ expectations of future returns from high present returns. When a particular asset is rising, higher leverage means greater returns. In a world where momentum investors are chasing growth stocks, why not join the party. It has been noted that the reporting of profit and loss for effectively captive leveraged hedge funds in the non-financial sector is quite malleable (Gilbert and Hrklicka 2018).

If leverage ratios are calculated at market value for outstanding debt and equity securities, they tend to fall during the hot phase of asset inflation, even given rampant debt issuance, as equity values skyrocket. The name of the game at such a time is to prevent leverage ratios from falling sharply, which would tend to depress the momentum of the given stock, making it unattractive in a momentum-driven market. A wide range of incentives may encourage such behaviour, restraining the fall of leverage as equity values soar.

For example, senior management overseeing financial engineers may have much potential remuneration in the form of options expiring soon. If financial engineers participate in pension fund management decisions, they could increase the mismatch between fixed pension commitments and variable investment returns, closing during the hot phase of asset inflation the so-called pension gaps and generating a boost in earnings. In the financial sector, engineers may implicitly consider too big to fail and deposit insurance when premiums are fixed, meaning that leverage can be increased without equity investors taking on commensurate risk.

Why High Leverage Rather than Genuine Enterprise Risk? The Case of Private Equity

Why does the demand for momentum and the related appetite for risk show up as pursuit of higher corporate leverage rather than as an extra 100% equity enterprise investment opportunity (in particular for new projects), which is riskier and potentially

has a higher return than normal? One should consider here whether, at an aggregate level, individual corporations boosting leverage to produce higher equity momentum than otherwise in a rising market can succeed. The equity repurchases alone reduce the supply of equity and increase the supply of debt. In the aggregate, portfolios become no heavier with respect to underlying equity exposure. Crucially, though, that assumes an unchanged equity price. If equity values are rising sharply, in part because of the irrational sparkle of momentum or leverage driven returns, increased leverage driven by equity buy-backs can in fact accompany an increased supply of equity at present inflated prices. Moreover, even without considering this value effect, from the viewpoint of each corporation acting individually, it may make sense to engage in financial engineering. Practical economics is full of examples of zero- or even negative-sum games driven by market forces.

Next consider time-horizons. Even the crazed investor during a bubble has a presentiment that good times will not last (Brown 2016). Hence horizons become shorter than normal. There is not great demand for long-gestation investments, but instead for leveraged-up investments that make quick, high returns or momentum investments that seem to be on a roll. The scope for leverage increases because normal caution does not apply to setting debt limits. A range of investors exist with abnormally large demand for higher risk credits (carry trade). High returns become the normal expectation for bond investors, who are no longer content with the low safe return, but believe that a more favourable trade off is possible between risk and return than in normal circumstances.

Enter the private equity industry that thrives on financial engineering during great monetary inflations. For example, the titans select current public-quoted companies, take them private with ramped-up leverage, and reap returns from a general environment of rising equity prices and even dizzier high-risk debt prices. They also gain from the carry trade into illiquid assets. Investors desperate for well above normal yield proportion their exposure to illiquidity, perhaps irrationally confident in the view that there is less danger of sudden illiquidity than in the past or that financial engineering has permanently reduced risk. The private equity industry has a powerful narrative to spin. By consolidating control of the company and taking it private, they can accomplish wonders on the asset side of the balance sheet. No one knows until the end of the financial cycle whether those claims are true.

In general, their success turns on the opportunity to issue massive debt at a fundamentally high price relative to equity. As experts in the bankruptcy process, they know how to contain the claims of creditors and force them into debt-equity swaps. They gain from the carry trade into illiquidity as investors frantic for yield are ready to unusually embrace such securities to obtain extra return, convincing themselves that normal illiquidity has been suspended, which may be the case during the hot phase for private equity investments. The combination of hunt for yield and carry trade into illiquidity fuelled in the present monetary inflation cycle (whether dated as starting in 2011 or the sub-cycle starting in 2015/16) another booming business under the private equity industry umbrella: sub-prime lending to households and businesses. The overall dazzle of private equity derives from the markets momentum that characterizes monetary inflations, such such as the gains in equity prices, the scope for projecting fantastic profit growth based on unappreciated underlying leverage (calculated at fundamental equity valuations which exclude the speculative froth), the giant carry trade into illiquidity, and of course the power narrative about superior management and

whispered narrative for those in the know about the gravy train from crony capitalist connections (Brown 2015).

Puzzles of the Equity Buy-Back Boom

Equity buy-backs in the U.S. have been a particular boom area for financial engineering during this cycle, which highlights some of the previous points (e.g., Lund et al. 2018; Asness et al. 2018). In 2018 equity buy-backs reached \$1.15tn (almost 6% of U.S. GDP).

Equity buy-backs are not entirely bad. In fact, they are best thought of as the company returning surplus cash from investments back to shareholders. It may indeed be most tax efficient to do this by buying back equity (wherein shareholders pay tax at the capital gains rate which can be lower than the tax on dividends). Moreover, dividend fluctuations tend to convey messages. For example, a reduction in dividends may suggest negative company developments. In contrast, no one assumes equity buy-back programs are permanent. Moreover, bold equity buy-backs with respect to surplus cash demonstrate to shareholders that there will be no clandestine raids on hard-to-justify reserves to spend on low return pet projects of empire-seeking management (including dubious merger and acquisition activity).

There is much nonsense regarding equity buy-backs, primarily against the background of “bubble markets” under conditions of monetary inflation. Perhaps one of the biggest falsehoods is that the company buying equities in the market pushes the price up via supply and demand. The corporate buyers of stock add to the pressure from the demand side (from the viewpoint of market makers in the stock).

It is best to think of equity buy-backs as cancellation of equity matched by a cash distribution. Imagine a company that has only equity outstanding. The company decides that it has no current use for a mountain of cash which at the current equity price is equal to 10% of outstanding equities. It announces that every investor will have one in ten shares cancelled and the cash will be paid out at the current share.

This would not happen in the real world because there is no legal or tax framework to facilitate it. Instead there is only the company buying back equity. For there to be absolute equivalence, every investor must decide after hearing about the buy-back operation to sell 10% of their holdings in the marketplace. That would be 100% rational. Otherwise the investor would be increasing the concentration of his portfolio's investment in company's core activities (beyond the holding of cash). There is no obvious reason why one would do so.

In the real world, many investors would not operate like this, perhaps influenced by reluctance to incur transaction costs. In this case, they would be potential sellers further down the line. If the price went up under transitory demand from the company's buyers, surely this would be snuffed out by widespread value selling. After all, nothing has fundamentally changed to justify a higher selling price, other than possibly the efficiency of the cash mountain being disposed of and it was sub-optimal that the company was ever holding such a mountain, which surely is more valuable in the shareholders' hands.

Earnings per share likely increased as low yielding cash was disposed of, but this would not translate into a higher equity price directly, as implicitly the overall risk of the company also increased. In any case, changing the composition of investments does not produce added value, except through increased efficiency. Cutting back cash is a

method of reducing negative leverage. Individuals could choose to reverse the operation on their own personal account. If all that was involved was a shift in negative leverage, there would be no added value from such a manoeuvre by financial engineers.

The same conclusions hold with respect to equity buy-backs that increase the amount of positive leverage. Equity buy-backs matching increased debt issuance, holding all else constant, are equivalent to using the proceeds of debt to retire equity. There would be a boost to earnings per share on the assumption that interest costs are low relative to the cost of equity, but this should not increase equity value. The equity's risk would increase in line with leverage and so the expected rate of return should be higher to justify the same price.

Yet amidst the froth of monetary inflation, as evident in capital markets during the present cycle, there has been much buzz about equity buy-backs and how they add to equity value. Some of the equity market bull analysts go so far as to say that equity buy-backs should be added to dividends and the combined rate of cash pay-out compared with the current yield on bonds in calculating the implicit equity risk premium! Of course, there are no hard tests here. When share prices rise on the announcement of buy-backs, who knows whether this is collective relief that the company is not going to engage in wasteful merger and acquisition activity. Even so, how much waste could there be on a consistent basis without the market in corporate control stepping in to exert discipline? Suspicion is strong that there are rewards to financial engineering that would not occur under ideal market circumstances and that stem from the climate generated by monetary inflation.

Corporate Leverage Boom in Emerging Markets

This paper thus far has concentrated on corporate leverage boom (albeit in aggregate camouflaged by sky-high equity valuations) in the U.S. during raging monetary inflation. Of course, on the global scale, the biggest boom in corporate leverage was in the emerging market world (Alter and Elekdag 2016; International Monetary Fund 2015; Aldasoro and Ehlers 2018). The ingredients are the same: yield-hungry investors in pursuit of income, momentum-crazed speculation, and considerable scope for camouflage of leverage that could bolster equity values, the growth of private equity and the narrative.

The narrative of convergence (emerging market economies catching up with faster growth in advanced economies in the globalization age) has promoted emerging market corporate debts, as has the prevalence of the real estate market boom (which means apparent solid collateral for debt issuance). Alongside, there is sometimes a financial narrative, that of perpetual real exchange rate appreciation (for the domestic currency of emerging market economies based on hypothesis of economic convergence), which means perpetual profit to be derived from foreign currency borrowing collateralized against local currency assets.

In all asset inflations going as far back as the 1920s, the appeal of high-yield foreign debt rose disproportionately from the viewpoint of investors and lenders in mature low interest creditor nations. In boom time, given powerful narratives about miracles in new debtor countries accompanied often by real estate market booms, corporate and other debts suddenly enter the eligible range of investments, especially on the part of

investors who in the prevailing asset inflation have become more confident about their ability to find areas of high return. Regarding local currency debt, the extra premium obtainable for exchange risk is seen as a good bargain by yield-hungry or over-confident investors who persuade themselves that this risk has faded.

Such was the case in the craze for German corporate, bank and local government debts during the mid and late 1920s against the background of pervasively low U.S. interest rates as the Fed sought to prevent U.S. prices from falling, as would normally occur in a sound money environment given rapid technological change. Some bonds were denominated in U.S. dollars, others at a higher yield in reichsmarks. The mark-dollar exchange rate was fixed, according to the Dawes Plan of 1924 following the end of the hyperinflation. Berlin real estate between 1924 and 1928 rose spectacularly in price. Ultimately when credit bubbles cool, emerging market debts and related economies are the hardest hit.

The question is whether monetary policy in emerging market economies, where corporate leverage and a wider leverage boom have been sparked by Fed monetary inflation in the ways described, could lessen the severity of their respective boom-and-bust cycles? The discussion is in the context of a floating exchange rate regime, where the emerging market currency is freely floating versus the U.S. dollar. Note that the leverage boom has two dimensions. First, local companies in the emerging market economies run up foreign currency liabilities against domestic currency assets, thereby assuming exchange risk. Second, local companies do the same but against foreign currency assets and perhaps facilitate a foreign asset acquisition boom. In this second case, there is no direct fanning of exchange risk exposures, though these may well still increase indirectly because local currency assets are part of the ultimate collateral for foreign currency loans to emerging market corporates. Both elements were present in the actual foreign currency lending boom into emerging market economies in the present cycle (McCauley et al. 2015).

The argument against the use of monetary policy in emerging market economies to break the foreign currency borrowing boom is that it sets off a vast cycle of local currency appreciation, severely damaging the locally traded goods and services sector. Even then, the economy may not be spared from the harmful effects of U.S.-led monetary inflation, though harm may be inflicted and spread in different ways from the scenario where the local central bank indeed was defiant. The purpose here is to present a counter-argument.

Tighter domestic monetary conditions in the local economy should slow down the growth of credit, at least the part denominated in local currency. High interest rates would, in themselves, be appealing to income-starved investors elsewhere, but with the currency in the stratosphere, appetite would be constrained by the knowledge that a big currency fall would lie ahead. High domestic interest rates would halt any incipient asset inflation in local real estate and equity markets under the influence of foreign demand as induced by Federal Reserve policy in particular.

There could be an irrational frenzy of demand by local borrowers for foreign currency credits, with domestic companies far too sanguine about the danger of currency mis-matching and future exchange rate movements in taking on foreign currency (chiefly dollar) liabilities. On the supply side of these credits global-yield-starved investors would also be far too sanguine. For example, local borrowers and lenders may take the view that the current sky-high local currency value will persist for a long time, certainly until the loan is due to be repaid. A switch into local currency can be made at some point well before any sudden crash.

This is a version of the stampede fallacy. Individual investors know there is something untenable about the present situation, but they plan on exiting before the stampede. Of course, in aggregate such an early exit is impossible. Alternatively, they may believe a miracle story that justifies a permanently high level of domestic currency. Given that the irrational forces rampant under monetary inflation might inflict considerable future economic cost via the intermediation of the foreign currency credit market as described, and that, in the interim, monetary defiance would cause huge short-term dislocations in the traded good sector, surely it would be better for monetary policy to be in part accommodative, following the lead of the foreign monetary superpower (most likely the U.S.) (Brauning and Ivashina 2018; Miranda-Agrippino and Rey 2018).

That is the conventional wisdom which has been almost universally followed, not just by the monetary authorities of emerging market economies, but by those in a whole range of small-and-medium-size advanced economies in the firing range of U.S. monetary inflation (via its effect on asset markets). However, suppose the local central bank and the political authority to which it is responsible made it quite clear to the population that the Fed's inflationary monetary policy would lead to a domestic monetary emergency. If the decision was made to follow the Fed, there would be great damage ultimately, most likely a real estate boom and bust, a consumer credit boom and bust, and a deterioration in the quality of local money. Suppose, subsequent to that explanation and persuasion, an alternative strategy was announced.

In view of the U.S. policies, the local central bank would double its resolve to follow non-inflationary policy. The local currency would shoot up, but domestic investors should see this as an opportunity to buy foreign assets cheap. Consumers and businesses should bring forward purchases of foreign goods (advance purchasing or buying now rather than later). The appreciation of the currency would bear down on domestic prices across the board. Consumers and businesses, seeing that the local central bank was on a steady long-run monetary path (e.g., with base money supply growing by a very low amount each year) would see higher prices in the future, justifying the bringing forward of expenditure.

In the export industry, there would be immediate wage cuts (or foregoing of bonuses) in local currency terms, but these would be rescinded once the emergency was over. Local finance and monetary authorities would be zealous in monitoring and pointing out the risks related to currency mismatch in foreign currency borrowing.

A key consideration here is that ultimately U.S. monetary inflation would reverse, either via policy action or via credit market revulsion. Then inward demand from abroad for domestic currency of the emerging market economy or small advanced economy, whether as a haven for sound money albeit with large exchange risk or just an irrational search for yield disregarding exchange risks, would moderate. In the meantime, a wider trade deficit and demand for foreign assets in the country defying the U.S. monetary lead may make the sky start to fall in.

When this happened, there would still be the long-run benefit of high-quality local money and an accumulation of foreign assets bought at cheap local currency prices, financed in aggregate by a long-run build-up of foreign holdings of domestic money. The currency gains on the dollar would be a cushion against foreign asset price falls in dollar terms, with the cushion translating into exchange rate losses for foreigners.

This escape plan from U.S. monetary inflation depends on there being a suitable local currency monetary pivot. The local central bank must be able to set parameters for

monetary policy that provide for independence, like setting the growth of high-powered money aggregate capable of becoming the pivot of the monetary system. Capability depends on there being a broad and stable demand for the aggregate, as would be the case if demand for cash (whether by banks or individuals) had not been truncated by a range of official interventions including too big to fail or bloated lender of last resort and tolerated monopolistic practices by credit card companies and big banks (Brown 2018).

If there is no such pivot and the local central bank is just pegging a short-term interest rate, then the likelihood of a set of expectations developing, including regression to the mean for goods prices and the exchange rate, is much less. Appreciation means more appreciation. That is the challenge. A small country may not have such a pivot, other than perhaps to gold which could be highly unstable (Brown 2018).

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