

# Beyond Pangloss: Financial sector origins of inefficient economic booms\*

Frederic Malherbe<sup>†</sup> and Michael McMahon<sup>‡</sup>

1st July 2019

## Abstract

After financial crises, GDP is typically persistently weak compared to pre-crisis trends. We proposed a simple competitive general equilibrium model to highlight the role that the financial sector may have in boosting investment, GDP and real wages to inefficient levels *before* financial crises. The basic mechanism is that, in equilibrium, government guarantees lead financial institutions to take a Panglossian, best-case view of the world leading to over-investment. Our key innovation is to show that allowing banks to freely trade in financial securities exacerbates the problem. Because loans generate collateral, banks are willing to make lending losses in equilibrium in order to generate trading profit. This leads to behaviour that is consistent with better than best case views of the world. Such beyond Panglossian behaviour lowers welfare despite boosting real wages. We show that the model predictions are consistent with the recent evolution of the US economy and suggests that ex-ante incentives in the financial sector can have strong effects on real economic activity. From this viewpoint, the great recession can look more like a reversing of a great distortion.

---

\*We would like to thank Antonio Fatas, Mark Hassler and Udara Peiris for discussion comments, Alex Clymo, Ricardo Reis, Jean-Charles Rochet, as well as seminar participants at the ABFER “Financial Regulations: Intermediation, Stability and Productivity” conference, Oxford NuCamp-Saïd Macroeconomics Conference Money, Credit, and Financial Stability (2019), the University of Surrey, Paris School of Economics, the Swiss Finance Institute in Geneva, University of Sheffield, the London School of Economics, the Bank of England, the Irish Economic Association Annual Conference, the CEPR Economic Growth Conference, London Business School, Oxford Financial Intermediation Theory (OxFIT) Conference 2017, University of Amsterdam, Universita Carlos III, Universite libre de Bruxelles, the Bundesbank, the ABFER conference, and the Reserve Bank of New Zealand for their useful feedback. Work in progress. Please do not circulate.

<sup>†</sup>University College London and CEPR

<sup>‡</sup>University of Oxford, CEPR, CAGE (Warwick), CfM (LSE), and CAMA (ANU).

# 1 Introduction

In the years after the onset of the financial crisis, there has only been a modest recovery of GDP in affected countries. The cause of this long-lasting weakness of GDP is not clear. It could be that aggregate demand remains highly deficient (Hall 2011, Krugman 2012, Mian and Sufi 2014, Summers 2015). Others argue that supply has weakened for example because shocks to equity financing have persistent effects on TFP through R&D investment Bianchi et al. (2019).<sup>1</sup> In some cases, the weakening of supply is thought to be driven by the weakness of demand propagated by hysteresis effects (Ball 2014, DeLong and Summers 2012) or excessive fiscal consolidation (Fatás and Summers 2015, Crafts 2019). Those who favour one of these demand-driven explanations typically suggest that greater economic stimulus is the correct macroeconomic policy response.

These explanations for the current weakness of output assume, explicitly or implicitly, that the pre-crisis behavior of GDP was normal. In this paper we challenge this assumption. That is, while there are many supply-side narratives for the relative weakness of GDP since the financial crisis, a novel feature of our analysis is that it focuses on factors affecting the run-up, not the aftermath.<sup>2</sup> In fact, our analysis is not at all trying to explain the crisis itself but rather the apparent strength of the economy before it. In particular, we argue that ex-ante incentives created by explicit or implicit government guarantees in the financial sector can have strong effects on real economic activity. These effects are magnified by a more advanced financial system that enables the financial sector to exploit these guarantees. The bottom line is that the pre-crisis strength in GDP may have been inefficiently high.

Our baseline model abstracts from many important aspects of banking / regulation in order to make our point in the most transparent way. The model comprises a banking sector, a firm sector that operates a constant-return-to-scale production function, a household sector that provides labor inelastically, and the rest of the world, populated by risk-neutral agents that provide inter-temporal substitution and insurance. All these agents act competitively. The key ingredients are: (i) investment is risky because it must be committed before the realization of a shock to Total Factor Productivity (TFP); (ii) firms need to borrow from banks, which exposes banks to investment risk; (iii) banks issue liabilities that are guaranteed by the government (for simplicity, we can think of insured deposits).

---

<sup>1</sup>Fernald (2015) argues that the TFP slowdown is separate to the financial disruption and instead it had already slowed before the Great Recession.

<sup>2</sup>A few other papers have focused on the distortion of pre-crisis GDP. But ours is not a story of GDP mismeasurement originating in the financial sector as in Oulton (2013) or Haldane et al. (2010). Nor is our channel a case of two effects that offset each other somewhat before the crisis as in Summers' hypothesis that a financial bubble masked underlying dynamics of secularly low long-term interest rates (Summers, 2014).

The main mechanism works as follows. When banks default, they do not repay depositors in full. Insured depositors do not need to be compensated by a higher return for the risk that the bank does not default. Hence, banks borrow from depositors at artificially low rates. But banks compete for firm lending, which means that they pass this artificially low interest rate onto the firms. Firms, in turn, equate the capital marginal rate of return to the borrowing rate, which leads to over investment in aggregate. This idea that bailout guarantees can lead to over-investment is, for instance, present in McKinnon and Pill (1997). In their paper, households base their decisions on valuations that correspond to the best possible outcome. Krugman (1999) calls these views Panglossian and points out that they can arise in a rational expectation equilibrium due to competition in an under-regulated and over-guaranteed financial sector. This is indeed what happens in our model.

Our first contribution to this literature is highlight simple, but overlooked, general equilibrium effects. Given that firms compete for workers, Panglossian equilibrium behaviour in the financial sector leads to real wage inflation. GDP is also inflated. (And if we include structures as a form of capital in the production function, their price is inflated too). For all realizations of TFP, GDP is higher than it would have been absent the distortion from government guarantees. However, whereas an increase in GDP would be an indicator of improved welfare in our economy without the distortions due to government guarantees, it is not when they are present. Instead, a better measure is Net Domestic Product (GDP adjusted for capital depreciation) because it captures the negative effect of the distortions on consumption. In equilibrium, while expected GDP is inflated, expected NDP is below its first-best value, which reflects the inefficiency of the boom.

In McKinnon and Pill (1997), Krugman (1999), and also in Schneider and Tornell (2004), it is the interaction of the financial sector incentives and access to world capital markets that creates the amplification. As such, the emphasis in these papers was on emerging markets as they liberalise their capital accounts. In our paper, we highlight the amplification that arises when financial innovation and financial deregulation make financial institutions better able to exploit government guarantees. In this sense, our results apply more to advanced economies than emerging markets.

The reason for this magnification of the inefficiency is that, from a bank's private point of view, any repayment it makes to depositors when it defaults corresponds to money left on the table. Hence, the bank has strong incentives to find ways to divert these resources. When banks can trade in securities backed by the assets of their loan book, such diversion of resources is possible. The bank can, for instance, use loans as collateral to fund derivative positions that pay off in the states where it does not default. In such a context, more collateral means more trades and, hence, potentially more profit in the good states at the cost of less left on the table in the good state. To

generate more collateral, banks have incentives to issue more loans, which leads to a lower lending standards and, ultimately, to further over-investment by firms. This is what happens in the model if we allow banks to trade in a set of Arrow securities and assume that trades must be collateralized for repayments to be credible. In equilibrium, banks make strictly positive expected profits from these trades, but this is compensated by expected losses on lending, which reflect a further deterioration of the real allocation. In fact, in this financially-advanced equilibrium, financial institutions behaviour is consistent with valuations that are even more favourable than the best case and therefore are beyond Panglossian.

Our theoretical methodology is relatively straightforward, but nonetheless original. We derive analytical results in a general equilibrium model that includes a financial sector, which we allow to engage in collateralized trade of Arrow securities. To achieve this, we do not analyse the transitional dynamics in the baseline model. We first make our main points in a single period model. Even though propagation mechanisms play a central part in modern macro, they are not essential to the points we want to make. Our approach, for most of our analysis, can be interpreted as a steady-state comparison between different regulatory regimes. We believe this is appropriate because our objective is to understand differences in trends rather than fluctuations around a single trend (Summers 2015, for instance, stresses the need for new models using such an approach).

Our first extension introduces a meaningful role for the main elements of our financial system and studies possible policy responses to the inefficiency. Specifically, banks provide both credit *and* liquidity, and guarantees are used to prevent Diamond and Dybvig panics. Financial trading allows banks to hedge risk to provide diversification to depositors. Nonetheless, the interaction of these roles generates the same effect as before. With guarantees, banks behave in a Panglossian way and do not hedge; with financial trading in addition to guarantees, they similarly don't hedge but rather they double down their bets. A ban on financial trading does not restore efficiency as it prevents banks from diversifying risk, but capital requirements calibrated to worst case scenarios, like in stress tests exercises, do.

Our second extension considers a more elaborate version of the model with two different types of capital. Equipment is imported and supplied elastically whereas structures are perfectly-inelastic in supply. In addition to the basic prediction of our baseline model, this modification to the environment highlights that the effect of over-investment would be reflected in asset price inflation in the inelastically-supplied capital.

In order to link our result to our initial motivation, we must address why the mechanism would have been at play in the run up to the crisis and less so in the aftermath. Focusing on the US, claiming that government guarantees were present before the cri-

sis and then suddenly removed may not be very credible.<sup>3</sup> However, nor is such a removal of guarantees vital for our story. What really matters is the ability for banks to exploit such guarantees. Hence, if this ability increased before the crisis but has been impaired in the aftermath, our story remains relevant.

We argue that several factors point in this direction. Deregulation (e.g. the repeal of the Glass-Steagall Act in 1999, the removal of capital requirement for Broker Dealers in 2004) is likely to have played a role. But financial innovation may have been important too. First, engineering trades corresponding to the one we describe above, and making sure that they are bankruptcy remote is not that straightforward. Second, one should also be able to generate the collateral. Securitization comes to mind, but also the use of subprime mortgages and the associated lowering of lending standards. Finally, general equilibrium effects can be important: in the early years, due to limited competition, it may have been the case that proprietary trading profit was not offset by expected losses on lending.<sup>4</sup> In the aftermath of the financial crisis, there has undeniably been a regulatory crackdown. Government guarantees are, of course, still present, but banks are arguably less able to exploit them. The Volcker Rule limits proprietary trading and stress-tests aim to make sure that, even in the most adverse scenario, banks would not fail. If we take stress tests' recent positive results at face value, this implies that our mechanism is no longer at play, which could explain a reversion to a lower, but, in our analysis, efficient and sustainable trend. We do not want to argue there is no residual effect of guarantees, but rather we believe that these elements contribute to a decrease in banks' ability to exploit the guarantees and, therefore, to mitigate the impact of our mechanism.

Our model places the emphasis on a particular channel, but, of course, many different channels, including those listed above, are likely operating simultaneously to determine the evolution of the economy. It is not our intention to claim that our story is the *only* explanation for the period of protracted weakness in economic activity. Rather, we simply wish to highlight that the empirical observation of these phenomena which have been labeled as hysteresis is consistent with our story in which the post-crisis level of activity may be more appropriate and sustainable than the pre-crisis level.

While a full quantitative assessment of all possible channels is beyond the scope of this paper (and our model), we show that a number of empirical developments in the US macroeconomic time-series are consistent with the predictions of our model.<sup>5</sup>

---

<sup>3</sup>In countries where bank bailouts tested the limits of the government's fiscal capacity, this may however not be so far-fetched. However, what really matters is the ability for banks to exploit the guarantees.

<sup>4</sup>Martinez-Miera and Suarez (2014) and Malherbe (2016) additionally show how the accumulation of banking capital erodes scarcity rents in the banking sector and endogenously increases the distortions from government guarantees.

<sup>5</sup>While our analysis focuses on the US economy, this mechanism is likely to have much broader relevance. Reinhart and Rogoff (2014), after examining 100 financial crises, highlight that financial crisis episodes are typically followed by protracted recoveries. They find that the mean time to recover to pre-

These include a divergence between GDP and NDP in the period before the financial crisis (indicating welfare rose by less than is suggested looking at GDP); significant asset price growth for investment goods that are, or need to be combined with goods that are, inelastically supplied; and there is evidence that lending standards and profit margins on lending activities fell.

We also provide a back-of-the-envelope calculation of the size of the distortion by calibrating changes in the capital-output ratio not accounted for other driving variables; in our model these are driven by the beyond Panglossian values. Armed with estimates of the size of the distortion over time, we calculate an adjusted GDP series that strips out the distortion. We show that, using the adjusted GDP series, there was less of a great recession and more of a reversal of a great distortion.

## 2 A baseline Panglossian model of inflated GDP

In this section we introduce the most simple version of our model. There is a single period, in which there is a single output good. The model economy comprises a household sector, a production sector, a banking sector, a government, and the rest of the world. We shall discuss each in turn as well as the links between them.

### 2.1 Model Setup

**Households** A risk-averse representative household maximizes expected utility:

$$E[u(c)],$$

where  $c$  is its consumption at the end of the period, and  $u(\cdot)$  is increasing and concave. Households are endowed with  $e$  unit of the consumption good at the beginning of the period, which they can use to buy securities. Available securities are indexed by  $i \in \{1, 2, \dots\}$ . The beginning of period budget constraint is:

$$\sum_i \theta_i p_i \leq e,$$

where  $\theta_i$  denotes the holding of security  $i$ , whose price is  $p_i$ . Households are also endowed with one unit of human capital which they supply inelastically (aggregate

---

crisis levels of GDP per capita is about 8 years (the median is 6.5 years). Others too find that financial crises give rise to recessions that are longer and deeper than other recessions (Jordà et al. 2013). Notably, Ball (2014) contrasts the effect of loss of output (hysteresis) with the even more serious lost growth capacity (super hysteresis). Blanchard et al. (2015) show empirically that both of these effects are present in broad panel of countries. In our model, the slower growth is actually a reversal of earlier inefficiently high growth. In that sense, the banking sector magnifies the business cycle, which is one of the broad insights from the financial cycles literature (see e.g. Borio 2013, Schularick and Taylor 2012, and Jordà et al. 2016).

labor is  $N = 1$ ) in return for a wage  $w$ . Households pay lump-sum taxes  $\tau$  to the government. Hence, realized consumption is given by:

$$c = w - \tau + \sum_i \theta_i R_i,$$

where  $R_i$  denotes security  $i$ 's payoff.

**Firms** There is a continuum of firms that each borrow capital from banks and hire workers to maximize expected profit. Each production firm is penniless and has limited liability. Firms competitively borrow capital from banks and hire workers. Physical capital fully depreciates in production. The firms operate a constant returns to scale production function which combines physical capital ( $k$ ) and labor ( $n$ ) to produce the output good:

$$Ak^\alpha n^{1-\alpha},$$

where  $A$  is an aggregate productivity shock that takes the value  $A_H$  with probability  $p$  and a strictly smaller value  $A_L$  with probability  $(1 - p)$ , and  $\alpha \in (0, 1)$ . Thus, total output in the economy is:

$$Y = AK^\alpha N^{1-\alpha}, \tag{1}$$

where upper case variables are the aggregate counterparts of the lower cases.

**Banks** There is a banking sector where banks intermediate lending between households and the production sector. Banks raise funds (consumption goods) competitively by issuing liabilities to households and the rest of the world. They transform them, one to one, into capital which they provide to firms.

For the sake of concreteness, we assume banks only issue two types of securities -deposits and equity- and that they lend capital to the firms according to a standard debt contract. This is without loss of generality.<sup>6</sup>

**Rest of the world** The rest of the world consists in a large number of risk-neutral agents that can buy and sell securities. Their opportunity cost of funds is  $1 + r$ .

---

<sup>6</sup>There are only two states, hence the state-space can be spanned with two securities. On the lending side, a standard debt contract replicates the allocation that would obtain under an optimal contract offered to production firms by the banks specifying a production plan  $\{n, k\}$  and contingent repayments per unit of capital  $\{\rho_H, \rho_L\}$ . Under such a contract, banks maximize expected profit given  $w$  and ensure that producers break even in all states. There is no possible profitable deviation for a couple bank-firm. Through this contract, banks effectively compete for workers and end up making zero expected profit in equilibrium.

**Government** The main purpose of this paper is to study the implications for economic activity of government guarantees. We will compare to different regimes. One with, and one without, government guarantees. While we could think of this as a formal deposit insurance scheme (which may cover deposits only up to a limit), we rather interpret this more broadly reflecting the implicit (and then explicit) guarantee that governments typically provide for banking systems during financial crises.<sup>7</sup> When deposits are guaranteed, they pay the world's safe interest rate (i.e. 0) and depositors are compensated even if the bank has a shortfall when production returns are realized.<sup>8</sup> In the absence of guarantees, depositors risk the loss of their deposits if the bank has a shortfall. The government collects lump-sum taxes from the household sector in order to cover any payments made through the bank guarantee scheme. For analytical simplicity, there is no other government spending or taxation and we assume that the government must balance its budget in all states.

**Equilibrium definition** All private agents are price taking and enjoy limited liability. In an equilibrium: (i) households maximize expected utility; (ii) banks and firms maximize expected profits; (iii) expected profits are nil (iv); the rest of the world breaks even in expectation; and (v) the government breaks even in all states.

## 2.2 Timing

### 1. Financial markets

- (a) Households, banks, and the RoW trade in securities
- (b) Banks lend to firms

### 2. Labour market

- (a) Firms hire workers competitively, for a non-contingent wage.

### 3. Production

- (a)  $A$  realizes, production takes place, factors are paid

### 4. Settlement

- (a) Banks repay deposits (in full if they can, or pro-rata if they are insolvent)
- (b) Other financial claims settle

---

<sup>7</sup>Even if it were a simple deposit insurance scheme, then if the institutional creditors were able to run faster than the household depositors (as we saw in the case of Northern Rock in the UK), then the lack of guarantee is not a problem for non-insured creditors.

<sup>8</sup>For simplicity, the government does not charge the banks for this insurance. What matters is that the insurance premium does not make the bank fully internalize the loss given default.

(c) The government compensates the depositors and taxes households.

## 5. Consumption

The essential aspect of the time-line is that investment decisions are taken before productivity realizes. Finally, note that given this is a single period model, the capital stock is equal to investment.

### 2.3 Benchmark: no guarantees

Real investment (changing consumption goods into capital) is risky because it is done before  $A$  realizes. Hence, banking is risky too. Given that agents from the rest of the world are risk neutral, they are willing to hold any security that yields an expected return equal to the risk free rate. Households, on the other hand, are risk averse. Hence, they would require a risk premium to hold risky securities. As a consequence, the rest of the world bears all the risk in equilibrium. That is, households hold deposits only if there is a sufficiently large buffer of junior securities (such as equity) to absorb the losses in the bad state. Except for this, the composition of liabilities is indeterminate.

**Lemma 1.** *In the economy without guarantees, the Modigliani and Miller irrelevance result applies. The equilibrium level of capital is  $K_B = \left(\frac{\alpha \bar{A}}{1+r}\right)^{\frac{1}{1-\alpha}}$ , where  $\bar{A} \equiv E[A]$ .*

*Proof.* See Appendix A.<sup>9</sup> □

Note that the subscript  $B$  stands for benchmark. Given that there is no risk premium in equilibrium, the expected marginal cost of funds for the bank is  $1 + r$ . Banks compete to lend to firms. So the expected marginal cost of capital for firms is also  $1 + r$ , and so must be the equilibrium expected marginal return to capital. The condition that pins down the equilibrium is thus:

$$\alpha \bar{A} (K_B)^{\alpha-1} = 1 + r.$$

### 2.4 Equilibrium with government guarantees

When the government guarantees deposits, households are willing to hold them irrespective of the buffer offered by equity. In particular, this will be the case if the bank promises a zero interest rate. This is because the government makes the depositors whole in the case the bank cannot repay in full. On the other hand, the government does not compensate junior creditors or shareholders. Hence, to be willing to buy equity, agents must be compensated by a higher return in the states where the bank does

---

<sup>9</sup>All the proofs that are omitted in the text are in Appendix A.

not default. To sum up, all securities yield an expected payoff of one to their holder in equilibrium. However, for deposits, if the bank defaults with positive probability, part of this payoff comes from the taxpayer. Hence, from the bank point of view, deposits are cheaper.<sup>10</sup>

**Lemma 2.** *In the economy with government guarantees, the bank only issues deposits in equilibrium.*

Thus, to lend an amount  $k$  of capital, the bank must promise to repay  $k(1+r)$  to depositors. The bank therefore solves:

$$\max_{k \geq 0} E [\tilde{\rho}k - k(1+r)]^+,$$

where  $\tilde{\rho}$  is the realized unit repayment on loans. That is,  $\tilde{\rho}$  is the minimum between the firm promised repayment to the bank and what it can repay if it does not have enough resources to meet the promise. That is:  $\tilde{\rho}k = \min \{ \rho k, Ak^\alpha n^{1-\alpha} - wn \}$ .

Without a sufficient equity buffer, the bank is vulnerable to an adverse shock.<sup>11</sup> As a result:

**Lemma 3.** *In the economy with government guarantees, in equilibrium, the bank fails in state  $A_L$ .*

As a result, in effect, the bank ends up ignoring the marginal effect of its decisions on the bad state (a marginal change in the negative profit does not affect its payoff in that state) and maximizing profits in the good state.

$$\max_{k \geq 0} \rho_H k - k(1+r).$$

The first order condition is

$$\rho_H \leq 1+r \tag{2}$$

Hence, in equilibrium we must have:  $\rho_H = 1+r$ .

**Lemma 4.** *In the economy with government guarantees, the equilibrium level of capital is  $K^* = \left( \frac{\alpha A_H}{1+r} \right)^{\frac{1}{1-\alpha}} > K_B$ .*

---

<sup>10</sup>For simplicity, the government does not charge the banks for this insurance. What matters is that the insurance premium does not make the bank fully internalize the loss given default. Likewise, imposing a sufficiently high capital requirement on banks would prevent the bank from defaulting and there would be no implicit subsidy. Our analysis would apply to economies where capital requirements are not sufficiently high and banks default with positive probability in equilibrium. See for instance Bahaj and Malherbe (2016) and Malherbe (2016).

<sup>11</sup>Adding a capital requirement to the model does not qualitatively affect our results as long as the bank still fails with strictly positive probability in equilibrium. We therefore delay the study of capital regulation until Section 4. We tend exploit in Section 5 the result that the stringency of bank prudential regulation and supervision will affect the magnitude of the distortion.

Banks borrow from depositors at artificially low rates. But banks compete for firm lending, which means that they pass this artificially low rate onto the firms. Firms, in turn, equate the capital marginal rate of return to the borrowing rate, which leads to more investment in the aggregate.

The relevant equilibrium conditions become.

$$\begin{cases} \alpha A_H (K^*)^{\alpha-1} = 1 + r \\ (1 - \alpha) A_H (K^*)^\alpha = w^* \end{cases} ,$$

where we use the superscript\* to denote equilibrium variables.

## 2.5 Efficiency

We first make a very simple but important point.

**Proposition 1.** *In the economy with guarantees, investment is inefficiently high. That is, while output is higher than in the benchmark economy, expected net output is lower.*

Output is  $AK^\alpha$ . For any realization of  $A$ , it is increasing in  $K$ . That is, more investment (which translates in a higher capital stock) always means more output. However, in terms of investment efficiency, the relevant concept is expected net output:  $E[AK^\alpha - K(1 + r)]$ . The difference is that between *gross domestic product* (GDP) and *net domestic product* (NDP), which takes capital depreciation into account.<sup>12</sup> For that very simple reason, a larger GDP is not necessarily a good thing. However, normative statements cannot be based on investment efficiency only. As we show below, it turns out that welfare is unambiguously lower in the economy with guarantees.

## 2.6 Welfare

Given that the rest of the world is risk neutral and always breaks even in equilibrium, the relevant notion of welfare is the representative agent expected utility.

**Proposition 2.** *In the economy with guarantees, the increase in wage is more than offset by the expected increase in tax. It follows that welfare must be strictly lower than in the benchmark economy.*

*Proof.* Because the rest of the world is risk neutral and must break even in expectation, we have  $p_i = \frac{E[R_i]}{1+r} \forall i$  and, therefore,  $E[\sum_i \theta_i^* R_i] = e(1 + r)$ . Hence, household expected wealth is given by:

---

<sup>12</sup>For simplicity, we have assumed full depreciation. Note that if capital could be transformed into consumption goods, at the end of the period, at a rate  $1 - \delta$  (where,  $\delta \in (0, 1)$  would capture the depreciation rate), the conclusions would be identical.

$$v \equiv w - E[\tau] + e(1 + r).$$

In the economy with guarantees, we have

$$\begin{cases} w^* = (1 - \alpha)A_H (K^*)^\alpha \\ \tau_H = 0 \\ \tau_L = - (A_L (K^*)^\alpha - (1 - \alpha)A_H (K^*)^\alpha - K^*(1 + r)) \end{cases}$$

Put together, these give:

$$v^* = \underbrace{\bar{A} (K^*)^\alpha - K^*(1 + r)}_{E[NDP]} + e(1 + r).$$

We have shown that: since the rest of the world must break even in expectation, households expected wealth equals the sum of their endowment and expected NDP (which is the economic surplus from production). Since expected NDP is lower than in the benchmark economy (Proposition 1), and in the benchmark economy households are perfectly insured, welfare must be strictly lower in the economy with guarantees.<sup>13</sup>

□

Let us consider two examples. First, assume that households can trade a full complete set of securities with the rest of the world. In that case, they will also get full insurance in the economy with guarantees. As a result they will consume their expected net wealth in all states. The welfare loss comes here only from investment inefficiency. Now, imagine that households can only buy equity or deposits of domestic banks. In that case, they will prefer to hold deposits only (equity as a low payoff in the bad state). As a result, they do not get any insurance against taxation risk, and it is easy to verify that their realized wealth corresponds to their endowment plus *realized* NDP.<sup>14</sup> Hence, guarantees imply additional welfare losses.

That NDP can be a good indicator of welfare is not new, nor is it a specific feature of our model. For instance, Weitzman (1976) shows that in a dynamic economy NDP is a proxy for the present discounted value of consumption.<sup>15</sup> However, what is clear and more novel from Proposition 2 is that when investment decisions are distorted, GDP growth is unlikely to be a good indicator of welfare growth. As we will highlight in Section 5, in these circumstances, current GDP trend is also unlikely to be a good indicator of the path for future GDP.

<sup>13</sup>It should now be clear that the benchmark economy is efficient in the sense that it maximizes social welfare (as it maximizes expected economic surplus and ensures perfect insurance).

<sup>14</sup>If households can short sell bank equity, this restores perfect risk sharing.

<sup>15</sup>Interestingly, Weitzman point was not about whether one should account or not for depreciation, which was seen as uncontroversial, rather it was about whether and how one should include current capital stock.

### 3 Deregulation and financial innovation

In the economy with guarantees, from the bank's point of view, any repayment made to depositors can be seen as money left on the table. To see this, imagine that the promised repayment is 10 and realized proceeds from lending in state  $A_L$  are 5. If, for some exogenous reasons, it were less than 5, this would not affect the bank payoff (it would still be 0), and depositors would not require compensation in the other state since they are insured.

This gives banks an incentive to find ways to divert such resources from the low state towards the high state. One way to do this is to pick riskier or more correlated borrowers. Here, however, inspired by financial innovation before the recent crisis, we consider the case where loans can be used as collateral for financial trades.

#### 3.1 Financial trades and magnification

**The trading environment** Assume the representative bank can trade in a set of Arrow securities, denoted  $H$  and  $L$ . These securities trade competitively in financial markets. As a consequence, they are actuarially fairly priced. For simplicity, we assume that the bank ex-ante trading position must be self-financed. That is, the bank trading position cannot be ex-ante financed by deposits.<sup>16</sup> Formally:  $ph + (1 - p)l \leq 0$ , where  $h$  and  $l$  denote the bank's net holding of the two securities (a negative number corresponds to the bank selling the security).

We still assume that wages are always senior to capital (alternatively, they are paid upfront). But, in effect, Arrow securities are senior to deposits (either because they are bankruptcy remote, like repo's, or because institutional investors run faster than insured depositors). Finally, for what follows, we assume  $A_L - (1 - \alpha)A_H > 0$ . If this condition is not satisfied, the bank cannot credibly issue Arrow securities in equilibrium.

#### Equilibrium

**Lemma 5.** *The equilibrium trade is given by  $l^* = -\rho_L^* k^*$  and  $h^* = \frac{(1-p)\rho_L^* k^*}{p}$ .*

*Proof.* By definition, one cannot default on an Arrow security in equilibrium. For a given amount of lending  $k^*$ , the maximum amount the representative bank can credibly commit to repay in state  $L$  is  $\rho_L^* k^*$ . Selling security  $L$  increases the losses of the bank in state  $A_L$ . But this does not affect expected profits because of limited liability. Hence,

---

<sup>16</sup>Otherwise, banks could make infinite profits by issuing deposits and buying one of the security (because, in practice, the government would then guarantee the short selling of securities). Alternatively, we could assume that banking supervision limits direct gambling with insured deposits. As long as there is such a limit, our analysis remains directly valid. Otherwise, we would have to explicitly model the limits of government fiscal capacity.

from the bank's perspective, the expected marginal cost of selling the  $L$  security is nil (this corresponds to selling promises that will, ultimately, be honored by taxpayers). The strategy that maximizes trading profit follows: sell as much as possible of the  $L$  security (hence, the constraint must be binding), and use the proceeds to buy the  $H$  security. Since the securities are fairly priced, this allows the bank to buy  $\frac{(1-p)\rho_L^*k^*}{p}$  of the  $H$  security.  $\square$

With this strategy, the bank extracts rent from the taxpayer. This materializes through an extra term, equal to  $h$ , in the bank profits in the good state. Hence the bank lending problem becomes

$$\max_{k \geq 0} \rho_H^* k - k(1+r) + \frac{1-p}{p} \rho_L^* k.$$

And, from the first order condition, we get in equilibrium:

$$\rho_H^* + \frac{1-p}{p} \rho_L^* = 1+r \quad (3)$$

This reflects that more lending helps relax the trading constraint and allows the bank to buy more of the security that pays in the good state. **Using the firm first order conditions, we can rewrite the above as:**

$$\alpha A_T (K_T^*)^{\alpha-1} = 1+r,$$

where

$$A_T \equiv A_H + \frac{1-p}{p} A_L = \frac{\bar{A}}{p}.$$

And the intuition is simple. Now that the bank can use the can funnel the proceeds from lending from the low state to the high state, this is as if the sum of all possible proceeds appear in the high state. Hence, the conditional expectation in the high state is simply:  $E[A]/p$ . As a result, over-investment becomes worse in equilibrium: since  $A_T > A_H$ , we have  $K_T^* > K^*$ , which implies:

**Proposition 3.** *In the economy with government guarantees, output is higher with financial trading and welfare is lower.*

Since there is even more capital, this means that banks make lending losses, even in the good state. In equilibrium, these losses are just compensated by financial trading profit:

$$\underbrace{\rho_H(K_T^*)K_T^* - K_T^*}_{\text{lending losses}} + \underbrace{\frac{1-p}{p} \rho_L^* K_T^*}_{\text{trading profit}} = 0.$$

This provides a novel interpretation to the well documented decrease in lending standards in the run up to the crisis in the US (see Section 5) and other countries, and for the sharp increase in the importance of trading activities for bank profits. In what follows, we refer to this version of the model as the economy with financial trading.

### 3.2 Regulation and innovation: exploitability of guarantees

So far, we have ignored bank prudential regulation like capital requirement and have assumed that banks are fully able to double down with financial trades. In practice, as we argue in Section 5, these factors are likely to vary over time. To preface such discussion, let us introduce capital regulation in the model, as well as a parameter capturing the extent to which banks are able to double down with financial trades.

First, assume that banks face a capital requirement of the form:  $e \geq \gamma k$ , that is equity  $e$  must be at least a fraction  $\gamma$  of lending. Generally speaking, we interpret  $\gamma$  as the strenght of prudential regulation. Second, assume that bank can only pledge a fraction  $\lambda$  of the proceed from lending as collateral. With  $\lambda$ , what we mean to capture is both a measure of financial innovation, or sophistication, of the bank, but also to which extent the purpose of its financial trades can be undetected by financial supervision.

Assuming that the bank still fails in the low state, its shareholders expected payoff is:

$$p \left( \rho_H k - k(1 - \gamma) + \frac{1-p}{p} \lambda \rho_L k \right) - \gamma k,$$

which yield in equilibrium (given first order and zero profit conditions):

$$p\rho_H - p(1 - \gamma) + (1 - p)\lambda\rho_L - \gamma = 0.$$

Rearranging gives:

$$E[\rho] = p + (1 - p) (\gamma + (1 - \lambda)\rho_L)$$

which provides a direct measure of the magnitude of the distortion in equilibrium. This is because, recalling that  $\rho$  is the realised return to physical capital, at the benchmark efficient allocation,  $E[\rho] = 1$ .

Consider  $\lambda = \gamma = 0$ . We get:  $E[\rho] = p + (1 - p)\rho_L$ , which is equivalent to  $\rho_H = 1$ , which characterises the Pangloss equilibrium. No, start increasing  $\gamma$  and  $E[\rho]$  will increase in equilibrium: we get closer to efficiency as we impose tighter capital requirements. If, instead, we start increasing  $\lambda$ ,  $E[\rho]$  will decreasing in equilibrium, and the inefficiency is magnified: we go beyond the Pangloss equilibrium.

So, if we have  $\lambda = 1$ , which is the case we started from in Subsection 3.1, we need a capital requirement of 1 to restore efficiency. Indeed, if it is allowed to freely trade in

financial securities, the bank must be financed with 100% of equity. Alternatively, the regulator could ban financial trading ( $\lambda = 0$ ), and impose a milder capital requirement  $\gamma = 1 - \rho_L$ .

This is of course extreme and must not be taken at face value. After all, we are in a context where financial trades have no social value, and government guarantees have no reasons to exist in the first place. What we consider next is cases where banks do provide liquidity and hedging services. In these cases, regulators face trade-offs and fully restoring efficiency is generally not feasible.

## 4 Model extensions and discussion

In this section, we present two extensions to the baseline model to show that the main findings carry over, with some interesting new results, to more elaborate environments.

### 4.1 Liquidity provision, bank runs, regulatory response

For the sake of tractability and transparency, we have so far abstracted from important dimensions of banking and banking regulation. In this section, we give a second economic role to banks next to credit provision to firms: they also provide liquidity and diversification to households. The problem is that they are then exposed to the risk of runs, which we show is a rationale for the existence of government guarantees. Still, absent government guarantees, banks would use financial trading to provide insurance to patient depositors. However, with guarantees, they instead choose to use it to extract rents and a Beyond Pangloss equilibrium occurs.

#### 4.1.1 Augmenting the model

In the tradition of Diamond and Dybvig (1983), we now consider households that have a preference for liquidity: household  $i$  has utility function.

$$E[u((1 - \beta_i)c_{aft} + \beta_i c_{eve})],$$

where  $u(\cdot)$  is as before but  $\beta_i \in \{0, 1\}$ , with  $\Pr(\beta_i = 0) = q$ , represents an idiosyncratic liquidity shock, which *iid* realisation is private information to the household and,  $c_{aft}$  denotes afternoon consumption, and  $c_{eve}$  evening consumption.

Financial and labour market activity takes place in the morning. Then, production starts and the households learn their type: *aft* ( $\beta_1 = 0$ ) or *eve* ( $\beta_1 = 1$ ). A first, safe payoff  $ak^\alpha$  arises in the early afternoon (with  $a \leq A_L$ ). It is used to pay wages. The

remainder can be repaid to the bank and used to repay early depositors. The risky part of the payoff  $((A - a)k^\alpha)$  arises in the evening, and goes to the bank.<sup>17</sup>

Here, households cannot directly trade with the rest of the world: they can only hold deposits or bank equity. Banks, on the other hand, can trade the Arrow securities described above. However, international financial markets can only settle at night. We normalize the risk-free rate to 0.

**First best** In a first best allocation, production is set at the efficient level, where the expected marginal productivity of capital is 1. Then, the full expected economic surplus from production is equally split among households. They therefore consume:

$$e + (\bar{A}K_B^\alpha - K_B) = e + (1 - \alpha)\bar{A}K_B^\alpha = e + w_B$$

#### 4.1.2 Sketch of the analysis and discussion

**Regime without guarantees** Without guarantees, the following decentralized arrangement can implement the first best. Household deposit their endowment with the bank (up to an aggregate level of  $K_B$ , for simplicity, the rest goes in storage) against a promise that they can withdraw it one for one, either in the afternoon or in the evening. The bank lends to firms, up to the point where, and hedges production risk with the rest of the world. As a result, total resources available to the bank is simply  $e$ . As long as  $aK_B^\alpha \geq qe$ , there is enough resource to repay afternoon depositors. We assume this is the case.

**Bank runs** Now, consider a coordination failure, where the all depositors run the bank in the afternoon. The bank cannot repay them all and is forced into bankruptcy. In that case, we assume the proceed from the second payoff are not collected in full. Hence, evening depositors that anticipate a run are better off running too, and a run can be self-fulfilling.

**Deposit insurance** As usual (Diamond and Dybvig 1983), deposit insurance (with ex-post lumpsum taxes on evening households) prevents the coordination failure. However, we now face an environment that is essentially identical to that leading to the Beyond Pangloss equilibrium. Now that depositors are insured, the bank has no incentive to use financial markets to hedge production risk away. To the contrary, it will use it to shift it onto the taxpayer as we described above.

---

<sup>17</sup>For simplicity we abstract here from contractual considerations between the firm and the bank.

**Proprietary trading ban** Banning the bank from trading in financial markets would prevent it from shifting the risk. However, it would also prevent it from diversifying production risk away. So, such a policy would not be enough to restore efficiency.

**Capital requirements** Capital requirements can help. Consider a capital requirement of the sort  $\kappa \geq \gamma Z$ , where  $\kappa$  is capital (i.e. equity),  $\gamma$  is a vector of parameters controlling the requirement, and  $Z$  is a vector of asset holding by the bank. If there is a proprietary trading ban, the only class of asset is bank loans. At the  $K_B$  level, at worst, they give a unit loss:  $1 - A_L$ . Hence, if  $\gamma \geq 1 - A_L$ , there's enough capital to absorb losses, and risk shifting will no occur. However, if the bank can freely trade in financial markets, such a capital requirement may be insufficient. In fact, given the optimal trade described in the previous section, any payoff from the loan (that has not been promised to afternoon depositors) would be pledged as collateral, and losses to the. For instance, if  $aK_B^\alpha = qe$ , a capital requirement  $\gamma' \geq 1 - a$  would be make sure that, at the  $K_B$  level, all the losses are covered.<sup>18</sup> Note that  $\gamma' > \gamma$  since  $a < A_L$ .

**Stress-tests** Note that, in the model without liquidity risk, with financial trading, the losses in the bad state correspond to 100% of the amount lent. So, from that point of view, a 100% capital requirement is needed. In practice, however, since the assets are posted as bankruptcy remote collateral, it can also make sense to apply capital requirements to the financial portfolio directly. Regardless of there being liquidity risk or not. The only way for capital requirements to prevent risk-shifting is to make sure that the bank cannot default, even in the worst possible scenario. This resonates with the stress-tests exercises that have been imposed on banks since the global financial crisis.

## 4.2 Asset price inflation

In the two previous sections, we have highlighted our mechanisms in the most transparent way. A drawback is that the model is perhaps too simple to draw a full set of testable empirical predictions. In this section, we outline a more elaborate version of the model. This model can then provide the basis of a comparison of the empirical predictions with recent developments in the US (section 5).

Our strategy will be to interpret our economy as two different regimes of the same economy; one with guarantees and one without guarantees. As we motivate below, we will first think (in the context of the US) of a gradual, relatively smooth transition from the former to the latter in the run up to the 2008 crisis. Then, we will consider a

---

<sup>18</sup>So, that this level of lending is an equilibrium. Now, one cannot rule out another equilibrium, where losses are greater because the level of lending is greater. This would be another sort of self-fulfilling equilibrium.

more abrupt change of regime, where, however, transition dynamics play a role due to wage downward rigidities. To facilitate this exercise, in this section we first highlight the empirical predictions across regimes and then consider the predictions related to a back-to-benchmark transition period.

#### 4.2.1 Modification to the environment

The first modification to the baseline model of Section 2 is to introduce a second type of capital. The production function in the economy is still the Cobb-Douglas function given by (1), but the stock of capital itself is given by the following constant elasticity of substitution aggregator:

$$K = (Q^\gamma + S^\gamma)^{\frac{1}{\gamma}},$$

where  $\gamma \in (0, 1)$  is the elasticity of substitution between  $Q$  and  $S$ ,  $Q$  denotes equipment and  $S$  stands for structures. For simplicity, equipment is imported, at an exogenous unit price  $q_e > 0$ , and structures are in perfectly-inelastic supply.<sup>19</sup> The firm buys structures from households at the beginning of the period at an endogenous competitive price  $q_s$ .

Because we want to be able to account for possible secular trends in the economy (which are potential confounding factors), we now parametrize capital depreciation. In particular, we assume that, at the end of the period, equipment and structures can be converted into consumption goods at rates  $q_e(1 - \delta)$  and  $q_s(1 - \delta)$ , respectively, with  $\delta \in (0, 1]$ . Finally, in a reduced form interpretation of the proprietary trading model, we assume that the bank can pledge up to a share  $\lambda \in [0, 1]$  of the structures to outside investors.<sup>20</sup>

#### 4.2.2 Equilibrium

Let us turn directly to the equilibrium with guarantees. As above, the representative bank will maximize rent extraction, which gives:

$$h^* = \lambda \frac{1-p}{p} (1-\delta) S^*.$$

Accordingly, the lending problem of the bank can be formalized as:

$$\max_{N, Q, S} p \left( A_H N^{1-\alpha} (Q^\gamma + S^\gamma)^{\frac{\alpha}{\gamma}} - Nw - q_e(\delta + r)Q - q_s(\delta + r)S + \lambda \frac{1-p}{p} (1-\delta)S \right).$$

<sup>19</sup>An alternative would be to have structures built with a combination of land, labor, and equipment. This would complicate the analysis without adding much further insight.

<sup>20</sup>Put differently, structure ownership is put into bankruptcy remote vehicles so that, in case the bank fails, the claims backed by such collateral are, in effect, senior to deposits.

From the first order conditions for  $Q$  and  $S$ , we get:

$$Q^* = S^* \left( \frac{q_s(\delta + r) - \lambda \frac{1-p}{p}(1-\delta)}{q_e(\delta + r)} \right)^{\frac{1}{1-\gamma}}. \quad (4)$$

Substituting for  $Q$  in the first order conditions for  $N$  and  $S$ , and using  $N = S = 1$  yields:

$$\begin{cases} (1 - \alpha) A_H \left( \left( \frac{q_s(\delta+r) - \lambda \frac{1-p}{p}(1-\delta)}{q_e(\delta+r)} \right)^{\frac{\gamma}{1-\gamma}} + 1 \right)^{\frac{\alpha}{\gamma}} = w \\ \alpha A_H \left( \left( \frac{q_s(\delta+r) - \lambda \frac{1-p}{p}(1-\delta)}{q_e(\delta+r)} \right)^{\frac{\gamma}{1-\gamma}} + 1 \right)^{\frac{\alpha}{\gamma}} = q_s(\delta + r) - \lambda \frac{1-p}{p}(1 - \delta) \end{cases}, \quad (5)$$

which is a system of two equations in  $q_s$  and  $w$  that pins down the equilibrium.

It is easy to check that to obtain the equilibrium conditions of the corresponding benchmark economy of the extended model, one must substitute  $\bar{A}$  for  $A_H$  and set  $\lambda$  to 0 in System 5 and Equation 4 above.

### 4.2.3 Regime comparison

Comparing the two regimes gives then the following empirical predictions. In the extended model, compared to the benchmark economy, the economy with guarantees exhibits:<sup>21</sup>

- Higher GDP and lower expected NDP;
- Inflated wage;
- Inflated asset (i.e. structure, or fixed asset) prices. In particular,  $q_s^*$  is increasing in  $A_H$  and  $\lambda$ ;
- Over investment in capital (materializing through an increase in  $Q^*$ );
- A higher capital to output ratio;
- Ambiguous changes in the share of fixed asset income in GDP  $\sigma^* \equiv \frac{Q^* q_e}{S^* q_s}$ . In particular,  $\sigma$  is increasing in  $A_H$ , but decreasing in  $\lambda$ . Total gross income of all factors benefit from the increase in GDP, but, for instance, if the latter effect dominates, the increase is greater for fixed assets (structures), then labor, then equipment.<sup>22</sup>

<sup>21</sup>Matlab code and full details available on request - the section is currently in progress.

<sup>22</sup>Studying the consequences of our mechanism for the factors of productions' share of income is beyond the scope of this paper. However, the way this prediction directly speak to the literature on the medium to long term trends for these indicators (see e.g. Karabarbounis and Neiman 2013, Piketty 2014, and Piketty 2014) only illustrates the potential for ramifications of our analysis.

## 5 Economic and Empirical Relevance

The main message of the model is that the beyond Panglossian model, driven by exploitability of government guarantees in the financial system, can lead to inefficiently large booms. In this section, we hope to convince readers of two things. First, that the theoretical channel is capable of generating economically meaningful distortions. Second, those distortions may have played an important role in the recent behaviour of the US economy prior to the Global Financial Crisis.

### 5.1 The scale of the amplification: A quantitative exploration

We now explore a quantitative exploration of the baseline model. The key message is that, for any reasonable calibration, financial trading gives rise to a substantial magnification of the basic Panglossian inefficiency induced by guarantees. To explore this, we define the relative values of these output and capital which we will compare across the three different environments:

1. Baseline (B): Neither government guarantees nor financial trading
2. Pangloss (P): Government guarantees but no financial trading
3. Trading (T): Both government guarantees and financial trading

Using the results from section 2, the relative level of capital and output in *good* times in Pangloss and Trading environments relative to Baseline are given by:

$$\frac{K_P}{K_B} = \left( \frac{\left( \frac{\alpha A_H}{(1+r)} \right)^{\frac{1}{1-\alpha}}}{\left( \frac{\alpha \bar{A}}{(1+r)} \right)^{\frac{1}{1-\alpha}}} \right) = \left( \frac{A_H}{\bar{A}} \right)^{\frac{1}{1-\alpha}} \quad \frac{Y_P}{Y_B} = \left( \frac{K_P}{K_B} \right)^\alpha = \left( \frac{A_H}{\bar{A}} \right)^{\frac{\alpha}{1-\alpha}}.$$

$$\frac{K_T}{K_B} = \left( \frac{A_T}{\bar{A}} \right)^{\frac{1}{1-\alpha}} = \left( \frac{1}{p} \right)^{\frac{1}{1-\alpha}} \quad \frac{Y_T}{Y_B} = \left( \frac{K_T}{K_B} \right)^\alpha = \left( \frac{1}{p} \right)^{\frac{\alpha}{1-\alpha}}.$$

The key determinants of the size of the magnification are the probability of the high state persisting ( $p$ ) which affects trading environment directly and the average productivity that is important in the baseline case, the  $\alpha$  parameter determining the curvature of the production function, and, for the Panglossian environment, the gap between productivities in the H and L environments. The value of the real interest rate does not matter for the relative effect of the environment.

For our default calibration, we assume that the high state is persistent with a duration of around 10 years ( $p = 0.9$ ). The production function parameter,  $\alpha$  is set to 0.333.

In the default calibration, the high state is set to 1.05 while the low state is 0.95. Using these calibration values, the effect of the Pangloss environment is to raise the level of capital by only 1.5% (Capital Multiplication is 1.015) and the level of output in the high state is only 0.5% higher (High State Output Multiplication = 1.005). However, the Trading environment generates capital that is 17% higher (Capital Multiplication is 1.17) which gives rise to output higher by 5.4% in the high state (High State Output Multiplication = 1.054). The Trading environment magnification is highly significant.

In figure 1 we retain the default calibration for all parameters apart from the high state probability ( $p$ ) which we vary from 0.75 to 0.96. As is obvious from the formulae above, and from the plots, a lower  $p$  raises the magnification of capital (LHS plot) and high state output (RHS plot). One reason for this is that it reduces the average productivity ( $\bar{A}$ ) that drives the baseline scenario. But the figures also highlight that the effect is much larger in the trading environment. If the high state was only expected to last around 6 years ( $p = 0.84$ ) then the high state output is around 9% higher than the baseline in the trading environment but just 1% higher in the Panglossian scenario.

In figure 2, we instead vary how high productivity is in the high state ( $aH$ ) from 1.01 to 1.15 and the low-state productivity is held at 0.95; other parameters are calibrated at their default values. There is no effect of this on the trading equilibrium but higher  $aH$  raises the Panglossian magnification. Nonetheless, the Panglossian scenario generates significantly less magnification even when the high state is around 20% higher than the low state productivity.

In figure 3, we vary only the production function parameter. In this case, the Trading scenario is more markedly affected.

The key message across all of these quantitative experiments is that the basic Panglossian effect is small. The effect becomes economically substantial in the Trading environment when the financial system and exploitability of guarantees gives rise to beyond Panglossian behaviour.

## 5.2 The US since the 1990s

In what follows, we argue that our mechanism may be relevant to the recent US history.

### 5.2.1 Time varying distortion

In our analysis, a requisite for inefficient booms is an environment with guarantees. But as highlighted in the previous section, the presence of a regime of exploitability is necessary for the largest amplification of the inefficiency. The extent of the exploitability will depend importantly on aspects of bank regulation (such as capital regulation).

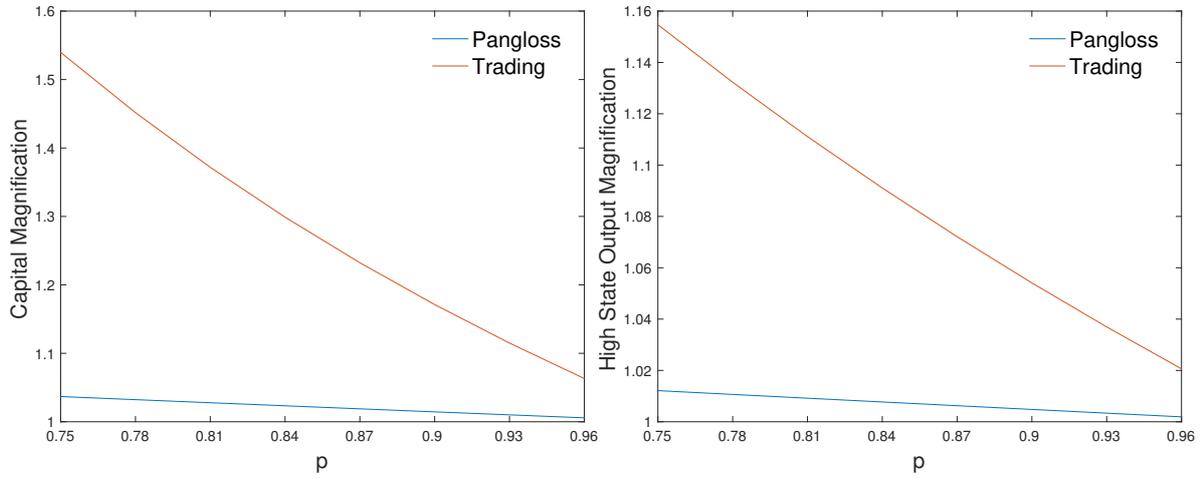


Figure 1: Effect of variation in high state probability ( $p$ )

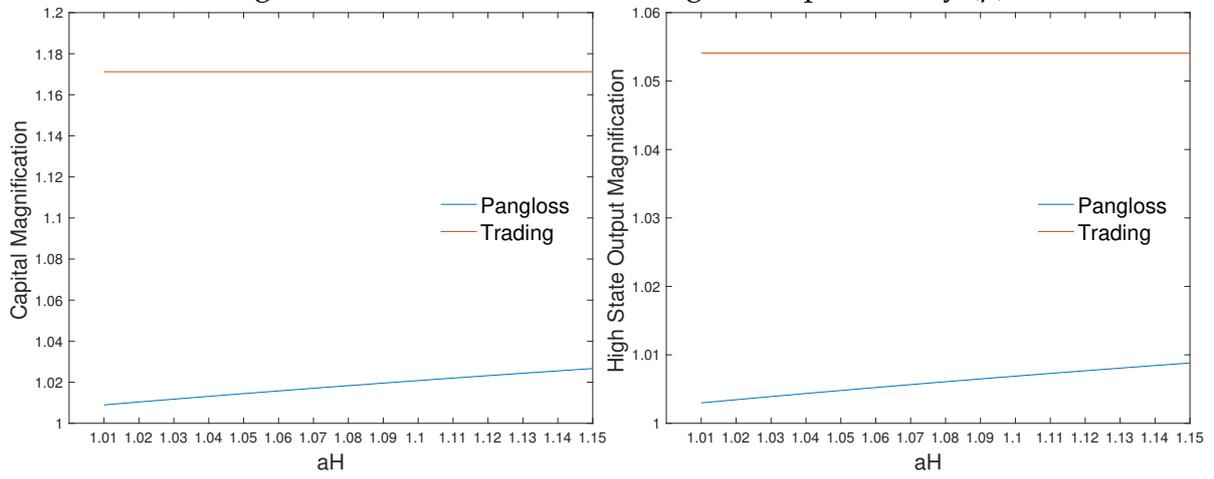


Figure 2: Effect of variation in high state productivity ( $aH$ )

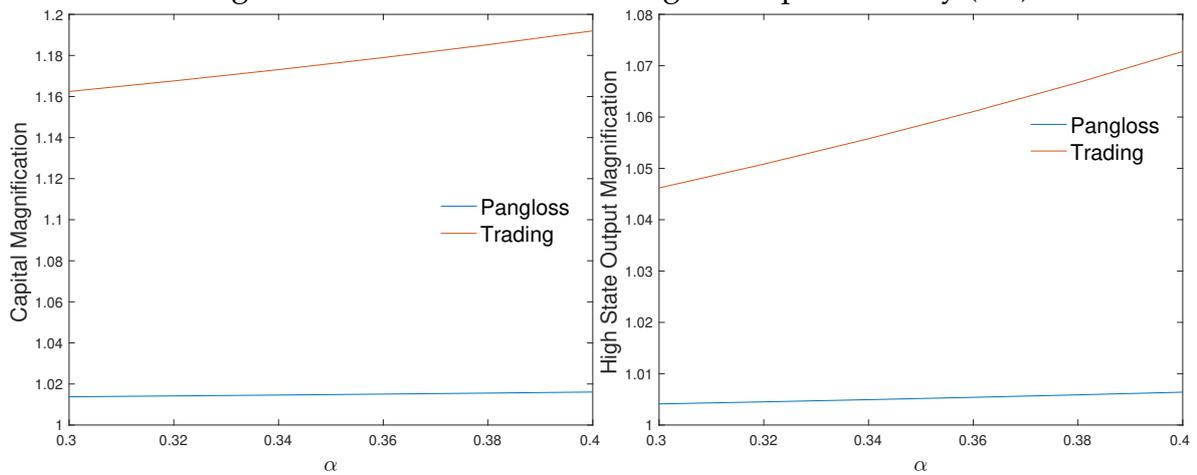


Figure 3: Effect of variation in  $\alpha$

A tougher regulatory environment could mitigate the extent of the distortion. With these considerations in mind, we argue that, in the two decades leading to the 2008 crisis, the US saw a significant increase in such exploitability. And a tightening of regulation has dramatically reduced it in the crisis aftermath.

We argue that several factors points in this direction. Deregulation (examples below) is likely to have played a role. But financial innovation may have been important too. First, engineering trades corresponding to the one we describe above, and making sure that they are bankruptcy remote is not that straightforward. Second, one should also be able to generate the collateral. Securitization comes to mind, but also the use of subprime mortgages. Finally, general equilibrium effects can be important: in the early years, due to limited competition, it may have been the case that proprietary trading profit was not offset by expected losses on lending.

As an illustration, we provide below a selected list of potentially important milestones which increase the exploitability of guarantees:

**1984** Repurchase agreements are confirmed to be bankruptcy remote (extended in mid-1990s and 2005).

**1996** The Glass-Steagall Act is reinterpreted to allow banks to have up to 25% of revenue from their investment banking activities.

**1997** Bear Sterns securitizes the first loans under the Community Reinvestment Act (these, potentially problematic, loans are guaranteed by Fannie Mae).

**1999** The Glass-Steagall Act is repealed.

**2000** The FDIC grants safe harbor protection for securitization.

**2004** The SEC removes leverage restriction on investment banks.

**2004** The OCC removes anti-predatory lending restrictions on national banks.

In the aftermath of the financial crisis, there has undeniably been a regulatory crackdown. Government guarantees are, of course, still present, but banks are arguably less able to exploit them. The Volcker Rule limits proprietary trading and stress-tests aim to make sure that, even in the most adverse scenario, banks would not fail. If we take stress tests' recent positive results at face value, this implies that our mechanism is no longer at play, which could explain a reversion to a lower, but, in our analysis, efficient and sustainable trend. We do not want to argue there is no residual effect of guarantees, but rather that these developments contribute to a decrease in banks' ability to exploit the guarantees and, therefore, to mitigate the impact of our mechanism.

## 5.2.2 Stylized facts over the pre- and post-crisis periods

In this section we examine the broad developments in the empirical counterparts to our model predictions. These data are presented in figure 4.

**GDP outgrew NDP in the pre-crisis period** The pre-crisis period was marked by a divergence between gross and net domestic product. Figure 4a shows that the ratio of annual nominal GDP (Billions of Dollars) to NDP (equivalent basis) increased from 1.17 in 1997 to 1.2 at the start of 2009; while this may not seem like a huge change, it represents a 1.3 standard deviation shift based on changes over the post-war period. It is driven by GDP growth of 67.5% over the period, while NDP grew by only 63.5%.

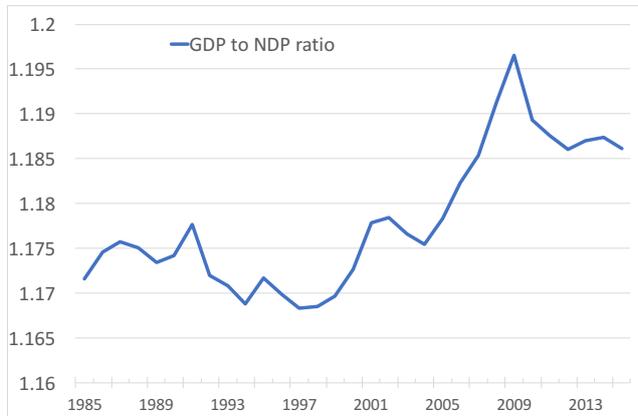
**Real wages accelerated before, and then stagnated after, the financial crisis** The prediction from the models presented above is that the period in advance of the crash would also have been marked by significant real wage growth. Figure (4b) shows the index of real compensation per hour. This begins to accelerate from around 1998 until the financial crisis. Between 2009 and 2014, real wages were virtually stagnant. Clymo (2016) provides evidence that real wages were gradually adjusted down in the US (as well as in the UK) after the crash. The persistent increase in the unemployment rate over this period is well-documented.

**The paths of the prices of different types of capital goods diverged** The extended model predicts that when banks become better able to exploit guarantees, this inflates the price of collateralizable assets. Figure 4c shows that the relative price of investment, which has been on a well-documented secular downward trend since the 1970s actually increased slightly before the financial crisis. While equipment goods prices continued to decline, the prices of residential and particularly non-residential structure prices grew strongly for many years before the crisis. These trends are consistent with our model predictions.

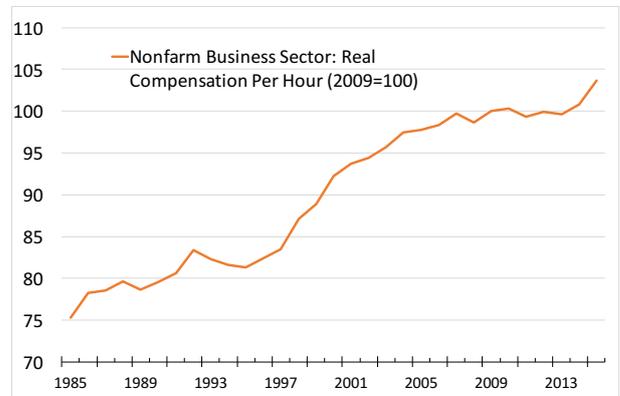
**Trading book profits increased and lending standards declined** Another implication of the model is that, as banks become better able to exploit the guarantees, trading book profits should grow in importance relative to profits from the loan book, despite an increase in lending volume.<sup>23</sup> Haldane and Alessandri (2009) document the growth of the trading book as a source of bank profits. They describe the period before the financial crisis as “an Alice in Wonderland world in which everybody had won and

---

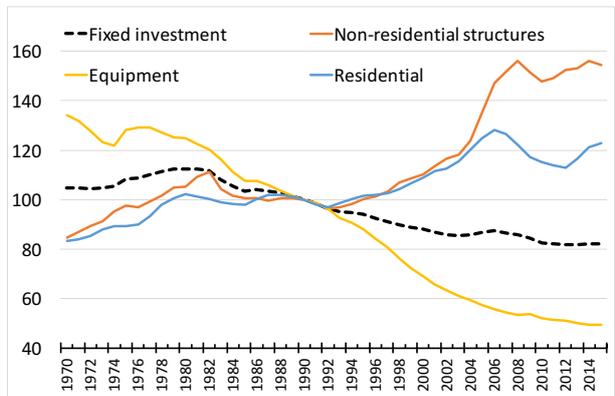
<sup>23</sup>Philippon (2015) documents the surge in the volume of intermediation and the overall increase in the income share of the finance industry.



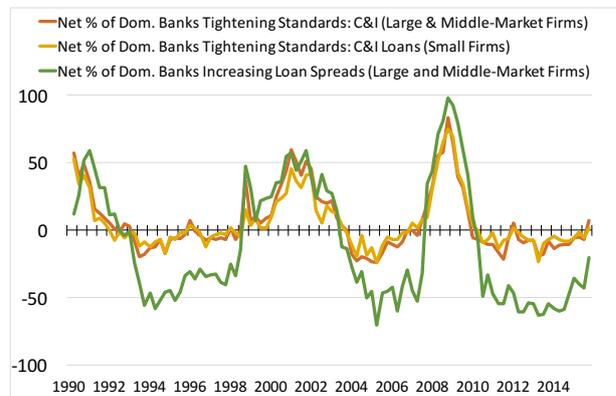
(a) US GDP to NDP Ratio



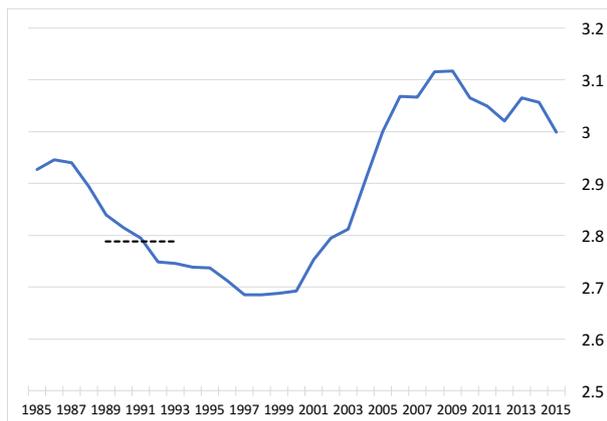
(b) US Real Wages



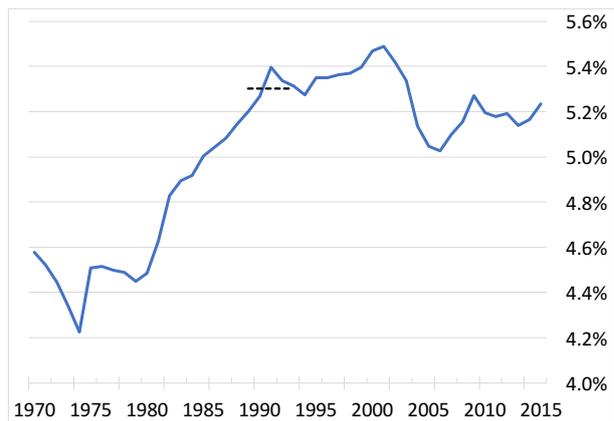
(c) US Relative Price of Capital Investment (Index, 1990=100)



(d) US Lending Standards from Senior Loan Officer Opinion Survey



(e) US Capital-Output Ratio



(f) US Depreciation Rate Implied by BEA Capital Consumption

Figure 4: US economy counterparts to key model variables: Time Series Behaviour

all had prizes.” When the financial crisis came, they highlight that trading book losses were sizeable.

In order to expand their trading book activities, banks in the model loosen lending standards. The Senior Loan Officer Opinion Survey (SLOOS), provided quarterly since 1990 by the Federal Reserve Board of Governors, provides an empirical assessment of lending standards. Senior loan officers are very senior bank officials (from a cross section of anonymous lending institutions in the US) who indicate in the survey if lending standards are becoming tighter that quarter relative to the previous one. We can also measure the percentage that are increasing their margins on lending (spread over funding cost). Figure 4d shows that the period from 2002 until the onset of the financial crisis in 2008 was first marked by a reduced proportions of banks tightening conditions, and then a period during which more banks were loosening both lending standards as well as the spread over bank funding (the profit margin). In early 2005, over 70% of respondents were reducing their profit margin. Given that the survey measures a flow of weakening (rather than the level of the standards), this period of persistent reducing of standards is likely associated with a large reduction in standard that was reversed only during the financial crisis.<sup>24</sup> Keys et al. (2008) and Bassett et al. (2014) document the decline in standards in more detail.

**The capital-output ratio initially fell from the 1989-1993 benchmark before steadily rising** Having been falling steadily from the end of the 1970s, the capital to output ratio started to increase again in the mid-1990s. Figure 4e shows the nominal capital-output ratio between 1985, the beginning of the period that became known as the Great Moderation, and 2015. These data come from the Bureau of Economic Analysis and the measure of capital stock includes both public and private fixed assets, but excludes consumer durables.

**The trend increase in depreciation happened up to 2000 before it fell back somewhat** Given that computers depreciate more quickly than other assets, it is often assumed that the rate of depreciation rose in the last quarter of a century. However, using BEA data on nominal capital consumption ( $\delta_t K_t$ ), we can derive an official estimate of depreciation in each period. Figure 4f plots the time-series of this depreciation rate extended back to 1970 (rather than 1985 as in other figures) to show that the trend in the implied depreciation rate continued only until the late 1990s. The depreciation rate actually fell back somewhat in the early 2000s.

---

<sup>24</sup>One weakness of this survey is that it does not measure the intensity of the reductions in margins or standards; more than 70% of banks could reduce standards a lot or a little with no difference in reported SLOOS indicator.

**Depreciation** Using BEA data on nominal capital consumption ( $\delta_t K_t$ ), we can derive an official estimate of depreciation in each period. Figure 4f plots the time-series of this depreciation rate. We extend the series in this figure back to 1970 (rather than 1985 as in other figures) to show that the trend in the implied depreciation rate continued only until the late 1990s. The depreciation rate actually fell back somewhat in the early 2000s.

### 5.3 Quantifying the magnitude of the distortion

To quantify the effect, consider the basic predictions of the model under a Panglossian economy (still indicated by subscript P) and an economy subject to our financial exploitation distortion (subscript T). With  $A$  as realized TFP,  $\bar{A}$  as expected TFP,  $A_H$  as the high state TFP, and  $A^+$  as the inflated conditional expectation that is central to the Trading distortion (which includes the effects of exploitation as described in section 3)<sup>25</sup>, we can write the equilibrium level of capital in each regime as:

$$K_{t,P} = \left( \frac{\alpha A_{H,t}}{\delta_t + r_t} \right)^{\frac{1}{1-\alpha}} ; \quad K_{t,T} = \left( \frac{\alpha A_t^+}{\delta_t + r_t} \right)^{\frac{1}{1-\alpha}}$$

The realised level of output is given by:

$$Y_{t,B} = A_t \left( \frac{\alpha A_{H,t}}{\delta_t + r_t} \right)^{\frac{\alpha}{1-\alpha}} ; \quad Y_{t,T} = A_t \left( \frac{\alpha A_t^+}{\delta_t + r_t} \right)^{\frac{\alpha}{1-\alpha}}$$

In an economy with the distortion, the level of GDP would be higher by:

$$\frac{Y_{t,T}}{Y_{t,P}} = \frac{A_t \left( \frac{\alpha A_t^+}{\delta_t + r_t} \right)^{\frac{\alpha}{1-\alpha}}}{A_t \left( \frac{\alpha A_{H,t}}{\delta_t + r_t} \right)^{\frac{\alpha}{1-\alpha}}} = \left( \frac{A_t^+}{A_{H,t}} \right)^{\frac{\alpha}{1-\alpha}}$$

Therefore, in order to get a sense of the size of this distortion in the data, we need to assess  $\left( \frac{A_t^+}{A_{H,t}} \right)^{\frac{\alpha}{1-\alpha}}$ . Expressing this distortion, or wedge, as a % of the benchmark level of output, we define:

$$m_t \equiv \ln \left( \frac{A_t^+}{A_{H,t}} \right)^{\frac{\alpha}{1-\alpha}}$$

In the model, this ratio also drives the behaviour of the capital-output ratio. Comparing a regime subject to the additional distortion with the baseline Panglossian regime facing the same series of shocks, the K-Y ratio is higher in the economy subject to distortions.

<sup>25</sup>With exploitation  $A^+ = A_H + \frac{1-p}{\alpha p} (A_L - (1-\alpha)A_H)$ .

$$\frac{K_{t,P}}{Y_{t,P}} = \frac{\alpha}{(\delta_t + r_t)} \frac{A_{H,t}}{A_t}, \quad \frac{K_{t,T}}{Y_{t,T}} = \frac{\alpha}{(\delta_t + r_t)} \frac{A_t^+}{A_t}$$

$$\Rightarrow \frac{\frac{K_{t,T}}{Y_{t,T}}}{\frac{K_{t,P}}{Y_{t,P}}} = \frac{A_t^+}{A_{H,t}}$$

### 5.3.1 Baseline back of the envelope calculation

As described above, we consider the period from the late 1990s until the financial crisis to be a period in which there were both guarantees and also an ability to exploit them; we call this the T regime. We compare it to a benchmark period of 1989-1993 which had guarantees but less exploitability (P).

As in Figure 4e, in the baseline period the capital output ratio was 2.8  $\left(\frac{K_{0,P}}{Y_{0,P}} = 2.8\right)$  and by 2008 it had risen to 3.1  $\left(\frac{K_{1,T}}{Y_{1,T}} = 3.1\right)$ . As a baseline back of the envelope calculation, we calibrate the scale of the distortion based on the observed changes in the ratios. Using  $\alpha = 0.35$ , we have  $m_1 = \frac{\alpha}{1-\alpha} \ln\left(\frac{3.1}{2.8}\right) = 5.5\%$ . This should be interpreted as GDP being 5.5% higher than the benchmark economy in 2008. If the post-crisis period was characterized by a reduced distortion of this magnitude, we should not expect to recover this portion of the (apparently lost) output.

### 5.3.2 A more complete calibration

This baseline calculation assumes that the earlier period is, apart from the ability to exploit the guarantees, otherwise identical to the later period. If, however, there are other things also changing, the earlier period is a less good control for this baseline calculation. For example, if there are secular trends in  $\delta$  and  $r$ , there will be other drivers of the capital-output ratio. Using the observed change in the ratios could wrongly attribute to  $\left(\frac{A_t^+}{A_{H,t}}\right)$  the changes in the other drivers. Allowing  $r$ ,  $\delta$ , and actual TFP draws to vary:

$$\frac{\frac{K_{1,T}}{Y_{1,T}}}{\frac{K_{0,P}}{Y_{0,P}}} = \frac{\frac{\alpha}{(\delta_1+r_1)} \frac{A_1^+}{A_1}}{\frac{\alpha}{(\delta_0+r_0)} \frac{A_{H0}}{A_0}} = \frac{(\delta_0 + r_0)}{(\delta_1 + r_1)} \frac{A_1^+}{A_1} = \frac{(\delta_0 + r_0)}{(\delta_1 + r_1)} \left(\frac{A_0}{A_1}\right) \left(\frac{A_1^+}{A_{H0}}\right)$$

This means we need to purge the change in the capital output ratio for these other drivers:

$$\ln\left(\frac{A_1^+}{A_{H0}}\right) = \ln\left(\frac{\frac{K_{1,T}}{Y_{1,T}}}{\frac{K_{0,P}}{Y_{0,P}}}\right) + \ln\left(\frac{(\delta_1 + r_1)}{(\delta_0 + r_0)}\right) + \ln\left(\frac{A_1}{A_0}\right) \quad (6)$$

The estimated  $\left(\frac{A^+}{A_H}\right)$  ratio remains the key driver of the effect of the distortion on

output. The  $m_1$  calculation will simply use the ratio estimated in (6).<sup>26</sup>

**Depreciation** We already discussed the behaviour of depreciation which we can use in this calibration (figure 4f). During the benchmark period, the rate was 5.3%. It varies only a small amount over the period; the range is 5% to 5.5%.

**Real cost of capital** The calculation above assumes that there is no change in the real cost of obtaining funds. Given that there is a large literature that suggests there has been a secular decline in interest rates over the last 25 years, this assumption may also be problematic. Rognlie (2015) backs out an implied measure of the real cost of funds from financial markets. He compares the difference between firms' market value and the value of their fixed assets which captures the discounted value of expected future pure profits which can then be used to infer an implied  $r$ . This approach helps to overcome the difficulty, caused by the fact that reliance on debt versus equity finance differ across firms, of backing the real cost of funds out of bond and equity prices.

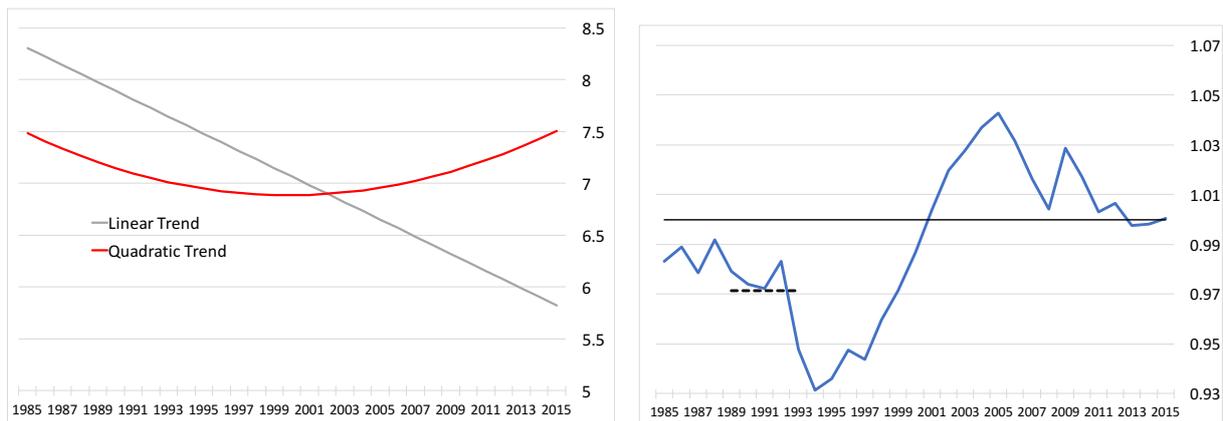
The Rognlie calculation yields a very high value of the real return; the estimates are in the range 12-15%. This is driven by the fact that in the US Financial Accounts the market value is below the book value for much of the sample and firms are assumed to make no pure profits on average. In his discussion of Rognlie's paper, Robert Solow questioned whether level was biased and so was too high saying: "It is hard to believe that the discount rate was this high from 1950 to 2010. (Household saving was available at an interest cost of 4 to 5 percent; one would have expected more investment to have taken place)" (Solow, 2015). Given this criticism, and because declines in  $r$  from a higher level would attribute more of the rise in capital-output ratios to our distortion, we adjust the level of the Rognlie estimates by a fixed 5pp across the entire sample reducing the impact of the distortion.

Rognlie estimates the trends over the period 1947 to 2013, as reported in Figure 7 of Rognlie (2015); we update the linear and quadratic trends to get estimates for 2014 and 2015. Over the whole sample  $r$  has declined overall but when using a quadratic trend, he finds that  $r$  was slightly rising in the 2000s. Figure 5a shows the adjusted trend values for  $r$  from 1985 to 2015. We calibrate the distortion using both of these estimates in order to compare the effects of different estimates for  $r$ .

---

<sup>26</sup>The difference in levels of output will be given by:

$$\frac{Y_{1,MM}}{Y_{0,FB}} = \frac{A_1 \left( \frac{\alpha A_1^+}{\delta_1 + r_1} \right)^{\frac{\alpha}{1-\alpha}}}{A_0 \left( \frac{\alpha \bar{A}_0}{\delta_0 + r_0} \right)^{\frac{\alpha}{1-\alpha}}} = \frac{A_1}{A_0} \left( \frac{\delta_0 + r_0}{\delta_1 + r_1} \right)^{\frac{\alpha}{1-\alpha}} \left( \frac{A_1^+}{\bar{A}_0} \right)^{\frac{\alpha}{1-\alpha}}$$



(a) Estimates of the secular trends in real costs of funds (b) Fernald's Capacity-Utilization Adjusted TFP: Deviation from Quadratic Trend

Figure 5: Additional variables needed to measure the distortion

An additional concern may be the endogeneity of  $r$ . In the model,  $r$  is exogenous whereas the distortion may cause it to change endogenously. However, the direction of the endogenous reaction is not clear cut. One channel of the effect would be that, because households' future tax liabilities increase on average, saving may increase meaning that in a closed economy  $r$  would decline. A second channel comes from increased investment demand which would cause  $r$  to increase. We therefore proceed without further adjustment of the cost of funds.

**TFP** The final driver of the capital output ratio that may differ across time are the realised productivity draws. Assuming that  $\frac{A_1}{A_0}$  is constant when in fact the later period ( $t = 1$ ) was marked by above trend productivity draws would bias down our estimate of  $\left(\frac{A_1^+}{A_0}\right)$  since  $\left(\frac{A_0}{A_1}\right) < 1$  contaminates the empirical measure of the capital output ratio. In order to adjust for this, we can use capacity-utilisation-adjusted TFP estimates provided by Fernald (2012). Figure 5b shows our estimates of non-trend TFP shock at time  $t$  measured as the deviation from an estimated quadratic trend.

**Counterfactuals** Armed with estimates of  $\delta_t, r_t$  and  $A_t$ , we use equation (6) to derive a more precise estimate of  $m_t$ . Using the same baseline as earlier, we can produce a time-series estimate of the relative effect of the distortion over time which allows us to plot a counterfactual path for GDP under the different assumptions in figure 6; as well as two different paths for  $r_t$  described above, we consider the naive assumption of unchanged  $\delta_t, r_t$  and  $A_t$  that we used for the baseline back of the envelope calculation.

The gap between the measured GDP series and any of the counterfactual lines captures the effect of the distortion under the assumptions of that counterfactual. This

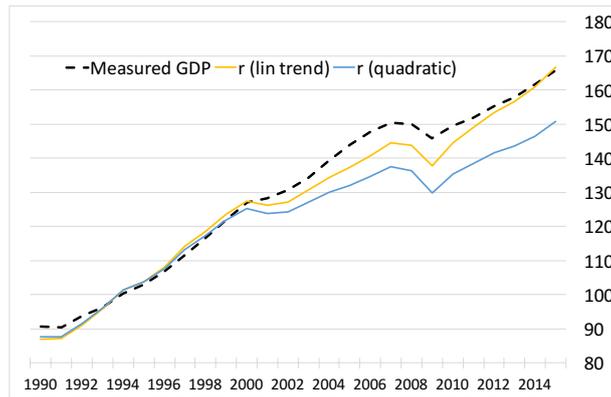


Figure 6: Counterfactual paths for US GDP

chart shows that during the late 1990s the size of this estimated distortion grew; the estimates come from increases in the capital-output ratio that cannot be explained by the movements in other drivers. The size of the distortion is particularly large when we use the quadratic trend in  $r_t$  because those assumptions actually suggest that the real return term was increasing which would have pushed the capital-output ratio down leaving more of an increase to explain with the distortion. Under all the assumptions the distortion pushed up GDP in the early 2000s. To the extent that we delude ourselves that this was sustainable, this distortion has exacerbated the perceived loss of output since the financial crisis.

## 5.4 The Great Distortion

We now exploit the adjusted series and ask how misleading the measured GDP series is. In other words, if we had access to adjusted GDP measure, would we have been less surprised by the slowdown following the financial crisis? We estimate a simple statistical measure of trend; we use simply linear and quadratic trends applied to the log of the GDP series we are considering.

There are two estimates of the trend that we calculate. First we use data until the end of 2007 (a 2008 trend) which is then extrapolated to the end of 2015. The second estimates a trend using all data to the end of 2015. A large difference between the lines captures the fact that the pre-crisis evolution of the series was misleading relative to what we now know (and would, with hindsight, have been ignored).

In the left panel of figure 7, we use the measured GDP index. Using this series in our exercise, we would, after eight years of the financial crisis and weak recovery, have revised the level 2015 trend GDP down by 20% of measured GDP. The right panel of Figure 7 runs the same trend analysis on our adjusted GDP series. The downward revision to trend GDP would have only been 1% suggesting that our adjusted series was much less distorted.

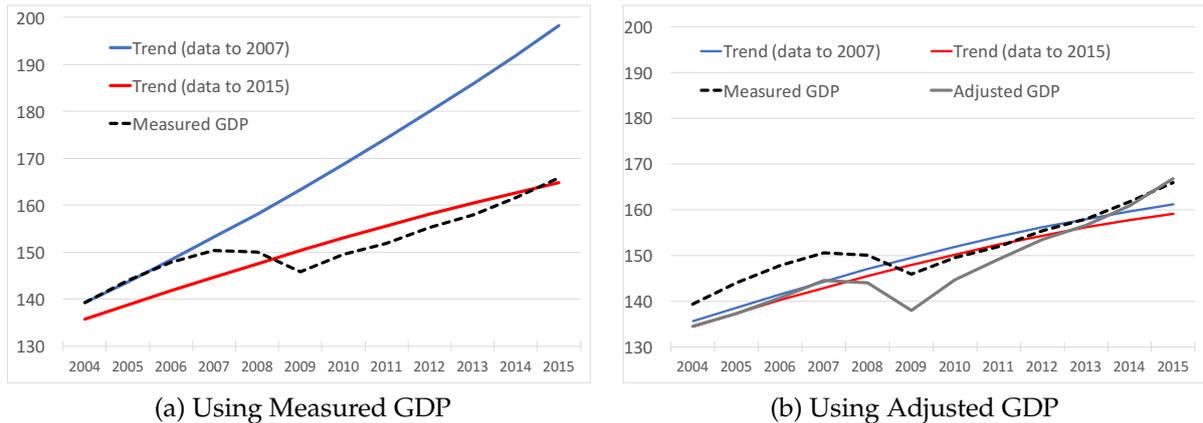


Figure 7: Revisions to GDP Trend between 2008 and 2013

Notes: These figures display a statistical measure of trend GDP estimated using a quadratic trend through the log of the GDP series. The blue line is the trend estimated using data through 2007 (as if the econometrician is sitting in 2008) and then extrapolated to 2015. The red line is the trend estimated through all of the data to 2015. The left panel (A) use the measured GDP series from the BEA which is plotted in both panels as the black dashed line. The right panel uses our adjusted GDP series which is plotted only in that panel as the grey line.

## 6 Conclusion

We provide a novel explanation for the persistent decline in measured economic output that typically follows financial crises. Our theoretical model highlights a finance-induced, supply-side mechanism by which the banking sector passes the implicit subsidy from government guarantees onto the real economy. It also highlights that a rise of banks' trading activities can magnify the problem. When we examine data for the US economy, our model is able to account for series of stylized facts associated with the run up to the 2008 crisis. Our analysis suggests a substantial role for our mechanism during that period. From that viewpoint, the great recession can look more like a reversing of a great distortion.

## References

- BAHAJ, S. AND F. MALHERBE (2016): "A positive analysis of bank behaviour under capital requirements," *CEPR Discussion Paper*, dP11607.
- BALL, L. (2014): "Long-term damage from the Great Recession in OECD countries," *European Journal of Economics and Economic Policies: Intervention*, 11, 149–160.
- BASSETT, W. F., M. B. CHOSAK, J. C. DRISCOLL, AND E. ZAKRAJŠEK (2014): "Changes in bank lending standards and the macroeconomy," *Journal of Monetary Economics*, 62, 23–40.
- BIANCHI, F., H. KUNG, AND G. MORALES (2019): "Growth, slowdowns, and recoveries," *Journal of Monetary Economics*, 101, 47 – 63.
- BLANCHARD, O., E. CERUTTI, AND L. SUMMERS (2015): "Inflation and Activity - Two Explorations and their Monetary Policy Implications," NBER Working Papers 21726, National Bureau of Economic Research, Inc.
- BORIO, C. (2013): "The financial cycle and macroeconomics: What have we learnt?" *Journal of Banking & Finance*.
- CLYMO, A. (2016): "Heterogeneous Firms, Wages, and the Effects of Financial Crises," mimeograph, Tinbergen Institute.
- CRAFTS, N. (2019): "The Fall in UK Potential Output due to the Financial Crisis: a Much Bigger Estimate," CEPR Discussion Papers 13428, C.E.P.R. Discussion Papers.
- DELONG, J. B. AND L. H. SUMMERS (2012): "Fiscal policy in a depressed economy," *Brookings Papers on Economic Activity*, 2012, 233–297.
- DIAMOND, D. W. AND P. H. DYBVIK (1983): "Bank Runs, Deposit Insurance, and Liquidity," *Journal of Political Economy*, 91, 401–419.
- FATÁS, A. AND L. H. SUMMERS (2015): "The permanent effects of fiscal consolidations," .
- FERNALD, J. G. (2012): "A quarterly, utilization-adjusted series on total factor productivity," Working Paper Series 2012-19, Federal Reserve Bank of San Francisco.
- (2015): *Productivity and Potential Output before, during, and after the Great Recession*, University of Chicago Press, 1–51.
- HALDANE, A. AND P. ALESSANDRI (2009): "Banking on the state," *BIS Review*, 139.

- HALDANE, A., S. BRENNAN, AND V. MADOUROS (2010): "What is the contribution of the financial sector: Miracle or mirage?" *The Future of Finance*, 87.
- HALL, R. E. (2011): "The long slump," *The American Economic Review*, 101, 431–469.
- JORDÀ, Ò., M. SCHULARICK, AND A. M. TAYLOR (2013): "When credit bites back," *Journal of Money, Credit and Banking*, 45, 3–28.
- (2016): "Sovereigns versus banks: credit, crises, and consequences," *Journal of the European Economic Association*, 14, 45–79.
- KARABARBOUNIS, L. AND B. NEIMAN (2013): "The global decline of the labor share," Tech. rep., National Bureau of Economic Research.
- KEYS, B. J., T. K. MUKHERJEE, A. SERU, AND V. VIG (2008): "Did securitization lead to lax screening? Evidence from subprime loans," *Evidence from Subprime Loans* (December 25, 2008). EFA.
- KRUGMAN, P. (1999): *What Happened to Asia*, Boston, MA: Springer US, 315–327.
- (2012): "Economics in the Crisis," *NY Times*, march 5.
- MALHERBE, F. (2016): "Optimal Capital Requirements over the Business and the Financial Cycles," Mimeo, London Business School.
- MARTINEZ-MIERA, D. AND J. SUAREZ (2014): "A Macroeconomic Model of Endogenous Systemic Risk Taking," Mimeo, CEMFI.
- MCKINNON, R. I. AND H. PILL (1997): "Credible Economic Liberalizations and Overborrowing," *American Economic Review*, 87, 189–193.
- MIAN, A. R. AND A. SUFI (2014): "What explains high unemployment? The aggregate demand channel," *Econometrica*, 82.
- OULTON, N. (2013): "Has the growth of real GDP in the UK been overstated because of mismeasurement of banking output?" *National Institute Economic Review*, 224, R59–R65.
- PHILIPPON, T. (2015): "Has the US finance industry become less efficient? On the theory and measurement of financial intermediation," *The American Economic Review*, 105, 1408–1438.
- PIKETTY, T. (2014): "Capital in the twenty-first century," .
- REINHART, C. M. AND K. S. ROGOFF (2014): "Recovery from Financial Crises: Evidence from 100 Episodes," *American Economic Review*, 104, 50–55.

- ROGNLIE, M. (2015): "Deciphering the Fall and Rise in the Net Capital Share," *Brookings Papers on Economic Activity*, 46, 1–69.
- SCHNEIDER, M. AND A. TORNELL (2004): "Balance Sheet Effects, Bailout Guarantees and Financial Crises," *Review of Economic Studies*, 71, 883–913.
- SCHULARICK, M. AND A. M. TAYLOR (2012): "Credit booms gone bust: monetary policy, leverage cycles, and financial crises, 1870–2008," *The American Economic Review*, 102, 1029–1061.
- SOLOW, R. (2015): "Discussion of "Deciphering the Fall and Rise in the Net Capital Share" by Matthew Rognlie," *Brookings Papers on Economic Activity*, 46, 59–65.
- SUMMERS, L. H. (2014): "Reflections on the New Secular Stagnation Hypothesis," *Secular stagnation: Facts, causes and cures*, 27–40.
- (2015): "Demand side secular stagnation," *The American Economic Review*, 105, 60–65.
- WEITZMAN, M. L. (1976): "On the welfare significance of national product in a dynamic economy," *The Quarterly Journal of Economics*, 156–162.

# Appendix

## A Proofs

### Proof of Lemma 1

*Proof.* First, note that no arbitrage condition implied by the presence of rest of the world agents implies:  $p_i = \frac{E[R_i]}{1+r}$ . This means that no security can offer a risk premium. Hence, in equilibrium, irrespective of its liability structure, the expected marginal cost of funds for the representative bank is  $1 + r$ , and so is the economy's expected marginal return to capital.  $\square$

### Proof of Lemma 2

*Proof.* The lemma directly follows from the reasoning in the text.  $\square$

### Proof of Lemma 3

*Proof.* Imagine the bank does not fail in equilibrium. Then, deposits are always fully repaid. Hence, the expected marginal cost of funds is  $1 + r$ . This means that the expected marginal return to capital cannot be greater than  $1 + r$  in equilibrium. But since  $A_L < \bar{A}$ , the bank must make losses in the bad state. From Lemma 2, the bank only issues deposits in equilibrium. Hence, there is no equity buffer and the bank defaults; a contradiction.  $\square$

### Proof of Lemma 4

*Proof.* Since the bank makes losses in state  $A_L$ , it must be that the representative firm repays less than what it has borrowed. Given the firm has limited liability, its decisions at the margin will only be based on state  $A_H$ . From, first order condition (2), we must have  $\rho_H = 1 + r$  in equilibrium. Hence, the relevant maximization problem for the firm is  $\max_{k,n} A_H k^\alpha n^{1-\alpha} - wn - k(1 + r)$ . The result follows.  $\square$

### Proof of Proposition 1

*Proof.* First,  $AK^\alpha$  is strictly increasing in  $K$ . Second, expected net output, which is given by  $E[AK^\alpha - K(1 + r)]$ , reaches a global maximum in  $K_B < K^*$ .  $\square$

### Proof of Proposition 3

*Proof.* From first order condition (3), we get the equilibrium level of capital (the subscript  $T$  stands for trading):

$$K_T^* = \left( \frac{\alpha A_H + \frac{1-p}{p} (A_L - (1-\alpha)A_H)}{1+r} \right)^{\frac{1}{1-\alpha}}.$$

Since  $A_L > (1-\alpha)A_H$ , we have that  $K_T^* > K^*$ . The result directly follows.  $\square$

## B Correlated investment

### B.1 An extension with idiosyncratic risk and diversification in a closed economy

In the baseline model above, we only consider aggregate risk. In macroeconomic models, such an assumption is often justified by the idea that idiosyncratic risk can be diversified, and that this will be the case in the presence of risk aversion. However, government guarantees can make banks risk loving. In this section, we provide an extension of the model, where the bank can use a safe storage technology (that yields a 0 net return) and lend to two sectors, which exhibit different levels of firm correlation. In the diversified sector, we assume, for simplicity, that firm risk is *i.i.d.* The correlated sector corresponds to the production sector we have considered so far.

In practice, we assume that firms in the diversified sector operate the following CRS production function:

$$Ak^\alpha n^{1-\alpha},$$

where we use bold equivalent letters for the notation. The key difference here is that  $A$  is a constant.

**Proposition 4.** *Assume  $1 > A > A_H$ . In the economy without guarantees, production only takes place in the diversified sector (and GDP is a constant). However, under government guarantees, production only takes places in the correlated sector. Considering  $A \rightarrow 1$ , compared to the baseline comparison,*

- (i) *The inefficiency in terms of net output is identical*
- (ii) *The inefficiency in terms of welfare corresponds to the incomplete market case.*

The logic is the following:

- We solve for the optimal contract between banks and firms

- First, we show that both sectors cannot operate at the same time. Then, if this is the diversified sector that is operated in equilibrium, there is a profitable deviation for a couple bank-firm: since the wage is the first-best. Operating at the high level of capital generates extra profit.
- In equilibrium, we get that not only the risky technology is chosen, but it is operated at an (risk-neutral) inefficient level.
- If there was only the correlated sector, since we are in a closed economy, the first best would be to operate at a level below the risk-neutral level. In the regime without government guarantees, this would ensue. Hence, again, the guarantees boost investment and wages compared to first best.

## C Back-to-benchmark transition

The motivation of the paper is intimately linked to the question of whether we are at a “new normal” or still in a transition period returning to the old trend. Hence, instead of thinking of a simple regime-change reversion to the benchmark economy, we can use our extended model to explicitly model the transition. The main idea behind treating the aftermath transition differently than the run up is the well established fact that wages exhibit downward rigidity.

Since the wage is inflated in the economy with guarantees, an easy way to think about back-to-benchmark transition dynamics is to consider an economy whose steady state is the benchmark economy of the extended model, but that starts from a situation where the wage is above steady state level and can only adjust downward at some decay rate  $\xi$ . Denote  $w_0$  the initial wage (which we will interpret as the wage just before the crisis) and  $w_B^*$  the relevant steady state wage, we have:

$$w_t = w^* + \xi^t(w_0 - w_B^*).$$

Then, we can solve for  $q_{s,t}^*$ ,  $Q_t^*$ , and the employment rate  $N$  from the corresponding system:

$$\begin{cases} (1 - \alpha) \bar{A} \left( \left( \frac{q_{s,t}^*}{q_e} \right)^{\frac{\gamma}{1-\gamma}} + 1 \right)^{\frac{\alpha}{\gamma}} (N_t^*)^{-\alpha} = w_t \\ \alpha \bar{A} \left( \left( \frac{q_{s,t}^*}{q_e} \right)^{\frac{\gamma}{1-\gamma}} + 1 \right)^{\frac{\alpha}{\gamma}} (N_t^*)^{1-\alpha} = q_{s,t}^* (\delta + r) \\ Q_t^* = \left( \frac{q_{s,t}^*}{q_e} \right)^{\frac{1}{1-\gamma}} \end{cases} ,$$

to obtain the following predictions. In a back-to-benchmark transition, if wages are sticky, the economy exhibits:

- Unemployment ( $N_t^* < 1$ );
- Depressed structure prices (that is,  $q_{s,t}^*$  instantly drops from a value that was inflated by the guarantees to a value below the benchmark value; an overshooting phenomenon);
- Depressed investment (same story for  $Q_t^*$ );
- A gradual decrease in the capital to output ratio (unemployment contributes to keeping it above its steady state level).