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John T. Harvey

Texas Christian University, j.harvey@charter.net

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Cover Page Footnote

I would like to thank (without implicating) the many helpful suggestions of both the referees and the editors.

An Economics Primer for Cyber Security Analysts¹

John T. Harvey²

To understand the systemic impacts of cyber attacks requires a reliable and updated model of the national economy one is trying to protect. Cyberspace today is an already potentially unstable system from cyber aggression; cyber defenders operating with a flawed understanding of the determinants of output, employment, asset prices, et cetera, condemn the nation to failure. Unfortunately, understanding of economic systems is challenged by the many economics approaches which vary not just in detail but in core foundational assumptions. These approaches differ dramatically in explanations of, for example, the 1930s Great Depression. The Monetarist view of the Great Depression argues that it occurred because workers ‘voluntarily’ quit their jobs in response to perceived (but not actual!) pay cuts, a misunderstanding created by bad monetary policy. The Keynesian model argues that the Great Depression was the result of an external shock to the economy that could not be processed efficiently due to “frictions.” The Post Keynesian approach sees the Depression simply as a particularly significant example of the endogenously-generated business cycle characteristic of market systems. In just these three models we see explanations of the single most significant economic event of the twentieth century, and they run the gamut from policy errors to exogenous shocks to systemic fluctuations. Nor are these the only choices.

If deciding which is the most relevant is difficult for economists, it is doubly so for those outside the discipline such as those seeking to defend national wellbeing and security in cybersecurity. However, decide they must if the costs of cyber attacks are to be estimated and eventually reduced. This article will argue that the Post Keynesian school of thought is the one that not only best describes the operation of a modern financial, global, and industrial economy,

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² Professor of Economics, Texas Christian University

but it is particularly useful in that it highlights those parts of the economy that would be most vulnerable to cyber attack.

The paper proceeds as follows. In section 1, the reasons why a solid understanding of economic theory is a prerequisite for effective policy design and implementation are outlined. Following that, Post Keynesianism is introduced and a brief justification for its choice is offered. Next, a simple model of the determinants of output and employment is built, both critically affected by losses due to illegal cyber financial and IP theft. Part of that will be an explanation of bank and non-bank financial institutions and asset markets – both targets for cyber state and nonstate adversaries. Section 4 focuses on the international economy, particularly exchange rates and trade flows – i.e., the mechanisms by which adversary states reap the benefits of cyber campaigns and subtle forms of cyber coercion. Both 3 and 4 close with a discussion of potential cyber issues. Conclusions follow, after which there is an appendix further clarifying those economic theories and concepts about which cyber experts are likely to be least comfortable and yet are critical to bridging this conceptual, practical, and ultimately critical knowledge gap.³

Why Economic Theory Matters

There are two essential reasons why cyber experts need to be armed with a solid understanding of the macroeconomy. The first is straightforward and relates to having a sense of where bad actors may find points of leverage to disrupt and disable our system. As will be explained below, economic activity depends heavily on the state of investor and consumer confidence, the availability of financing, and the ability of economic agents at every level to communicate via efficient and reliable electronic networks. All of these make us vulnerable to cyber attack, much more so than standard economic analyses would suggest.⁴ Furthermore, the longer we wait to address these, the more difficult it will become to do so.

³ The latter is based on impressions gained from my participation in the Cyber, Security, and Economics: Challenges to Current Thinking, Presumptions, and Future Cyber Defense Transformations Workshop (Naval War College, December 6-8, 2016).

⁴ The mainstream school of thought in economics is Neoclassicism, which places (by their own admission) much less emphasis on the financial sector, something they, themselves, lamented after the Financial Crisis (see de Araujo, O’Sullivan, and Simpson 2013, Blinder 2010, and Shiller 2010). They also discount the likelihood that investment spending may not be sufficient to generate full employment (in part because they accept the loanable funds theory of interest discussed in section 3.1). Thus, analyses based on their premises would reveal many fewer potential problem areas.

The second reason is less obvious and relates to the philosophical and political obstacles that we may face in implementing reforms. We have raised capitalism to the level of a national mythology, so much so that we are extremely reluctant to intervene in ways that may be necessary in developing effective defenses for an emerging and dangerous cybered world. Worse yet, that mythological capitalism is a perverted version of that described by Adam Smith, et al, and it often ignores the system's weaknesses while recommending policies that diminish its strengths. Part of the reason for this state of affairs comes from that the perceived high stakes in political defense against Soviet-style socialism; during the Cold War, that scholars who did not profess undying faith in the capitalist system were suppressed and even persecuted (Amadae 2003, Harvey 2015: 45-6). Realistic and pragmatic analyses are difficult under such circumstances and the economics discipline continues to suffer from this legacy. Today, for example, it is quite common that, in the average economics classroom, potential problems with the capitalist model are assumed away and the ideal is presented as if it were the actual reality.

Also key is the fact that those most able to take control of the conversation are the firms and business people who have been educated during the Cold War. They are able to concentrate sufficient power to have their often dated assumptions built on the legacy capitalism-socialism divide dominate debates in the media and on the floor of Congress. As Adam Smith argued over two-hundred years ago, those business people will tend toward "conspiracy against the public, or in some contrivance to raise prices." When they argue for deregulation, it is almost never of the variety that would then create more competition and resilience supporting national defense. Rather, Adam Smith argued that it tends to be the type that allows them to concentrate power, take advantage of information asymmetries over their customers, and create additional barriers to entry. None of these distortions of Smith's original capitalism helps understand how to defend the whole nation against cyber adversaries. These policies simply allow yet another merger or supporting yet another bailout rather than the systemic responses required.

Perhaps most disturbing is the fact that these conflicting economic models are not something with which our adversaries have to contend. We are reluctant to recommend the systemic level of reforms that the Chinese do not hesitate to attempt to implement if deemed essential for national security. The western assumption is that these kinds of reforms would interfere with a well-functioning, efficient economic system, the very one that brought us victory over the Soviet Union and its satellites. But this Soviet system was already in the process of

deterioration before the Cold War ended and the internet had even been built. Today, we are left with an economic system based on a variety of capitalism that has experienced decades of declining levels of competition and a disappearing middle class (*The Economist* May 16, 2016). The legacy Cold War assumptions built into our economic models may be ill-structured to fix either competition or the fading center class given the emerging cybered world dominated by nonwestern states like China. Indeed, in the US, the fact that these degenerative processes occurred is now so widely accepted that both political parties treated them as facts in evidence during the 2016 presidential campaign. Power is concentrating today even though in our idealized economic as well as political models both capitalism and democracy operate on the philosophical assumption that it should be diffused.

Economic power is also diffusing out of the United States and the West to Asia at an alarming rate in the emerging cybered world. The lack of understanding of economic models and implications have accelerated the harmful effects of massive cybered extractions called the “greatest transfer of wealth in human history” by the first commander of the US Cyber Command in 2012. ((Paganini, 2013) We are not defending systemically across our critical economic system because those guiding and implementing national cyber defense simply do not understand how the choice of economic assumptions, models, and practices undermine the ability to defend successfully overall.

In summary, cyber experts would be well-served to develop a strong working knowledge of economic theory, and not just because this provides insights regarding possible chinks in our armor. An equally pressing problem is the fact that policy recommendations may face significant push back from both selected scholars and powerful vested interests. Readers of this journal need to be able to distinguish between reasonable objections and smoke screens, and to be keenly aware of the flimsy foundations upon which latter will be built.

Post Keynesian Economics Best Suits Today's Reality

Mainstream economics is dominated by the Neoclassical paradigm and has been since the 1960s. Broadly speaking, this approach argues that economic systems seek resting points (i.e., equilibrium) and that those equilibria are routinely consistent with full employment and maximum GDP (Gross Domestic Product) growth. Only when frictions or external shocks occur do we

experience less-than-optimal outcomes. Take for example this quote from a Neoclassical who was once the Chair of President Barack Obama's Council of Economic Advisors:

“The prevailing view among economists is that there is a level of economic activity, often referred to as full employment, at which the economy could stay forever” (Romer 2008).

Within their adopted framework, the financial sector plays a passive, accommodative role. Indeed, it is typical to omit it entirely. Nobel Laureate and Neoclassical economist, Joseph Stiglitz, argued: *“But even more fundamentally, the Standard Models left out both banks and the shadow banking system, central to the determination of the flow of credit, which in turn is central to the determination of aggregate demand”* (Stiglitz 2011;604).

Nor is debt considered to be an important factor (these are again Neoclassical economists and Krugman is also a Nobel Laureate): *“Given the prominence of debt in popular discussion of our current economic difficulties and the long tradition of invoking debt as a key factor in major economic contractions, one might have expected debt to be at the heart of most mainstream macroeconomic models—especially the analysis of monetary and fiscal policy. Perhaps somewhat surprisingly, however, it is quite common to abstract altogether from this feature of the economy”* (emphasis added; Eggertsson and Krugman 2012: 1470-1).

While a full explanation of why they take this approach is beyond the scope of this paper, part of the problem is their insistence on using a general equilibrium framework. Such models are basically sets of simultaneous equations. While we can talk about alternate equilibrium positions, there is no inherent explanation of the transition and thus time does not pass—that is why we call them “simultaneous” equations! And yet the financial sector is all about time. Firms and consumers borrow today and repay tomorrow; banks lend now in order to earn a stream of payments in the future; the reason for buying a financial asset is not what it can offer today, but how its price will fluctuate in the coming weeks and months; and so on. It is impossible to account for these processes in a general equilibrium framework.

It is therefore not surprising to learn that their approach did not serve them well in either predicting or explaining the Financial Crisis. To their credit, multiple mea culpas were issued by Neoclassical economists after the collapse. Paul Krugman wrote, for example, “How Did Economists Get It So Wrong?” (Krugman 2009). Others recognized and lamented the fact that

traditional macro models do a very poor job of explaining and integrating the operation of banks, non-bank financial institutions, and asset markets (de Araujo, O'Sullivan, and Simpson 2013, Blinder 2010, Shiller 2010, Taylor 2011, and Stiglitz 2011). Even Queen Elizabeth II took a shot at the discipline during a visit to the London School of Economics (Pierce 2008).

Despite all this, however, there is zero evidence that any real changes are in store. Rather, as the dust has settled it has become clear that the crisis is being treated as a black swan event. Mainstream economists therefore see no reason to make changes and their models continue to be based on the assumption that economies tend to automatically eliminate unemployment and financial markets play only a passive, accommodative role.

Fortunately, not everyone was taken by surprise by the events of 2007-8. Dirk Bezemer made a study of those who had most accurately predicted the collapse to see what they had in common. He eliminated from consideration those who continuously predicted crises and also required that: *“Second, the analysts included went beyond predicting a real estate or credit derivatives crisis, also making the link to real-sector recessionary implications, including an analytical account of those links. Third, the actual prediction must have been made by the analyst and available in the public domain, rather than being asserted by others. Finally, the prediction had to have some timing attached to it”* (Bezemer 2011: 4). Those he identified shared: *“a concern with financial assets as distinct from real-sector assets, with the credit flows that finance both forms of wealth, with the debt growth accompanying growth in financial wealth, and with the accounting relation between the financial and real economy”* (Bezemer 2011: 9).

This emphasis on the financial sector is central to the Post Keynesian approach. Indeed, the economist voted as having most accurately forecast the Financial Crisis, Steve Keen, based his prediction on a model he had published in the *Journal of Post Keynesian Economics* in 1995 (Real-World Economics Review Blog 2010; Keen 1995).⁵ There, he writes with prescience, that “a long period of apparent stability is in fact illusory, and the crisis, when it hits, is sudden” (Keen 1995: 633). Debt—the issue that Eggertson and Krugman admit is typically glossed over in the Mainstream—is a key factor in Keen’s analysis. It is also noteworthy that he chose to model the

⁵ Not by coincidence, Steve Keen was also the keynote speaker for the Cyber, Security, and Economics: Challenges to Current Thinking, Presumptions, and Future Cyber Defense Transformations Workshop (Naval War College, December 6-8, 2016).

economy dynamically and used a computer simulation to demonstrate how events would unfold over time.

It is for these (among other) reasons that the approach adopted in this paper is the Post Keynesian one. Not only does it have a superior track record, but it takes explicit account of sectors where cyber attack may be most likely. What appears below will, of course, be rather elementary. But it should give the reader a good sense of the foundation on which more sophisticated models are built.⁶

Key Determinants of Economic Systems: Output and Employment

The capitalist system is inherently unstable. This is not to say that it should be abandoned or that it creates consistently negative outcomes. Powered flight is also unstable, and yet the many advantages it brings mean that we work hard to engineer into it as much stability as possible. Aircraft designers do not do this by simply assuming away the problems. Rather, they admit them, confront them, and--as much as possible--solve them. So must do we with the economy as well. By its very nature, instability provides leverage points for bad actors. As will be shown below, key in the processes that determine output and employment are investor and consumer confidence and the availability of financing. Each of these is easily disrupted and could be prime targets. An extended explanation of their nature follows.

Saving, Investment, and Banking

A key assumption here is that employment should be the focal point of our analysis. High levels of unemployment are not only undesirable in terms of wasted potential production of goods and services, but they create myriad social problems and political instability. In short, poor neighbors make bad neighbors.

This part of the analysis is relatively straightforward. While firms' employment decision is affected by many factors, none is more important than changes in demand. The higher the level of total spending in the economy, the more jobs are created. Wages, taxes, and regulations change only periodically and relatively slowly; economic downturns, however, can be sudden and

⁶ Note that Keynesian and Post Keynesian are not the same thing. Ironically, it is the latter that is built more self-consciously on the work of John Maynard Keynes, while the former is a branch of Neoclassicism.

catastrophic. Evidence of this is seen in Figure 1. Shaded regions are economic recessions, or sustained declines in GDP, while unshaded ones are expansions (sustained increases in GDP). As GDP is a measure of total spending, this supports the above contention that there is a very strong inverse relationship between total spending and unemployment.

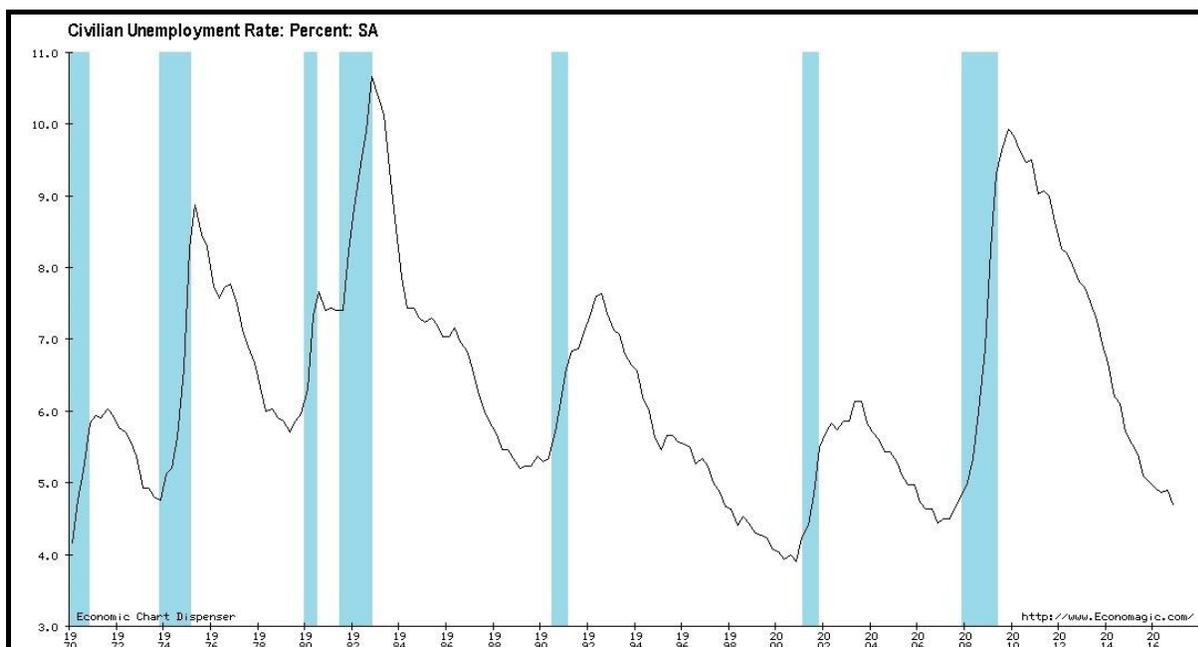


Figure 1: The unemployment rate over the business cycle, 1970-2016. Shaded areas are recessions.

This begs the question of what determines total spending. To start, consider only the domestic private sector. With no government or foreign sectors this leaves only households and firms. The former undertake consumption expenditures like buying groceries, paying rent, and purchasing appliances. The latter's spending is comprised solely of physical investment spending, or additions to their ability to produce goods and services (such as factories and equipment—note that this is distinct from financial investment!). We do not measure their purchase of raw materials separately on the assumption that these were already included in the prices of final goods and services (the sales of which are already counted under household consumption and firms' physical investment spending).⁷

⁷ For example, a \$50 dining room chair already includes the cost of the materials. There is no need to count the wood separately.

Equation (1) shows this with total spending (GDP) as the sum of consumption spending (C) and investment spending (I):

$$(1) \quad \text{GDP} = C + I$$

Meanwhile, at the aggregate level it must be that total spending equals total income since *every time someone makes an expenditure it becomes someone else's income*. They are simply two sides of a single transaction. Thus, the value of GDP must logically be equal to both spending (as above) and income (as below).⁸ Equation (2) shows the two things people can do with their income (again, in a world without a government sector or international trade):

$$(2) \quad \text{GDP} = C + S$$

where GDP is income, C is (still) consumption, and S is saving.

Because spending = income, comparing equations (1) and (2) shows something very important:

$$(3) \quad I = S$$

In equilibrium in this simple world, investment spending must be equal to total spending. This is not controversial among economists. No one disagrees with equation (3). The arguments are related to its relative significance and the process by which the equality is maintained. What follows reflects the Post Keynesian school of thought's approach.

Investment is an injection into the income stream (in that it creates new income) while savings is a leakage. Only when injections are equal to leakages can we be in equilibrium. A useful analogy is a bucket with a hole in its side and a garden hose above. The water level will be stable only when the inflow is equal to the outflow. Likewise, GDP (the water level) is in equilibrium if and only if S (the hole, supplemented by any overflow) is equal to I (the garden hose). If the hose is filling the bucket faster than it can possibly leak out of the hole, the water level (GDP) will rise until the overflow at the top adds just enough to the leakage from the hole to make inflow (I) equal to outflow (S). On the other hand, if the garden hose is filling the bucket at a rate slower than the maximum at which the hole leaks, the water level will fall until the hole

⁸ In fact, GDP is officially calculated both by adding up all spending in the macroeconomy (the expenditures approach) and all the income (the income approach). While they do not end up with the same number, they know that they should and that any discrepancy is due simply to reporting errors and omissions.

lets out only as much as is coming in. If the hose is turned off, water will flow out until the leak, too, stops (once the water level is just below the hole). One way or another, we have an equilibrium level of water (GDP) only when the outflow (S) = the inflow (I).⁹

In this relationship, I is the driver while S simply follows. Continuing the analogy, imagine that the hole is of a fixed size but that the gardener is periodically altering the flow from the hose. After every variation there will be a period of adjustment during which the level changes until the flows are once again equal. This is precisely what happens in the real world (with the exception that there are more holes and hoses and the economy doesn't wait for the new equilibrium to prevail before the next alteration hits). Saving is largely a residual because the range over which households have discretion in their spending is pretty small. House and car payments have to be made, groceries have to be purchased, and so on. Investment determines income which determines how much you can save in the same way that the flow from the hose determines the water level which determines the size of the leak.¹⁰ This is a critical point: in the real world, investment (and more broadly all injections) are in the driver's seat.

One may be tempted to imagine that in the real world the water from the hole (S) somehow feeds the hose (I). This is false but worth examining because a) it is a widespread belief and b) it leads the discussion toward other key points that need to be highlighted. A critical assumption in that fallacious argument is that banks loan out people's savings. As savings rise, the story goes, so the banks are induced to lower interest rates which then raises investment. This is called the loanable funds theory of interest and it is what lies behind the Neoclassical argument that America needs to increase its savings rate if we are to grow faster. But not only do banks not loan out people's savings, increasing the savings rate just makes the hole in the bucket bigger. This would actually lower the level in the bucket rather than raise it. In reality, the only way to

⁹ The next logical step is to add imports and taxes as leakages and exports and government spending as injections, but this will be saved until later.

¹⁰ One thing this simple analogy does not capture is the fact that the investment spending is subject to a multiplier effect which causes one additional dollar of investment to create several additional dollars of spending. For example, if a new restaurant is built for \$10 million (investment spending), those for whom the \$10 million was income will no doubt spend some percentage of it. If that rate is 50%, then incomes actually rise by \$15 million (\$10 + \$5 million). Furthermore, if those receiving that 50% (i.e., \$5 million) also spend 50%, then incomes have risen by \$17.5 million, and so on. This means that the investment hose (and the hoses we will add later) is even more important than the bucket analogy suggests.

truly save more is to have the firms invest more because, as argued above, investment creates income which creates saving.

The manner in which the process actually works is not only fascinating in and of itself, but it turns out to create an area of particular vulnerability to cyber attack. In the real world, banks create money out of thin air. Their only potential constraint, which in practice is rarely relevant, is maintaining sufficient reserves (money on hand to meet demands for withdrawals).

To understand this, imagine a simple agrarian economy where farmers need to buy seed and fertilizer before they grow, harvest, and sell a crop. Unless they are lucky enough to have a great deal of savings, they will need credit. And so, farmer Pat goes to the local general store and asks if she can take the seed and fertilizer today and then pay at the end of the season. Store owner Chris, accustomed to this arrangement, says sure, but Pat must sign an IOU for the amount of the seed and fertilizer. Assuming that this is \$100, Pat walks away with \$100-worth of seed and fertilizer and Chris has a piece of paper that Pat will purchase (and then destroy) for \$100 in the future.

Note that merchant Chris would only do this if she trusted farmer Pat to repay. *Trust is absolutely critical to a well-functioning financial system as the latter essentially consists of a series of interconnected promises to pay someone in the future.* Even in this simple economy this has significance well beyond merchant Chris and farmer Pat, for what they have done is created money. Consider this: what if farmer Pat is well-known in the community and widely trusted? Then merchant Chris could spend the \$100 IOU at other stores. Those shop owners could then do the same, with the IOU circulating throughout the town until the end of the harvest when the last holder sells it back to farmer Pat for \$100 (or \$100-worth of crops). In the meantime, it was as good as gold. In fact, even if farmer Pat ultimately defaults, it still served as money right up to the last transaction. The IOU is money and it is created by the extension of credit. Merchant Chris was in no way limited by the volume of others' savings that she already held—indeed, she had none. It is all driven by trust.¹¹

This, in principle, is exactly what happens when you buy a new car. The biggest difference today is that we now have a sector of the economy that specializes in determining

¹¹ If trust in farmer Pat were to fluctuate after the initial transaction, subsequent IOU holders may discover that others are unwilling to accept it at face value.

credit worthiness. The car dealer, unlike merchant Chris, does not therefore need to do this as well (though some branch of the company may do so). When you buy a car, you do not write an IOU to the dealership, but arrange with the bank to do so for you. The bank thereby actually buys the car and lets you use it so long as you keep up with your promise to meet the debt repayment schedule.

This may seem different in the sense that the dealership got real, honest-to-goodness money while Chris the merchant just got Pat's promise to repay. If Chris holds the IOU, it could be that on judgement day it's worthless because Pat defaults. But this is no different than the situation in which the dealership finds itself. The bank doesn't send over a bundle of cash, they give the dealership a demand deposit account—created out of thin air on a keyboard—of the appropriate amount. *If that bank were to fail, the money is gone just as much as it was in the simple agrarian society.* While today the government insures these deposits (within limits), that is external to the market and not part of the essential process. In fact and without government guarantees, the dealership is every bit as dependent on the bank's promise as merchant Chris was of farmer Pat's. Incidentally, moving that demand deposit to a different bank just changes which institution needs to remain sound if the dealership is to access those funds. The same problem of trust remains.

Though this runs counter to the public's image of money, the overwhelming majority of it came into existence as a result of this very process (somewhere in the range of 97% of our money is just an IOU as described; Werner 2014: 71). Mortgages, college and car loans, and the financing of appliance purchases all create money. Even in the simple agrarian economy, one can easily imagine that with a sizeable number of farmers all using IOUs to buy seed, fertilizer, etc., a great many of these would be floating around town at any given moment and that IOUs would end up being used to settle IOUs! Farmer Pat might pay off her IOU with merchant Chris by using a \$100 IOU written to her by rancher Jim, for example. Production takes time and therefore debt, credit, and IOUs are essential to the process.¹²

Though today it is required by law that the bank keep some percentage of outstanding loans in reserve as cash, central banks are generally very accommodative about supplying such funds. This is so because central banks a) understand the need to allow extensions of credit for

¹² Note that just as loans create money, defaults and repayments destroy it.

the economy to grow and b) target interest rates. If the system as a whole is running short of reserves, this would not only constrain growth, it would tend to cause interest rates to rise. To prevent the latter (assuming they want to maintain their interest rate target), central banks automatically provide those reserves. A need for reserves is therefore rarely a binding constraint on banks.

This explanation leaves out a number of details (a few of which will be filled in below), but it gives the essence of the story. *Investment depends in no direct way whatsoever on saving.* Banks make loans from thin air and Americans' savings rate has no effect on banks' ability to make loans. When firms invest, this generates income and creates the savings. As Keynes wrote (where by cash he means bank loans): "*The investment market can become congested through shortage of cash. It can never become congested through shortage of saving. This is the most fundamental of my conclusions within this field*" (Keynes 1937: 669).

Returning to the bucket analogy, this explanation of the financial system reinforces the idea that it is the hose at the top (i.e., physical investment spending) that is really driving the whole process and is thus the true determinant of the level of output in the macroeconomy. The more firms decide to invest, the more GDP will rise; if firms cut back, GDP falls. More on this in just a moment.

Something implicit in the discussion above is that there might be another constraint on the investment hose other than just the gardener's decision how much to turn the spigot. Since investment is extremely expensive and the costs come well before the revenues, firms must finance their projects by borrowing. And just because banks can create money at will does not mean they will choose to do so. Loan officers must agree that firms' plans are sound or the investment will not occur. To extend the analogy, unless the gardener has paid his water bill, his desire to fill the bucket will be irrelevant. Note, too, that the bank must be in a position to make such loans. *In short, a healthy financial sector is thus a necessary prerequisite to a strong flow from the investment hose.*

The begging question now is what determines firms' level of physical investment spending. Investment determines GDP which determines employment—but what makes someone decide to build a new restaurant in the first place? The quick answer is expected profit. Entrepreneurs must believe that they will earn more than the project costs. Those costs are more

than just monetary. Not only are investment projects generally extremely expensive, but they represent long-term and largely irreversible commitments. An entrepreneur who decides to open a restaurant will find herself carrying a great deal of debt and she will expect to be involved in its operation for years if not decades. Furthermore, she cannot magically change the restaurant into a gift shop if things are not going well. This is not a decision to be made without careful consideration.

This, alone, is discouraging news if we require a strong flow from the investment hose to avoid stagnation and unemployment; but it gets worse. Unfortunately, the nature of the real world is such that entrepreneurs lack the basis for making reliable forecasts of future profit. Keynes was fascinated by this. Why do people make important decisions based on inconclusive evidence? To understand this, consider first a world in which we know all the possible futures and the odds of each one. In that case we can create mathematically objective forecasts. This is possible at the roulette table, for example. We may not know which number will come up, but we know the odds. In the event that our prediction does not come true, we do not then question the very foundation of our forecast.

Agents acting in such a world do not panic in the face of unsuccessful wagers, nor would they decide that the odds have changed in their favor after successful wagers. Assuming the same game is repeated, the probability distributions are constant. But that is not the world in which we live. In reality, we do not know all the possible outcomes nor the probabilities associated with each. These things are, according to Keynes, not simply difficult to determine, but fundamentally unknowable. And it is in this environment that entrepreneurs must make decisions about their extremely expensive, long-term, and practically irreversible investment projects. They have to determine their plans with painfully inconclusive evidence.

One may ask, then, why any coldly rational individual would invest at all. Indeed, they would not, but then we are not coldly rational. Instead, Keynes argued that “a large proportion of our positive activities depend on spontaneous optimism rather than on a mathematical expectation” (Keynes, 1936: 161). When our spontaneous optimism (also known as animal spirits) outweighs the reluctance created by the fundamental uncertainty of the real world, we act; when it does not, we do not. Little wonder that investment is the most volatile component of GDP.

This is not to say that the investors are irrational. That would imply that they had all the relevant information and simply ignored it or made illogical inferences. Choosing alternative A or B below is an example of irrationality (assume each opportunity has the same cost and the alternative outcomes are \$0):

A: 50% chance of earning \$100;

B: 75% chance of earning \$100; C: 99% chance of earning \$100.

Fair enough, but which is the rational choice below?

A: 50% chance of earning \$100;

B: 75% chance of earning \$??;

C: ??% chance of earning \$100.

It is impossible to create a conclusive argument and barring a sufficient level of spontaneous optimism (“I know others failed, but it will work for me!”), the subject in question will simply not play the game. The investment hose thus depends on, in addition to the other factors mentioned above, the psychological state of the business community. Keynes summarizes the situation thusly (the state of long-term expectation governs the investment decision):

“We should not conclude from this that everything depends on waves of irrational psychology. On the contrary, the state of long-term expectation is often steady, and, even when it is not, the other factors exert their compensating effects. We are merely reminding ourselves that human decisions affecting the future, whether personal or political or economic, cannot depend on strict mathematical expectation, since the basis for making such calculations does not exist; and that it is our innate urge to activity which makes the wheels go round, our rational selves choosing between the alternatives as best we are able, calculating where we can, but often falling back for our motive on whim or sentiment or chance” (Keynes, 1936: 162-3).

A great deal of blood, sweat, toil, and tears is expended when collecting and analyzing the data relevant to an investment project. But, at the end of the day, it doesn’t happen unless the decision maker (and a banker) says, “What the hell—I think it’ll work!”

The analysis thus far builds a case for believing that the investment hose is unreliable as a stable and consistent source of the flow necessary to generate sufficient spending to create full employment. Quite right, but the resulting patterns are not random nor is our fate simply the

result of self-fulfilling prophecy. Ironically, downturns tend to begin while entrepreneurs are still optimistic and upturns while they are still pessimistic. Tracing the stages of the business cycle will show just how the interaction between animal spirits and the fundamental uncertainty of the real world work and why there are logical reasons for the turning points. Start with the first moments of an economic expansion. Entrepreneurs and bankers are likely to still be somewhat pessimistic given the recent recession. Indeed, so far as they know, they are still mired in it. But investment spending will inevitably start to recover. This is so because businesses will eventually be unable to put off repairing and replacing equipment. If your shop has two cash registers and one breaks down during the recession, you make do with one; when the second one malfunctions, you no longer have a choice.

This increase in economic activity, which manifests itself as a rise in investment, will translate into profits and comes as a pleasant surprise to entrepreneurs (and the bankers who must finance their projects and depend on the same psychological forces). Their animal spirits are fueled and they revise forecasts upward—the main part of the upturn begins. Through this period, optimism is high and expectations of profit are continually justified because of the strong flow into the bucket. However, this will not continually indefinitely because a) firms' debt levels are increasing and b) they are reaching target levels of capacity. Once businesses expand as much as they thought would be profitable, they stop—not because they are pessimistic, but because you don't make a profit from building a restaurant, only from operating it. They want to start earning income and repaying those loans.

This means that the volume from the investment hose is being lowered little by little as individual firms find they have built as much new capital as they wanted. This causes a decline in income (because $Y = C + I$) and, therefore, profits. Unfortunately, entrepreneurial expectations of profit were formed back when the hose was being run at full force and incomes were high. This means that they are disappointed as the projects come on line.¹³ At first, they may write this off as temporary or random chance. But, as the realization sets in that they aren't going to earn what they expected, so agents recall with discomfort the fact that they never really had a solid basis for their forecasts. Panic may ensue as their error of optimism “is replaced by a contrary

¹³ They may also find profits are being squeezed by the fact that many more restaurants exist at the top of the business cycle than earlier.

‘error of pessimism’” (Keynes 1936: 321). The recession starts (sometimes catastrophically) and we will not recover until the volume of replacement investment described above creates profits sufficient to come as a pleasant surprise to entrepreneurs and bankers.

This does not, by the way, depend on the idea that overinvestment took place. Entrepreneurs did not necessarily build more restaurants than would be profitable at full employment; rather, the problem is that they built them based on expectations that were bound to be disappointed (which, combined with the flimsy foundation of their forecasts, led to panic).

Because of that, slowing the expansion is not a reasonable means of addressing this problem. Keynes discusses the folly of raising interest rates during an upturn at length (which is standard practice at the Federal Reserve, incidentally). If our goal is to fill the bucket, slowly squeezing off the investment hose addresses one problem by creating another.

The Financial Sector Background to Crises

The importance of the financial sector goes beyond the IOU/loan/money-creation process discussed above. Though the other mechanisms constitute a minority of financial market activity, they impact the economy out of proportion to their size and are certainly more dramatic. For example, firm financing via stock sales is actually not very common.¹⁴ Nor can it be, for you can only sell the company once! After that initial offering, the firm never sees a penny from any subsequent sales, which at that point simply represent a transfer of ownership. But, if that same firm decides to finance a later project by borrowing from a bank, you can be sure that the latter will use the current stock price as an indicator of creditworthiness. In addition, a falling stock price can lead owners to replace management or to a buyout that does the same. Management is therefore very sensitive to the results of the resale of their stock even though they do not directly benefit. In this manner, stock prices affect firm behavior and financing beyond the initial offering.

Meanwhile, for other firms those stocks and other financial assets are an important part of their balance sheet. Because this is key to understanding both the Financial Crisis and one of our

¹⁴ Note that in this case, people’s savings **are** the funds used for the financing. For that reason, this process does not create money.

vulnerabilities to cyber attacks, I will go into some detail. Consider first the factors that contribute to the solvency of a commercial bank:

Basics of First National Bank of USNWC

Assets (millions)	Liabilities (millions)
\$60 T Bills \$160 Loans <u>\$20 Reserves</u> Total \$240 million	\$200 Checking \$10 Borrowed Funds <u>\$30 Net Worth</u> Total \$240 million

Items on the left add to the bank’s value while those on the right represent their obligations. Though net worth is not a liability, per se (except in the sense that it is what the bank owes its shareholders), it is included on the right to make the two columns balance. It is the excess of the value of assets over liabilities. In the above example, First National Bank of USNWC owns \$60 million worth of Treasury Bills, which is government debt that offers a low-interest but low-risk financial investment. These add to the bank’s value. So do the loans they have extended, which will be their biggest source of income. They also hold \$20 million in reserves, just in case withdrawals exceed deposits. Consistent with currency federal regulations, this is set at ten percent of checking deposits (see <http://www.federalreserve.gov/monetarypolicy/reservereq.htm>). Were this a world in which no such regulation existed, the ratio of reserves to deposits would be determined solely by what the bank manager thought prudent. On the right, the bank owes its depositors \$200 million in checking and has borrowed \$10 million from households, firms, other banks, or the government. Thus far I have left stocks out of the example but they will be added shortly.

To review a bit of what was discussed above but in this new context, the following is how a bank loan shows up on its balance sheet. Say an entrepreneur approaches the loan officer with an investment project that the latter thinks will be very profitable. She will scramble to make this loan as soon as possible so that the customer will not go to a competing bank. She does not need anyone’s savings, nor will she even bother to worry about the requirement that she have ten percent of deposits in reserve. This is so because, by law, she has fourteen days to meet the

latter.¹⁵ And so, assuming a loan of \$10 million, the balance sheet changes as follows (new values are italicized):

Loan for First National Bank of USNWC

Assets (millions)	Liabilities (millions)
\$60 T Bills	\$210 Checking
\$170 Loans	\$10 Borrowed Funds
<u>\$20</u> Reserves	<u>\$30</u> Net Worth
Total \$250 million	Total \$250 million

Bank assets have increased to \$250 million because they have an additional ten million in loans on the books. Meanwhile, since the manner in which the loan was extended was by creating (out of thin air) a checking deposit for the entrepreneur in the amount of ten million, liabilities rise by the same amount. The books again balance and were it not for the Federal Reserve's requirement regarding reserves we would be done. Instead, the bank has a couple of choices. The first thing they will likely do is check the federal funds market, which is the interbank market for reserves, to see if other banks had any excess. Since under normal circumstances reserves earn no interest, those with excess will be happy to loan them out overnight.¹⁶ This counts toward meeting the requirement and in that event, the balance sheet would change as follows (new values subsequent to the loan are italicized):

Loan Consequences for First National Bank of USNWC

Assets (millions)	Liabilities (millions)
\$60 T Bills	\$210 Checking
\$170 Loans	<i>\$11</i> Borrowed Funds
<u><i>\$21</i></u> Reserves	<u><i>\$30</i></u> Net Worth
Total <i>\$251</i> million	Total <i>\$251</i> million

Borrowed funds (and liabilities) rose by one million, as did reserves (and assets).

¹⁵ It is a bit more complicated than that (she needs to hit the target based on a fourteen-day average of deposits), but the fact remains that she has time to meet the target.

¹⁶ After the Financial Crisis emergency measures were introduced that did pay interest, but these will eventually be suspended

It is quite possible, however, that the entire banking system is short of reserves. This would be very likely during an expansion. In that event, the federal funds market will not be a viable alternative and banks will compete for the available reserves. This will drive up interest rates. If the Federal Reserve has not changed its interest rate target, this will be an unwelcome development and they will therefore offer to buy assets from banks to make sure that rates remain stable. The balance sheet below shows this possibility (new values subsequent to the loan are italicized):

Reserves Poor Banking and First National Bank of USNWC

Assets (millions)	Liabilities (millions)
\$59 T Bills	\$210 Checking
\$170 Loans	\$10 Borrowed Funds
<i>\$21 Reserves</i>	<i>\$30 Net Worth</i>
Total \$250 million	Total \$250 million

Note that in this event, neither total assets nor total liabilities change, only the form in which the former is held. Here, it is assumed that the Federal Reserve purchased one million dollars worth of Treasury Bills from FNB of USNWC, the proceeds of the sale being added to reserves. Note further that this implies that central banks, if they are targeting interest rates, are obliged to accommodate private sector needs for reserves. If the banking system runs short, the central bank must supply reserves by buying T Bills. If the banking system finds itself with net excess reserves, the Fed will soak them up by selling T Bills (which banks would prefer since they pay interest).

Commercial banks and similar institutions therefore do not realistically face any reserve constraints in lending. If they believe that customers are proposing profitable projects, loans are made with little thought to the reserve requirement (and absolutely no thought to making sure they have enough of people’s savings in the vault—they do not need them). An important constraint does exist, however, and one that featured in the Financial Crisis. Furthermore, it could represent a point of vulnerability to cyber attack. It is net worth.

The ratio of net worth (or capital) to assets is key to the institution’s financial health. Using the last balance sheet above, for FNB of USNWC that figure is \$30 million/\$250 million,

or 12%. This means that while at present liquidating all its assets would allow the bank to both pay all its creditors and walk away with \$30 million, *it could no longer do so if the value of its assets fell by more than 12%*. The bank would become insolvent and management should expect a knock on the door by federal regulators who will decide whether or not to shut down the institution— and maybe set a few examples pour encourager les autres.

The real risk therefore lies not in having insufficient reserves, but in the chance that asset values decline. The likelihood that such a disaster strikes varies considerably with the type of asset in question. In this example, two of the three are very safe. Reserves are already cash and T Bills have a near zero chance of default. But, loans--indispensable to the bank as their main source of income and therefore their preferred asset--are vulnerable. If defaults force them to write off a sufficient dollar value, this could spell trouble. As that number changes from \$170 million to \$169 million to \$168 million, so net worth falls from \$30 million to \$29 million to \$28 million. And if the banking system as a whole is experiencing such a write down, everyone will become increasingly hesitant to extend new loans. This, of course, makes any economic recovery even more difficult as firms absolutely need loans for investment and many day-to-day activities.

All this said, rapid changes in the bank's loan portfolio, while possible, are unlikely. Generally speaking, they should have at least some notice of trouble brewing on that front. However, imagine instead that the entry for loans was instead stocks (or subprime derivatives!). These can change dramatically and without warning. In 2008, the market lost 21% in about a week. Taking the above balance sheet and substituting stocks for loans, that would leave the bank with $\$170 \text{ million} \times 21\% = \35.7 million less in assets and a net worth of $-\$5.7 \text{ million}$ —insolvency. Or assuming instead that the loans remained the same but the bank held stocks instead of the \$59 million in T Bills, this would see their net worth fall from \$30 billion to \$17.61 million. This is why commercial banks are restricted in the volume and type of assets they own. Other financial institutions (including shadow banks, or financial institutions that issue cash-like assets but are not subject to the same restrictions) are not similarly as limited, however, and those holding large volumes of subprime derivatives, for example, were dangerously exposed before the crisis.¹⁷ In 2008, Lehman Brothers net worth-to-assets ratio was somewhere

¹⁷ I will not go into great detail on how non-bank financial institutions work on the assumption that the essential lessons are clear from the above. In short, they do not create money in the same way commercial banks do and instead provide a variety of other services like brokering, risk pooling, and contractual saving. See, for example,

in the range of three to five percent—they were just a three to five percent depreciation of assets away from insolvency. Apparently, this was not enough.

Thus, while stocks (and bonds and financial derivatives) play a relatively small role in the financing of most activities, their values are not only extremely important to the original issuer but also in determining the health of those institutions who later hold them.¹⁸ Fluctuations in asset prices can wreak havoc on the ability of the financial system to provide the funding necessary to keep the investment hose is open and flowing. The critical shortage of funding after the Financial Crisis, a result of the collapse in asset (and housing) prices, simply compounded the problems we were already experiencing. It is not just your retirement savings at risk when institutions fail, it has a decisive impact on current spending and employment, too, and is thus squeezing off the investment hose because firms cannot get access to credit. This is why the Federal Reserve monitors banks' net worth-to-asset ratios and sets the formula by which these should be measured and the minimum value permitted. That the latter was raised after the Financial Crisis while the required reserve ratio remained unchanged is evidence of their relative importance.

Not answered so far is what determines stock and other financial asset prices. After all, if it is a stable, rational process whose inputs are based on the fundamental determinants of the profitability of the asset issuer, then we have little to fear in terms of a sudden collapse in asset prices that might lead to financial havoc. Unfortunately, those undertaking financial investment face the same root problem of fundamental uncertainty as those involved in physical investment. This means that objective mathematical forecasts are impossible and so we are once again left to depend on animal spirits for the ultimate force driving asset agents' purchases. One significant difference here is the relative ease with which an individual can divest herself of an asset. While it is difficult to sell a second-hand restaurant, there is an extremely well-organized and quite popular market for second-hand financial assets. Hence, individuals are less reluctant to commit here than is true with physical investment.

Werner (2014) for further discussion. The near-exception is shadow banking, which issues assets claimed to be as safe as cash. This cannot be true, however, as they do not boast the same federal guarantees (Adrian and Ashcraft 2012). Subprime derivatives were marketed this way.

¹⁸ They play a more important role in certain sectors, however, like venture capital for riskier endeavors.

That is, however, a mixed blessing. On the one hand, it adds depth to the market; on the other, it tends to attract large numbers of ill-informed, poorly prepared buyers (who assume they can get out if things go bad). This is particularly true during booms when everyone is convinced that they are a genius because prices continue to rise. The reality is that under such circumstances almost any conceivable portfolio of assets appreciates. It is easy to see how bubbles emerge under these circumstances and why they eventually burst when the profits of the issuers do not justify the stock prices (recall what profits tend to do at the top of the business cycle and as expansion turns to recession). In fact, there exists a litany of psychological and environmental reasons (in addition to the interaction between fundamental uncertainty and animal spirits) to expect stock prices to separate themselves from fundamental determinants for extended periods and to exhibit considerable volatility (see pages 97-100 in Harvey 2015). Among these is the fact that both individuals and financial institutions are constantly tempted to take greater risks since these promise higher returns. This is especially during calm periods, which Steve Keen warns us not to accept as anything “other than a lull before the storm” (Keen 1995: 634).

Cyber Insecurity and National Economic Instability

The above paints a picture of an economic system where there are plenty of instabilities even without adding to the mix a large volume of bad actors who hope to exploit and destabilize it through cyber access and tools. Employment depends on the volume of water in the leaky bucket, which means that it depends on the flow of water from the investment hose. Meanwhile, investment turns out to be the most volatile component of GDP. This is so because it does not occur unless entrepreneurs’ (and those of the bankers who must fund them) ‘animal spirits’ are sufficient to overcome the fact that this very expensive, long-term, and practically irreversible decision must be made without conclusive evidence. The last is the inescapable consequence of living in a world where we never know all the possible outcomes or their likelihoods.

Business optimism is easily upset and is therefore a weak link. Keynes recognized this even in 1936:

“This means, unfortunately, not only that slumps and depressions are exaggerated in degree, but that economic prosperity is excessively dependent on a political and social atmosphere which is congenial to the average business man. If the fear of a Labour Government or a New Deal depresses enterprise, this need not be the result either of a reasonable calculation or of a plot with political intent;—it is the mere consequence of upsetting the delicate balance of spontaneous optimism. In

estimating the prospects of investment, we must have regard, therefore, to the nerves and hysteria and even the digestions and reactions to the weather of those upon whose spontaneous activity it largely depends” (Keynes 1936: 162).

And while it need not be the result of a “plot with political intent,” it certainly may be. The advantage for the attacker here – whether cyber or no – is that there are so many avenues in a complex integrated national system by which one can upset the “delicate balance of spontaneous optimism.” Attacks on infrastructure would be terribly disruptive. They could, for example, interrupt supply and distribution lines (Dubowitz and Fixler 2015: 33) and energy sources like oil and natural gas (Shulsky 2015: 57-8). Furthermore, the internet itself has become central to sales, communication, and coordination for nearly all firms in modern democracies (Shulsky 2015: 59-60). Outages would be costly – even if ephemeral – and repeated outages would increase anxiety and reduce animal spirits. Nor do attacks need to be exclusively economic or physical to have such effects. Russian efforts at undermining our confidence in the electoral process, for example, have disrupted American life well beyond November 8 and January 20 and created a divisive atmosphere of fear and distrust (Ravich and Fixler 2017:14-5). All of these dampen spontaneous optimism and therefore all act to squeeze off the flow of water from the investment hose.

To add yet another layer of danger, no flow is possible without financing. On the one hand, the fact that banks create money at will is a plus. It means that we are not dependent on anyone else to create the funds necessary for investment or to provide mines to happen to discover just the right amount of gold or silver at the right time. On the other hand, - and as emphasized above – that entire system is built around trust. It is a series of interrelated promises to pay someone else in the future (typically with someone else’s promise). Money is not paper and metal, it is an entry on a computer screen. It can, unlike a dollar bill, disappear. It is no doubt for this reason that so much has been written on the vulnerability of finance to cyber attack. Perhaps the most terrifying to business and the community at large would be a hack that erased the names of depositors. Replacing lost funds would not be that difficult from a practical perspective because, again, they are just electronic. The government could easily play such a role in easing fears (in a manner similar to that they employ following conventional financial crises). The absence, however, of a record of who lost what would very quickly drive people to seek alternatives to the regulated banking system. This would have national system-wide negative

consequences for consumption, investment, and animal spirits. The investment hose would slow and the saving leak get larger. The turmoil would serve adversaries interests, especially if they are able to maintain opacity in their role in stimulating or enhancing this loss of depositor names at critical moments.

Strikes on the financial market aimed at driving down asset prices would also be effective a number of levels. To start, they would create panic by reducing the value of people's savings and retirement portfolios. Second, it would make problematic the funding of those projects that do not rely on bank loans (like venture capital). Third – and what may be most significant – is the impact that precipitous declines in asset values would have on the solvency of financial and nonfinancial firms alike. As shown above, it does not necessarily take a large fall to push net worth near, to, or below zero so that what had otherwise been a safe net worth-to-assets ratio can suddenly become problematic. That this could affect so many businesses at once makes it a particularly useful avenue of attack for adversaries or their proxies in a cybered world.

Implications: More hoses, Government Spending, and Government Debt

The news is not all bad, however. One may wonder how, if the above is accurate, we are not in a constant state of recession or very sluggish growth even without cyber attacks. The reason is that in the real world, there are two more hoses filling the bucket: government spending and exports (or G and X). And although this means there are also two additional leaks (taxes and imports, or T and M), the net impact is almost always positive.¹⁹ Dealing first with exports versus imports, this is actually a net leakage. The US buys more from the rest of the world than they do from us, meaning that the export hose does not offset the import hole. In 2015, with US GDP around \$18 trillion, the trade deficit was \$0.5 trillion (a level around which it has varied for the past fifteen years). This is not huge, but it is nevertheless negative.

On the other hand, the government spending hose has added more than taxation has subtracted every year since the end of the Clinton administration. While last year this was barely sufficient to offset the trade deficit (thus leaving investment to do the heavy lifting), from 2009

¹⁹ Note that with the addition of the new hoses and holes, it is no longer necessary for $S = I$ in equilibrium. Now, with this more realistic model, total leakages ($S + M + T$) must equal total injections ($I + X + G$) but there is no assumption that any of the individual pairs match one another.

through 2012 the net addition was at least \$1 trillion every year. This was, of course a function of the fiscal stimulus package passed after the Financial Crisis. But even without such extraordinary measures, the manner in which we program government budgeting causes an automatic increase in $G - T$ whenever the level in the bucket starts to fall. Since a decline in the water level represents a decline in income, this tends to lower T .²⁰ And because more individuals will then automatically qualify for income-support programs like welfare and unemployment, G will rise.²¹ This creates at least a partial buffer against any downturns caused by fluctuations in investment and is a major reason why recessions since WWII have lasted about half as long as those before. The government sector today is much larger than it was before the war, making the automatic stabilization effect much more potent.

Because it has direct implications for cyber security both in terms of a non-vulnerability and in how we can finance reforms, a pervasive myth about national deficits must be addressed at this point. While on the one hand, any net inflow created by the government spending hose minus the taxation leak serves to stimulate the economy and keep the water level high, it also represents a budget deficit and an addition to the national debt. Thus, many worry that any short-term benefit may be offset by the long-term costs. But such concerns are based on a fundamental misunderstanding of how the process works. Despite what is written on innumerable blogs and doomsday web sites (usually loaded with pop ups about buying gold and survival items), federal government debt is not analogous to that of a household or firm. It is, first and foremost, impossible for the US to be forced to default on the national debt—not unlikely, not improbable – but impossible. This is so because 100% of our debt (unlike that of Greece and most developing and transitional economies) is in our own currency. We do not have to earn or borrow dollars; we make them. Were China to suddenly cash in all of its US government debt (which would not, incidentally, be in their best interest), we could create the new dollars at the drop of a hat and from thin air. Indeed, we already do so continuously. Before I expand on that and because this is so poorly understood, let me cite others making the contention that the US cannot be forced to default.

²⁰ Since we have a progressive tax system, the actual size of the hole would even shrink as people fell into lower brackets.

²¹ Note, too, that G also benefits from the multiplier effect mentioned in footnote 13.

“In the case of governments boasting monetary sovereignty and debt denominated in its own currency, like the United States (but also Japan and the UK), it is technically impossible to fall into debt default” (Mahe 2011).

Erwan Mahe, European asset allocation and options strategies adviser

“There is never a risk of default for a sovereign nation that issues its own free-floating currency and where its debts are denominated in that currency” (Market Wired 2011).

Mike Norman, Chief Economist for John Thomas Financial

“As the sole manufacturer of dollars, whose debt is denominated in dollars, the U.S. government can never become insolvent, i.e., unable to pay its bills. In this sense, the government is not dependent on credit markets to remain operational” (Fawley and Juvenal 2011).

Federal Reserve Bank of St. Louis

“The necessity for a government to tax in order to maintain both its independence and its solvency is true for state and local governments, but it is not true for a national government” (Ruml 1946).

Beardsley Ruml, Chair Federal Reserve Bank of New York (1937-1947)

“The United States can pay any debt it has because we can always print money to do that. So there is zero probability of default” (Allen 2011).

“Central banks can issue currency, a non-interest-bearing claim on the government, effectively without limit” (Greenspan 1997).

Alan Greenspan, Chair of the Federal Reserve (1987-2006)

“A sovereign government can always make payments as they come due by crediting bank accounts — something recognized by Chairman Ben Bernanke when he said the Fed spends by marking up the size of the reserve accounts of banks” (Wray 2011).

L. Randall Wray, Professor of Economics at Bard College, Senior Scholar at the Levy Economics Institute, and Co- Editor of the Journal of Post Keynesian Economics

“In the case of United States, default is absolutely impossible. All U.S. government debt is denominated in U.S. dollar assets” (Zeihan 2011).

Peter Zeihan, Vice President of Analysis for STRATFOR

“I am not worried about the deficit. It is big enough to take care of itself” (Saikowski 1984).

Ronald Reagan, President of the United States (1981-1989) Gridiron Club annual dinner, Mar. 24, 1984

“Reagan proved that deficits don’t matter” (Dayen 2016).

Dick Cheney, Vice President of the United States (2001-2009)

While appeal from authority is generally frowned upon, this issue is not a theoretical one, but a legal and practical one. If you promise to repay in a medium that you are allowed to produce at will, you can never fail to meet a payment. Note, too, that these cites come from a variety of sources including scholars, public officials, private investors, and Federal Reserve researchers. In terms of the federal government’s budget, default is simply off the table as a potential issue.

One may wonder whether or not this means that we simply print money to finance federal government deficits. Yes we do, with the exceptions that the money is electronic (and hence it is not “printed”) and the process followed is indirect. In order to generate the cash flow necessary to cover a deficit, the Treasury Department sells Treasury securities. The vast majority of these are purchased by *primary dealers*, who have agreed in advance to buy as many as the government wishes to sell (with an eye toward profiting from resale). Significantly, the Treasury is not allowed to sell securities directly to the Federal Reserve. Recall from above that the Fed regularly buys and sells Treasury bills from banks in order to adjust reserve levels and maintain interest rate targets. This creates (when the Fed buys a Treasury bill) and destroys (when they sell a Treasury bill) money. What they are not allowed to do, however, is buy those Treasury bills

directly from the Treasury. The reason for this is to prevent one government agency (the Federal Reserve) from automatically creating the financing for the other (the Treasury). But for all intent and purposes, that is exactly what happens.

The reason is that primary dealers **are** permitted to sell their Treasury securities to the Fed. Thus, with the exception that they must go through an intermediary, the Treasury trades their securities for cash from the Fed. This is illustrated in Figure 2. The Fed is all but obligated to carry out this transaction (i.e, to purchase the newly-sold Treasury bills) so long as the Fed is targeting a specific interest rate. This is so because the Treasury's sale of securities adds to the overall demand for cash (the Treasury's demand for cash has been added to everyone else's) and is therefore likely to drive interest rates up. If the Fed does not inject new cash into the financial system to replace that withdrawn by the Treasury, banks required reserve targets are likely to come up short. If this resulted in competition among banks for reserves then interest rates would rise, frustrating the Fed's attempt to target them. This is precisely why the Treasury always contacts the Fed before a new sale. They are not just being polite, the latter needs to be prepared to act to neutralize the impact of the Treasury Department's sale.

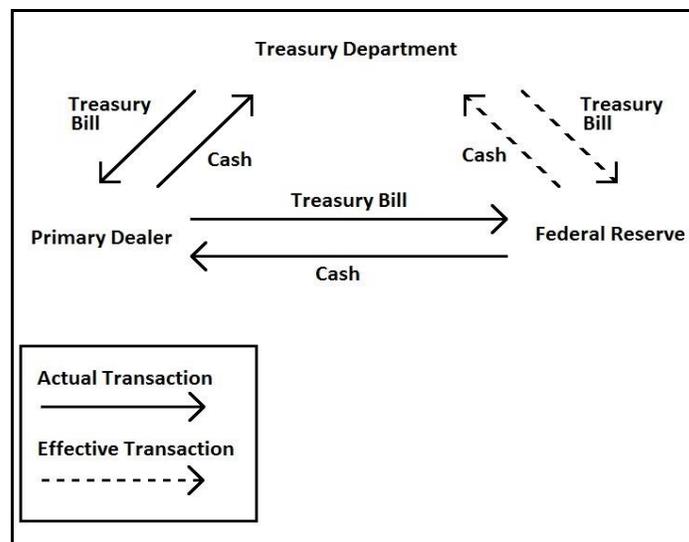


Figure 2: How the Federal Reserve effectively purchases T Bills from the Treasury for cash.

What this establishes so far is that the US cannot be forced to default on debt issued in its own currency because we can create dollars at will and that we do precisely that whenever the

Treasury sells securities to finance a budget deficit.²² Though legally prohibited from directly funding Treasury activities, this is in effect what the Fed does via an intermediary (primary dealers). Only in the event that they have changed their interest-rate target would they act differently. Generally speaking, the government “prints” money to finance operations.

Contrary to popular belief, this does not automatically cause inflation. It may, but only under unusual (and otherwise positive!) circumstances and even then not because of the printing of money but as a result of the government spending it was used to finance. Consider, for example, the fact that after the Financial Crisis, the deficit (as a percent of GDP) rose to levels not seen since WWII, and yet inflation has been practically non-existent. This has been despite the fact that the Fed bought so much of the debt that the Chair of the Fed was being called “Helicopter Ben.”²³ But there is no reason to expect stimulation of the economy to cause inflation if we are at less than full employment. When firms have excess capacity, the first thing they do in response to an increase in demand is raise production. Only as they near capacity do they start raising prices.

Because most modern democracies tend to engage in high levels of deficit spending only when the economy is in crisis, we almost never see it result in inflation. The major exception for the US was during WWII, when we continued at what are still historic levels of deficit spending while unemployment was under 2%. This would, indeed, have caused terrible inflation, but then that is why FDR enacted rationing and wage and price controls. Deficit spending thus tends to be inflationary whenever conditions are such that we do not need to deficit spend (at least for economic reasons)! It would be akin to increasing the volume on the government spending hose when the investment and exports hoses have already filled the bucket net of the three holes.

These issues are important both because they indicate that US federal government debt is **not** a source of potential cyber vulnerability, but also that funding any counter measures should not be (economically if not politically) problematic up to the point of full employment. The government does not have to “find” the money for programs in the way generally portrayed in the media and politics. We know exactly where it is: at the Fed! And while continuing to raise government spending when our resources are fully employed is potentially inflationary, that’s a

²² Note that this is in addition to the money created by commercial banks as they make loans.

²³ In reference to a famous article by Milton Friedman in which he uses a helicopter to increase the money supply.

good problem to have. At the macro level, money is never a binding constraint, only resources are.²⁴

International economics

Ours is not the only bucket in the world, of course. In reality, we have a series of interconnected ones, linked both by the import and export flows and financial markets. Dealing with the latter first, these represent by far the most common cross-border transaction. There are roughly ten currency market transactions aimed at securing a foreign financial asset to every one undertaken in order to buy a foreign good or service. Exchange rates are therefore essentially determined by the relative attractiveness of national financial capital markets. This is why currency prices are so volatile and have no tendency to move in a way that eliminate trade imbalances. Were exchange rates actually driven by imports and exports, then currencies of deficit nations would tend to depreciate since those deficits would necessarily correspond to a relative lack of demand for that nation's currency. If no one wants Japanese goods and services then no one wants the yen and it would fall, thus making Japanese goods and services more competitive. But if this is instead a world dominated by financial capital flows and Japanese financial assets are very popular, then this can easily offset the unpopularity of their goods and services. Nations can therefore have a trade deficit or surplus indefinitely and this is the situation we actually face.

Exchange rates and trade flows

Currency prices are therefore subject to many of the forces discussed above when considering financial markets. They, too, are caught up in the same animal spirits vs uncertainty issues and thus psychological factors can play a significant role in driving exchange rates. Consider as evidence the fact that in the two years leading up to the opening of the financial crisis the dollar lost 28% of its value against the euro. It then rose by 18% over the next year, fell 17% in the next nine months, rose 16% for the following seven, and finally fell 18% in the next

²⁴ One may wonder if the federal government even needs to tax under these circumstances. It does for two reasons: taxes can achieve purposes other than funding (e.g., income distribution or encouraging certain types of activity like charitable giving) and it creates a base value for the dollar. If dollars are the only thing the Treasury will accept in payment for taxes, it creates a reason for people to hold and use dollars. There is nothing else backing up the dollar or compelling people to use them in lieu of other forms of currency.

twelve (leading up to June 2011; Harvey 2012). This is typical and it is extremely difficult to justify in terms of changes in the fundamental determinants of the relative strengths of the economies in question. Bear in mind that exchange rates are prices and consider the public reaction had we suffered general inflation and deflation at these rates. It would have been considered a national disaster. Even during the oil crises of the 1970s and 1980s, U.S. inflation never reached 14% (it averaged 8.75% from 1973 to 1982).

Such volatility is a function of the fact that currency prices are so tightly linked to already volatile financial markets (Quinn and Harvey 1998). Overreaction is common and crashes and crises in currency markets are directly related to the same events in domestic financial ones. Contagion moves in both directions. Meanwhile, those trading goods and services must do so at the prices set by these largely unrelated processes. Note first the difficulty an importer/exporter would have in maintaining profitability in the face of such fluctuations. This has a tendency to drive the small entrepreneur out of the market and leave it more concentrated, one of the things we hope to avoid in capitalism. Second, it means that a nation with very popular financial assets will find it more difficult to export and vice versa. This is one of the reasons why, when the Thai baht collapsed after the Asian financial crisis in 1997, their trade account suddenly shifted from deficit to surplus.²⁵ The very same thing happened in Mexico after their financial crisis in 1994. The financial market set the exchange rate which influenced trade flows.

It should not be read, however, that currency prices are the only factor affecting trade flows. *Ceteris paribus*, resource costs also play an important role as does technology (Milberg and Winkler 2013). Simply put, lower costs and more advanced technology both increase exports. The former is often derivative of lower wages, reduced protections for labor, and the absence of environmental regulations. The Chinese hold a considerable “advantage” here and we have little reason to want to try to compete with them along this particular dimension! Technology, on the other hand, is a different matter. Not only does technology-gap trade theory suggest that nations with a leg up tend to experience a virtuous cycle in staying ahead of their competitors (Vieira and Elmslie 1999), but it puts them in a very powerful position in the global supply chain (Milberg and Winkler 2013: 103-56). The fundamental nature of international production has changed over the past thirty years. Firms have increasingly sought to break the

²⁵ People also had a lot less income with which to buy foreign goods and services.

process into multiple segments, keeping for themselves the most profitable stages and outsourcing the others. The lead firm in the chain is able--indeed, intends--to pressure, cajole, or manipulate the others so as to earn the highest possible profits. This includes, for example, making potential manufacturers compete among themselves for the right to assemble the product in question. The power to do is often a function of proprietary advantages. Brand, management techniques, and, of course, technology feature prominently. While on the one hand, we should want to avoid such concentrations power as these dilute the advantages of capitalism, on the other if it is going to happen then better us than them.

Cyber Issues Changing International Economics

Many of the factors covered in section 2 remain important. Financing, for example, is still critical to business. In fact, there is considerable evidence that part of the collapse of trade following the Financial Crisis was simply because importers were unable to secure credit (Auboin 2015). This, therefore, remains a vulnerability (though one the Chinese might not want to exploit for as long as they need to continue selling to us or have not yet replaced the US' markets in those in Africa or elsewhere in Asia!). Meanwhile, any financial market volatility or crises perpetrated by bad actors through extractive or disruptive cyber campaigns would certainly be transferred directly to currency markets. If the Dow Jones collapsed or was so often disrupted that it became viewed as crippled, the dollar would follow suit. As the latter would actually make US goods and services more attractive, this would likely not be a primary goal but simply a side effect. In any event, the increase in exports would hardly offset the damage elsewhere.

Another internationally-related issue is the impact of lost technology on US firms' position in the value chain. The theft of proprietary knowledge was not discussed in section 3 as its effect is harder to gauge at that level. One could potentially have solid growth and full employment without playing host to any cutting-edge industries. It may affect the standard of living enjoyed by citizens but, again, this is uncertain and nevertheless impossible to judge given the tools employed above. Here, however, the impact is obvious: the power of US and allies to dominate the value chain as we have done since WWII is profoundly – possibly irremediably – diminished as our technological advantages are lost. While this can already occur as a result of normal market competition, it is an expressed goal of cyber espionage and, more recently, cyber economic coercion or even operational sabotage through third parties. Losing industrial secrets

to foreign powers not only constitutes a national security risk, it pushes us down the hierarchy of international global supply chains. Economically and politically, we want to be the country dictating terms and not competing to be the low-cost producer. Recall, too, that research shows that gaining advantages tends to create a virtuous circle of continued dominance over years and even decades. Losing such advantages over ten to fifteen years due to massive IP theft, for example as the US and EU have to China, has the obvious adverse longterm effects on our national competitive wellbeing. We cannot defend in the future because we did not understand how to defend economically in a cybered world today.

Conclusions

A proper understanding of what drives economic activity is indispensable to designing effective cyber defenses. While elementary, the approach outlined in this article describes an economic system that is unstable and has vulnerabilities on a number of dimensions. In some ways, however, that is the easy part. The more difficult step may be in getting reforms implemented for, even without the philosophical and political objections suggested above, ours is a democratic society in which the rights of individual citizens are assumed to trump those of the collective. If the best interests of these two do not coincide, as is the case here since security measures will almost certainly add costs, coercion may appear to be the only solution.

The trick seems to be to change the incentive structure. Rather than simply forcing firms and consumers to adopt certain practices, we could reward them for doing so. Tax breaks and subsidies are likely to be viewed as more consistent with our political philosophy than fines and penalties, even though they achieve the same purpose. In addition, recall that the federal government is not dependent on taxes for funding so that we could afford to implement such a policy up to the point of full employment (at which point tradeoffs would become necessary). And for whatever resistance may remain, we may be able to borrow the flag and apple pie from our opponents. Indeed, for our purposes, these would be appropriate symbols and not a smoke screen.

APPENDIX

Above and beyond the question of economic theory and modeling, there are certain basic concepts that may require clarification if effective communication between economists and cyber security scholars is to take place.²⁶ Starting at the highest level of analysis, what an economist means by the word paradigm is often quite different from what the non-economist means. For the former, it is the approach adopted by a community of scholars to explain economic behavior and institutions. School of thought, while arguably more narrow, means largely the same thing.

Paradigms or schools of thought include Neoclassicism, Marxism, Austrianism, and Institutionalism. What they do not include are capitalism, socialism, communism, mercantilism, free trade, feudalism, imperialism, and the like. These are to economists economic systems, not paradigms. They are what a particular paradigm or school of thought might study. Narrowing the focus slightly, a model would mean a set of assumptions and theories used to explain an aspect of an economic system. Paradigm, school of thought, and model are all related to economic theory but not (except insofar as they are used to explain them) economic systems.

Confusion can also arise over the meanings of micro versus macro economics. While it is not entirely incorrect to view the former as small scale phenomena (individuals, households, and firms) and the latter as large scale (entire nations), this is useful only as a starting point. The problem is that economists tend to categorize their sub disciplines by the tools of analysis most often employed rather than any sense of size. For example, while international trade is most clearly a large-scale phenomenon, it is generally viewed as a micro field because it uses models and concepts derived from the study of individuals, households, and firms (most importantly, opportunity cost tradeoffs in a state of full employment—more on the latter term shortly). Similarly, the economics of labor markets is generally viewed as micro. On the other hand, exchange rates and international capital flows are macro. This is further muddled by the fact that these demarcations may actually be specific to a single school of thought.

Speaking of labor, economists often make reference to something called “full employment.” While it is probably safe to say that the lay public understands that this does not mean zero unemployment, there is nevertheless a tendency to want to associate it with a

²⁶ My choice of subject matter here is informed by my participation in the “Cyber, Security, and Economics: Challenging to Current Thinking, Presumptions, and Future Cyber Defense Transformations” workshop at the Naval War College in December 2016. These are the topics where I thought the most confusion existed.

particular number. Economists are sometimes tempted to do the same, but are really more focused on the underlying theory. First off, we mean only involuntary unemployment. Those who choose not to seek employment for whatever reason are not included. Hence, the unemployment rate is the ratio of unsuccessful job seekers to all job seekers (both successful and unsuccessful). Second, no attempt is made in the basic unemployment rate to account for underemployment (a cyber security expert working as a greeter at WalMart), the quality of the jobs held, the number of discouraged workers (who no longer show up in the standard statistic because they are not job seekers), and other factors that clearly and directly impact on the quality of life of the worker. That said, the Bureau of Labor Statistics does generate alternate measures that attempt to account for these (something of which the general public seems to be increasingly aware). But, strictly speaking, these are not considered when thinking of “full employment.”

Given this, economists generally attribute the inability to find a job to one of three things:

1. Structural Factors: The individual’s skill set does not match current labor market needs. Foreexample, someone who is an expert in repairing eight-track players, regardless of their work ethic and experience, is unlikely to find gainful employment today!
2. Frictional Factors: One of the features of a capitalist system is supposed to be that firms with inferior products or higher prices go bankrupt. Since their employees will not, regardless of their individual qualifications, find new jobs instantaneously, they will add to the unemployment rate at least temporarily.
3. Cyclical: Even well-managed firms with industrious and highly skilled workers can go bankrupt in the wake of a significant fall in the level of economic activity. Recessions create unemployment that is not directly related to either out-of-date skill sets or market competition.

While all of these could be mitigated to an extent, *full employment refers only to the situation that prevails when cyclical unemployment is reduced to zero*. This is not, of course, a specific number we can then target. That said, it does give a clear goal: avoid downturns in the level of economic activity. And so while you may get some argument among economists regarding whether full employment is 5%, 4%, or 3%, they are nevertheless largely agreed on what they

are trying to accomplish: the reduction of unemployment until it is only structural and frictional.²⁷

So far, these definitions and distinctions have been fairly standard. What follows hereafter, however, is more closely related to Post Keynesianism.²⁶ To start, capitalism (a term actually invented by Karl Marx) is not a natural system, it is a human institution. It is a tool, just one possible means of determining the allocation of resources to the production of goods and services and the distribution of the latter among the populace.²⁸ Markets are to the economy as hammers are to carpentry. Not only are they ideal for some tasks and ill-suited to others, but there is more than one variety. Markets are neither evil nor brought down from Mount Sinai by Moses (on a third tablet etched with a supply and demand diagram). It makes as much sense to say that you are pro-market as it would for a carpenter to say she is pro-hammer (short of meaning that she is glad there is one in her tool box). Ideology has no place in useful economic analysis.

Another area of confusion regards “market efficiency.” This term is often used in an objective, engineering sense and as if it were an absolute good. It is not that simple. Indeed, there may be times when we wish the market were not efficient!

Market efficiency is essentially the speed with which relevant information is reflected in the market price. As such, it is typically used to describe conditions in financial markets, but it may be easier to start with something more basic. Say a report is released that a particular model of automobile has an electrical wiring problem that makes it a fire hazard. Assuming the public really cares about this issue, the price of that vehicle should fall, and rather quickly. If it does not, that is evidence of an inefficient market. On the flip side, if it is somehow determined that consuming eggs prevents cancer and once again the public cares, then we should expect the price of an egg to rise. If it does not, this, too, suggests that the market is inefficient.

From the description so far one could reasonably conclude that market efficiency is, indeed, an objective measure: the faster relevant information is reflected in prices, the more

²⁷ These, too, could be reduced of course, but as the means of doing so (retraining programs and centralized job banks, for example) tend to be more long term in nature, they are usually ignored in discussions of how to achieve full employment (which involves solving a short-term issue). ²⁶ It is also closely related to Institutionalism, another school of thought that I would recommend to the cyber community but will not discuss here.

²⁸ Command can do this instead, as in ancient civilizations or feudalism. Some authority decrees who will do what and how they will be rewarded. Tradition can play a similar role. Indeed, both of these were dominant throughout most of human history and elements of each remain today.

efficient the market. In a very strict sense one could make such an argument. But the problem is the word “relevant,” for this is subjective and a function of the values of the society in question. Take for example a racist culture. If the wage paid to the oppressed race were equal to that of the dominant one, this would imply that the society’s racism was not showing up in the wage structure. Relevant information, which in this racist culture includes the race of the worker, is not being reflected in the market price. In an efficient market, oppressed-race workers would be paid less. Likewise, in a society where status is highly valued, an efficient market would value luxury goods such as designer clothes, diamonds, and country club memberships higher than (relative to a society where status is not valued) those of more pragmatic items including books, healthy foods, and fuel-efficient cars. Meanwhile, in a culture that praises scientific achievement, the structure of earnings across careers will be such that the best and brightest are more likely to be attracted to engineering than modeling. Though some of these examples may be extreme, it is not idle conjecture. These are issues that exist in the real world and have played a significant role in, for example, the lack of economic development in some nations (James 1996).

All that said, it is likely that in many cases we would, indeed, prefer market efficiency. But is nevertheless important to keep in mind the fact that markets are just people and one of the factors determining prices is the weighted (by the distribution of income) expression of their values—no matter how twisted or noble. Having an efficient market does not guarantee that a nation will advance more quickly, nor are markets mechanistic arbiters of justice. In the maze of graphs and equations it is easy to lose sight of the fact that what we are really studying is homo sapien behavior.

One last common fallacy to be addressed is the idea that capitalism is pro-business. The truth is quite the opposite. A key premise of Adam Smith’s analysis was that we cannot trust entrepreneurs:

“People of the same trade seldom meet together, even for merriment and diversion, but the conversation ends in a conspiracy against the public, or in some contrivance to raise prices” (An Inquiry into the Nature and Causes of the Wealth of Nations, Book I, Chapter X).

Thus, we must design a system that weakens individual businesses to the point that they are forced to do the bidding of their customers. This is achieved primarily via competition. A healthy capitalist economy is one in which there is a wide diffusion of power with many firms fighting it

out for the consumer's dollar. The alternative, industry concentration leading to monopoly and oligopoly, greatly reduces the benefits of a capitalist system.²⁹ One must therefore be very careful to consider the impact of regulations and rulings on the power of business relative to consumers—especially when industry leaders appear to be in favor of them! Corporate lobbyists are paid to represent the corporation and increased competition is rarely good for profits. What is good for Wall Street is not necessarily good for Main Street.

²⁹ Interestingly, Adam Smith was not dead set against unions. He believed that even in a competitive market, there was no question as to who held the upper hand in the wage negotiation.

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