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BEYOND PANGLOSS: FINANCIAL SECTOR ORIGINS OF INEFFICIENT ECONOMIC BOOMS

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Government guarantees to banks are ubiquitous. We study an equilibrium model where, in the presence of such guarantees, the equilibrium allocation can be characterised as Panglossian: it corresponds to that of a deterministic economy where the best possible state always occurs. However, GDP is inefficiently high and expected consumption inefficiently low. Financial sophistication magnifies this distortion, taking the allocation beyond the Panglossian outcome (i.e. with even higher GDP and even lower expected consumption). We argue that this mechanism is empirically relevant for advanced economies and suggest that the Great Recession, partly, reversed a Great Distortion.

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Beyond Pangloss: Financial sector origins of inefficient economic booms*

Frederic Malherbe[†] and Michael McMahon[‡]

18th August 2020

Abstract

Government guarantees to banks are ubiquitous. We study an equilibrium model where, in the presence of such guarantees, the equilibrium allocation can be characterised as Panglossian: it corresponds to that of a deterministic economy where the best possible state always occurs. However, GDP is inefficiently high and expected consumption inefficiently low. Financial sophistication magnifies this distortion, taking the allocation beyond the Panglossian outcome (i.e. with even higher GDP and even lower expected consumption). We argue that this mechanism is empirically relevant for advanced economies and suggest that the Great Recession, partly, reversed a Great Distortion.

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1 Introduction

Globally, governments guarantee a substantial fraction of bank debt. A well-understood rational is that this helps alleviate financial panic (Diamond and Dybvig, 1983). On the other hand, this distorts bankers' incentives and promotes excessive risk-taking (see, e.g. Kareken and Wallace, 1978). There is a large literature dedicated to various ramifications of such guarantees: for instance, to the measurement of the burden to the taxpayer(e.g. Merton (1977) and Atkeson et al. (2019)), to how capital requirements for banks can mitigate the problem (e.g. Rochet (1992), Repullo and Suarez (2012), Malherbe (2020)).

We ask what the implications of such guarantees are for the macroeconomy, and how financial innovation affects the implications. 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 through over-investment. But our main contribution is to show how such guarantees interact with financial sophistication. Nobel-Prize-winning financial economist William Sharpe once told Paul Volcker that financial engineering contributed to nothing to economic activity (Volcker and Harper, 2018, p.206). Our answer would differ; in the presence of government guarantees, financial innovation of the sort that took place before the Global Financial Crisis (GFC) actually boosts GDP, but to *inefficiently* high levels and thereby *lowers welfare*.

The basic mechanism of government guarantees driving over-investment works as follows. When banks default, they do not repay depositors in full. Instead, depositors are made whole by the taxpayer. Given this implicit subsidy, banks effectively borrow from depositors at artificially low rates. But banks compete for firm lending, which means that they pass this artificially low interest rate onto firms. Firms, in turn, equate the marginal return on capital to the borrowing rate, which leads to over-investment in aggregate. This idea that bailout guarantees can lead to over-investment and financial instability has been studied in the context of emerging-market capital account liberalisation. This mechanism is, for instance, present in McKinnon and Pill (1997). In their paper, households incorrectly base their decisions on valuations that correspond to the best possible outcome. Krugman (1999) calls these valuations Panglossian and points out that they can also arise in a rational expectation equilibrium due to competition.

The novelty of our analysis is that Panglossian effects can be magnified by financial innovation. This means not only that Panglossian effects are relevant to more advanced economies, but also that the effects can be much more serious where there are certain types of financial sophistication. 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, and these are collateralised in a way that makes them bankruptcy remote (and, in effect, senior to deposits), such diversion of resources is possible. In such a context, more collateral means more trades and, hence, potentially more profit in the good states at the (privately irrelevant) cost of a higher bill for the taxpayer. To generate more collateral, banks have an incentive to issue more loans, which leads to lower lending standards and, ultimately, to further over-investment by firms. In fact, in equilibrium, banks maximise profit by making expected losses on lending which are compensated by strictly positive expected profits from the trading book. This increase in over-investment marks a further deterioration of the real allocation.

We develop a direct measure of the magnitude of the distortion in equilibrium which we call *implied break-even productivity*. It captures, for a given level of capital, the level of realised productivity that would be required for real investment to break even with respect to the opportunity cost of funds. We show that with the most basic financial sector, implied valuations are indeed Panglossian, reflecting the best of all possible worlds. As financial sophistication increases, financial institutions' behaviour is consistent with implied valuations that are even more favourable than the best case; they are, therefore, beyond Panglossian (and unattainable).

An important takeaway of our findings is not just that such Panglossian effects *could* occur in advanced economies, but instead that the distortion is potentially much larger in such economies. In the earlier related work (McKinnon and Pill (1997), Krugman (1999), and Schneider and Tornell (2004)), the interaction of the financial sector incentives and access to world capital markets drives the distortion, and 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.

As mentioned above, the distortion reduces welfare. In such an environment, for all realisations 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, it is not when such growth reflects over-investment. Instead, as in earlier papers (such as Weitzman, 1976), a better measure of welfare is Net Domestic Product (GDP adjusted for capital depreciation) because it captures the associated decrease in consumption. The novel implication of our analysis is that when investment decisions are distorted by government guarantees, and especially when the distortion is magnified by financial trading activity, GDP is a particularly poor indicator of welfare.

A second important takeaway is that capital regulation alone is not sufficient to offset the distortion from government guarantees. While it is true that the distortion decreases with the capital requirements, for any level of capital requirements there is a level of financial sophistication such that the bank is able to exploit the guarantees. This stands in contrast to Krugman's notion that Panglossian valuation must be a problem of under-regulated banking sectors. We show in a calibration of our model that even if capital requirements are very high (such as 50% of risk-weighted assets), a substantial Beyond Panglossian distortion can occur.

In order to make our point in a transparent way, we build the intuition of results by gradually adding features to a relatively simple macroeconomic equilibrium model. The model comprises a banking sector, a firm sector that operates a constant-return-to-scale production function, a household sector that provides labour inelastically, and the rest of the world, populated by risk-neutral agents that provide funds and insurance. All these agents act competitively. The first three key ingredients are: (i) investment is risky because it must be committed before the realisation of a shock to TFP; (ii) banks are exposed to real investment risk; (iii) banks potentially benefit from government guarantees.

In a world without guarantees, the equilibrium corresponds to the Modigliani-Miller world. The introduction of government guarantees shifts the equilibrium to a Panglossian allocation, with inefficiently high investment and GDP, and inflated real wages.

In our Beyond-Panglossian environment, we add a fourth key ingredient: banks can trade in a set of Arrow securities. Crucially, these trades are senior to deposits. As explained above, motivated by the financial innovation prior to the GFC, we think of this as similar to trades backed by bankruptcy-remote collateral, where collateral in our model would consist of the loans to firms. As we described above, the bank uses such trades to extract rent from the tax payer by moving revenue from the states where it defaults, to the states where it doesn't. However, in equilibrium, such rents are competed away by entry, which magnifies the distortion.

Finally, in the most general model, we add capital requirements on banks and also vary the extent of pledgeability of the loan book as collateral for the trades. This allows us to stress that, in our analysis, what matters most is not simply the existence of government guarantees but rather their exploitability (i.e. parameter values for the capital requirement and pledgeability). We link such parameters to real world counterparts to argue that, in the two decades leading to the 2008 crisis, the US saw a significant increase in such exploitability, and a dramatic reduction in the crisis aftermath.

This time pattern for exploitability has implications for how one should evaluate the level of GDP in the years after the GFC.[1] While the cause of observed persistent weakness of GDP after the GFC is not clear, and there are many other supply-side narratives for the relative weakness, a novel feature of our analysis is that it focuses on factors affecting the run-up, not the aftermath.[2] In fact, our analysis is not at all trying to explain the crisis itself but rather the apparent strength of the economy before it. The bottom line is that the pre-crisis strength in GDP may have been inefficiently high. This is different to the literature that emphasises deficient aggregate demand (such as Hall (2011), Krugman (2012), Mian and Sufi (2014), or Summers (2015)). While a natural conclusion from such papers is that fiscal policy did not respond enough, taking our model results at face value, no demand stimulus was warranted. Of course, ours is not the only channel operating, but to the extent that it was playing an important role, further fiscal stimulus may not, in fact, have been beneficial.

Empirically, we propose a simple, residual-based estimate of the scale of the capital distortion, and what this might mean for the distortion of GDP. Our calculation is calibrated using changes in the capital-output ratio not accounted for by other driving variables; in our model, such a residual would reflect the beyond-Panglossian distortion. Armed with estimates of the distortion over time, we calculate an adjusted GDP series that strips out the distortion. The distortion is estimated to be between 3% and 8% before the financial crisis. This is sizeable given that a recession gives rise to an output gap of 1-3% typically. The gap between the measured GDP series and our counterfactual series began increasing during the late 1990s. The difference was largest before the GFC,

[1] We focus on the characteristics of regime-specific equilibria, not business cycle dynamics.

[2] 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).

and while both measures suggest a significant decline in 2009, the recovery of the distortion-adjusted series is faster. This suggests that some of the Great Recession may have been the reversing of a Great Distortion that was due to increased exploitability of government guarantees.

Our analysis also sounds a cautionary note for the extensive use of guarantees. In many countries, an element of the policy response to the Covid-19 pandemic has been for the government to directly guarantee firm debt; for example, in the UK the Coronavirus Business Interruption Loan Scheme provides lenders a government-backed guarantee for loans up to £5m to small and medium enterprises. The motivation is to prevent costly defaults and hopefully reap gains from keeping most entities afloat. But what about the wider, longer run macroeconomic impact of this, especially if such guarantees prove hard to unwind (e.g. because they would then put banks in trouble)? Our analysis suggests that blanket guarantees could generate severe distortions and that governments should be wary of potential adverse unintended consequences.

2 A baseline Panglossian model of inefficient booms

In this section we introduce the most simple version of our model. There is a single period, in which there is a single consumption good. The economy comprises a household sector, a production sector, a banking sector, a government, and the rest of the world.

2.1 Model Setup

Households A risk-averse representative household maximises expected utility:

$$E\left[u\left(c\right)\right],$$

where c is its consumption at the end of the period, and $u(.)$ is increasing and concave. The households is endowed with x units of the consumption good at the beginning of the period, which it can use to buy available securities indexed by $i \in \{1, 2...\}$:

$$\sum_i \theta^i p^i \leq x,$$

where θ^i denotes the holding of security i, whose price is p^i. The households is also endowed with one unit of labour, which it supplies inelastically (aggregate labour is normalised to $N = 1$) in return for a wage w. We assume that wages are agreed prior to the realisation of the productivity shock. This makes the wage non-contingent but this is not important for our main results. The household pays lump-sum taxes τ to the government. Hence, its realised 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 maximise expected profit. They operate a constant returns to scale production function which combines physical capital (k) and labour (n) to produce the output good:

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

where $\alpha \in (0,1)$ and A is aggregate productivity that takes the value A^H with probability q and a strictly smaller value A^L with probability $(1-q)$. The two productivity states represent lower frequency shifts in the economic state rather than shocks at a business cycle frequency as in a standard DSGE model. Capital fully depreciates in production. Firms start penniless and there is free entry.

Firms compete to obtain capital from banks at the beginning of the period against the promise of a repayment at the end of it (ρ), and to hire workers. Wages must be paid before any payment can be made to banks.[3]

Banks There is a banking sector in which banks intermediate lending between households and firms. Banks raise funds (consumption goods) competitively by issuing liabilities to households and the rest of the world. In Section 3, we allow banks to issue any kind of liabilities. But, to build up our argument, we first restrict these liabilities to be deposits and/or equity only.

Banks have the ability to transform consumption goods into capital (one for one), which they provide to firms.

Government We compare two different Government regimes: one with, and one without guarantees. In the former, deposits are fully insured, at no premium.

[3]Positive profits (which only occur out of equilibrium) are distributed to shareholders (the representative household). And shareholders are protected by limited liability in case of losses. So, in effect, banks absorb all losses and there is no need to keep track for firm ownership.

In case a payment is needed, the government breaks even by imposing an ex-post lump-sum tax on households. Capital requirements are introduced later, in Section 4.1. Finally, for analytical simplicity, there is no other government spending or taxation.

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 $1 + r > 0$.

Timeline In sequence, banks and firms raise funds, firms hire workers, A realises, production takes place, factors are paid, banks repay deposits, other financial securities settle (including deposit insurance), taxes are raised, and consumption takes place. The essential aspect of the timeline is that investment decisions are taken before productivity realises. Finally, note that given this is a single period model, the capital stock is equal to investment.

Equilibrium definition All private agents are price taking and enjoy limited liability. In an equilibrium: (i) households maximise expected utility; (ii) banks and firms maximise expected profits; (iii) no bank or firm has an incentive to enter the market (i.e. shareholder profits are zero in expectation) (iv); the rest of the world breaks even in expectation; and (v) the government breaks even in all states.

2.2 Model discussion

Because we want to focus the *consequences* of government guarantees for banks, our baseline model assumes banks exist and may benefit from guarantees. This keeps the analysis simple and highlight the main mechanisms in a transparent way. However, these mechanisms would naturally generalise to more elaborate environments, some of which we explore in later sections of the paper.

Economic role for banks and rationale for government guarantees We assume that only banks can produce physical capital. This is a metaphor to capture the intermediation role played by banks in the economy. Also, for simplicity, we assume that firms do not issue securities directly to households or the rest of the world. This is without loss of generality for our results as firms at least weakly prefer to obtain funds from banks in all the regimes we study. In practice, reasons why bank intermediation adds value to the economy include liquidity provision (Diamond and Dybvig, 1983) and monitoring and diversification (Diamond, 1984). In Online Appendix I, we propose a more elaborate version of the model in which households have liquidity preferences on top of risk aversion. Offering demandable deposits can maximise households' utility but exposes banks to the risk of runs, which rationalises deposit insurance.[4]

Dynamics Even though propagation mechanisms play a central part in modern macro, they are not essential to the points we want to make. Our analysis in a single period model can be interpreted as a steady-state comparison between different regulatory regimes. And we don't study the transitional dynamics between these regimes. We believe this is appropriate because our objective is to understand differences in the level of economic activity in different environments rather than fluctuations around a single trend; Summers 2015, for instance, stresses the need for new models using such an approach.

2.3 The economy without government guarantees

Our benchmark economy, with no guarantees, has no relevant friction. Hence, the competitive equilibrium is efficient. In particular, Proposition 3 in Modigliani and Miller (1958) applies: the cutoff for real investment (i.e. the equilibrium marginal product of capital) only depends on the opportunity cost of funds in the economy $(1 + r)$.

This is not surprising, but let us still explore this benchmark economy in some detail, so as to define useful objects and set the stage for the main analysis. Because we will study several economies, or regimes, we will name them formally as we introduce them.

Definition 1. We refer to the economy without government guarantees as the Modigliani and Miller (or simply MM) economy. Where necessary, we use a subscript MM to indicate variables at the equilibrium of this economy.

[4]In the real world, government guarantees can either be explicit, like deposit insurance (partial or full), or implicit, for instance if the bank is deemed too big to fail. In the model, we do not impose limits on the support the government offers. In countries where bank bailouts test the limits of the government's fiscal capacity, government support may not be so generous. For the purpose of our analysis, the exact nature of guarantees and their extent is not important. What matters is that, ex-post, there are states of the world (i.e. financial crises) in which banks' creditors benefit from taxpayer money.

Production sector Firms act competitively. Because of constant returns to scale at the firm level, all firms operate at the same capital to worker ratio in equilibrium, and 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.

Since firms start penniless and have limited liabilities, the contract with the bank must be such that there is no state in which they make strictly positive profit in equilibrium (otherwise they would make profits in expectation, which would trigger entry). Their relevant first order conditions are:

$$\begin{cases} \alpha E[A]k^{\alpha-1} = E[\rho] \\ (1-\alpha)E[A]k^{\alpha} = w \end{cases},$$

where ρ is the realised repayment to the bank per unit of capital.

Banking sector Given that firms make zero profit in all states in equilibrium, it must be the case that the entire capital share is used as a repayment to the bank.[5] Hence, aggregating at the representative bank level, we have:

$$\rho(A, K) \equiv AK^{\alpha-1} - (1-\alpha)E[A]K^{\alpha-1}. \tag{2}$$

This cash flow depends on A and is therefore risky. In equilibrium, it must be the case that:

$$\rho(A^L, K) < 1 + r < \rho(A^H, K).$$

There are several ways to interpret (2). We think of the bank lending to the firm at a gross interest rate $\rho(A^H, K)$, which is higher than $1 + r$, to compensate the losses made by the bank when the firm can only repay $\rho(A^L, K)$. Alternatively, one can think of the bank owning all the equity of the firm given that the bank is, essentially, the residual claimant on the firm assets.

How do banks raise funds to finance risky lending? For now, we restrict the set of liabilities that the bank can issue to deposits and equity (in this benchmark equilibrium, this is without loss of generality). Given that agents from the rest of the world are risk neutral, they are willing to hold any security that

[5] Competition and constant return to scale also imply a linear contract between to firm and the bank.

yields an expected rate of return equal to r. 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 must bear all the risk in equilibrium. That is, households don't hold bank equity and hold deposits only if they are safe. That is, if there is a sufficiently large buffer of equity to absorb the losses in the bad state. Except for this, the composition of liabilities is indeterminate.

Equilibrium investment

Proposition 1. *The equilibrium allocation in the economy without government guarantees is pinned down by the following condition:*

$$\alpha E[A] K^{\alpha-1} = 1 + r,$$

which corresponds to the investment cut off rule in Modigliani and Miller (1958) (Proposition 3). We denote the corresponding level of capital K_{MM}.

Proof. All the proofs that are omitted in the text are in Appendix A, where we formally solve for equilibrium in the relevant regimes. □

The intuition is simple. All investors must break even in expectation. Hence, the cost of fund for banks is $1 + r$, by competing they pass this cost along to the firms, which then invest accordingly.

Implied breakeven productivity Given a level of capital K, one can back out the implied level of realised productivity required for real investment to ex-post just break even with respect to the opportunity cost of funds in the economy. (The relevant value need not be in the support of A.**)** Formally, it is defined as:

$$\boldsymbol{\mathcal{A}}(K) \equiv \left\{ A \mid \alpha A K^{\alpha-1} = 1 + r \right\}$$

Corollary 1. *In the equilibrium of the economy without guarantees, we have:*

$$\boldsymbol{\mathcal{A}}(K_{MM}) = E[A].$$

This makes perfect sense: there are no frictions and risk is borne by risk neutral agent. Hence, the allocation is the same as the one that would ensue if productivity was deterministic, and equal to $E[A]$.

However, this will generally not be the case in the presence of government guarantees. $\boldsymbol{\mathcal{A}}(K)$ will then provide us with a direct measure of equilibrium distortions: $\boldsymbol{\mathcal{A}}$ increases with over-investment because higher productivity is needed to compensate decreasing marginal return to capital.

2.4 The economy 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 an interest rate r. 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 shareholders. Hence, to be willing to buy equity, agents must be compensated by a higher return in the states where the bank does not default since all securities must yield an expected payoff of $(1+r)$ 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.

It is easiest to make our point by first ignoring capital requirements. Hence, we only introduce them later in Section 4.1.

Definition 2. We refer to the economy with government guarantees and no capital requirement as the Panglossian economy (with associated subscript P).

Lemma 1. *In the Panglossian economy 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:

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

where $\rho(A,K)$ is the realised unit repayment on loans. The bank takes K as given, so from the bank's perspective, ρ can only take two values in equilibrium, which we denote ρ^L and ρ^H. Since the bank has no equity buffer, it is vulnerable to any adverse shock.[6] Hence:

Lemma 2. *In the Panglossian economy 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 (e.g. a marginal increase or decrease in losses is irrelevant since shareholders get 0 anyway) and, accordingly, maximising profits in

[6] Later, when we introduce capital requirements, the bank is vulnerable if the buffer is insufficient compared to the shock.

the good state:

$$\max_{k \geq 0} \rho^H k - k(1+r).$$

The associated first order condition:

$$\rho^H \leq 1 + r$$

binds in equilibrium due to free entry. Hence:

Proposition 2. *The equilibrium allocation in the Panglossian economy is pinned down by the following condition:*

$$\alpha A^H K_P^{\alpha-1} = 1 + r, \tag{3}$$

Note that $\rho^H = 1 + r$ implies $\rho^L < 1 + r$. Hence $E[\rho] < 1 + r$; the expected repayment by firms is below the opportunity cost of funds in the economy, which reflects over-investment. What happens is that banks borrow from depositors at a subsidised rate and, through competition, pass this artificially low rate onto firms. Firms, in turn, equate the capital marginal rate of return to this rate, which leads to more investment than in the MM allocation.

Corollary 2. *In the Panglossian economy, investment only breaks even if productivity is at its highest:*

$$\boldsymbol{\mathcal{A}}(K_P) = A^H.$$

Since banks are the claimants to the capital share, this applies to them as well: they only break even on lending if the high state realises. Why are they willing to lend, then? Building on the above, a useful interpretation is the following: because of the guarantees, banks do not care about the downside risk. Instead, all that matters to them is profits in the good state. But such profits are competed away in equilibrium. Hence, they lend up to the point where they just break even in the high state.

So, their investment decisions correspond to the efficient one in a fictitious world where productivity would always be at its highest level (the result readily generalises to more than two states). Accordingly, Krugman (1999) dubs such equilibrium valuation of loans *Panglossian*. This is after Professor Pangloss who, in Voltaire (1759), keeps on arguing that *all is for the best, in the best of all possible worlds*. This why, as per definition 2, we refer to the outcome in the economy with government guarantees as the Panglossian equilibrium.

That government guarantees can induce Panglossian financial and real investment has been pointed out by Krugman (1999). Formalising this in an equilibrium model, first allows us to derive further results on equilibrium wages and to study welfare. Second, and most importantly, it will serve as a backbone on which we can build, in a transparent way, our main results.

Panglossian wages

Proposition 3. *In the Panglossian economy, the equilibrium wage is Panglossian too.*

$$w_P = (1-\alpha)A^H K_P > w_{MM}$$

There are two differences with respect to the benchmark. First, there is more capital ($K_P > K_{\text{MM}}$), which mechanically boosts the marginal product of labour. But we also have a factor A^H instead of $E[A]$. The parallel with $\boldsymbol{\mathcal{A}}(K_{\text{P}})$ reflects that labour is also valued in a Panglossian way in equilibrium. That is, the equilibrium wage is that of a fictitious economy without friction and with deterministic productivity A_H. The reason why wages are inflated is that, given K_P, firms could make profits in the high state if the wage was in line with $E[A]$ rather than A^H.[7]

If instead of being set in advance of the productivity realisation, wages were set after A realises, wages would still be inflated (through the increase in K_P) but would not be fully Panglossian.

Investment efficiency

Proposition 4. *In the Panglossian equilibrium, investment is inefficiently high. That is, while output is higher than in the MM economy, expected net output is lower.*

Aggregate output is AK^α, which corresponds to *gross domestic product* (GDP). For any realisation of A, GDP is increasing in K. That is, more investment always means more output. However, in terms of investment efficiency, the relevant concept is expected net output, or *net domestic product* (NDP): $E\left[AK^\alpha - K(1+r)\right]$, because it accounts for capital depreciation.[8] Put differently, an increase in expected GDP is not necessarily a good thing, and is inefficient if it corresponds to a decrease in expected NDP.

[7]Positive profits lead to entry, which raises the equilibrium wage because of increased demand for labour. Note that a higher wages implies, ceteris paribus, larger losses for the firm, and therefore the bank, in the bad state. But these losses are ultimately passed onto the taxpayer and, therefore, do not prevent the wage increase.

[8]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.

Of course, normative statements cannot be based on investment efficiency only. As we show below, even if wages are higher, it turns out that welfare is unambiguously lower in the economy with guarantees.

2.5 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's expected utility.

Proposition 5. *In the Panglossian equilibrium, the higher wage is more than offset by the expected increase in tax. It follows that welfare must be strictly lower than in the MM economy.*

The intuition is simple. 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 4), and in the benchmark economy households do not bear risk, welfare must be strictly lower in the economy with guarantees.[9]

Government guarantees may impair risk sharing Household face taxation risk. To assess welfare, we need to specify whether they have the means to hedge it or not. Let us consider two examples.

First, assume that households can trade a complete set of securities with the rest of the world. Since securities are priced in an actuarially-fair manner, households can fully hedge at no premium. As a result they will consume their expected net wealth in all states. In this case, government guarantees do not affect risk-sharing and the welfare loss only comes from investment inefficiency.

Second, imagine that households can only buy equity or deposits of domestic banks. In that case, they will prefer to hold insured deposits only (equity has 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 realised wealth corresponds to their endowment plus *realised* NDP.[10] Hence, in this case, government guarantees also impair risk sharing as banks refrain from passing the risk onto

[9] It should now be clear that the benchmark economy is efficient in the sense that it maximises social welfare (as it maximises expected economic surplus and ensures perfect insurance).

[10] If households can short sell domestic bank equity, this restores perfect risk sharing, which corresponds to the case above.

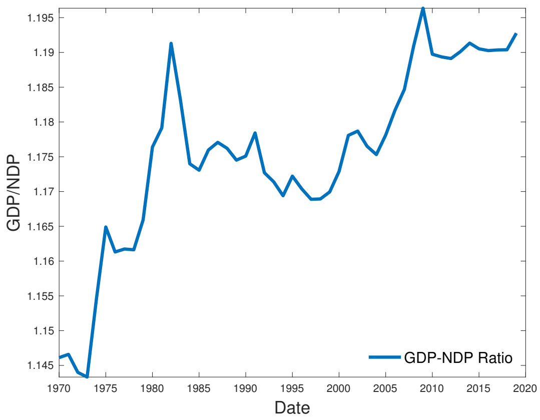


Figure 1: GDP to NDP Ratio

Notes: This figure shows the ratio of nominal GDP to nominal NDP using BEA data.

international shareholders through equity issuance. As we will see below, if the banks can themselves trade in Arrow securities, the outcome is even worse.

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. However, what is clear and novel from Proposition 5 is that when investment decisions are distorted by government guarantees, GDP is a particularly poor indicator of welfare.

Stylised fact We shall assess the empirical relevance of our analysis later. Still, let us already flag a broadly overlooked stylised fact: the run up to the GFC in the US was marked by a divergence between gross and net domestic product. Figure 1 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%.

3 Beyond Pangloss: Financial trades and magnification

In the Panglossian economy, given that the bank is bankrupt in the low state, the bank shareholders' payoff is zero and depositors are fully compensated, regardless of the extent of bankruptcy. In fact, the extent of bankruptcy only determines the fiscal cost of the guarantee and so, from the bank's point of view, any repayment made to depositors in the low state can be seen as money left on the table. This gives banks an incentive to divert residual value from the low state towards the high state.[11] Once they have means to do this, our key contribution follows; the distortion from government guarantees is magnified by financial sophistication to the point that implied break-even productivity actually goes *beyond* Pangloss.

3.1 The Beyond Pangloss economy

The economy is the Panglossian economy but with a trading environment:
(i) The representative bank can trade in a set of Arrow securities: security H is a promise to pay 1 unit of consumption good in state A^H, and similarly for L in state A^L. These securities trade competitively in financial markets and 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 directly financed by deposits.[12] Hence, to be able to buy some securities, the bank must sell others. Formally, we impose: $qh + (1-q)l \leq 0$, where h and l denote the bank's net holding of the two securities (a negative number corresponds to the bank selling the security).
(ii) We continue to assume that labour is always senior to capital. However, we assume that Arrow securities are, in effect, senior to deposits. This captures the real world feature that many financial trades (such as repos and securitised products) are bankruptcy remote (see the discussion in Section 5). However, government guarantees do not cover Arrow securities. Hence, the bank cannot credibly promise a payment in a state of the world that is higher than the total cash flows it will receive in that state (from its loan portfolio–or other trades financial trades). For instance, the representative bank loan book generates a cash flow $\rho^L k$ in the low state. This cash flow can be used to repay counterparts to the trades and so we adopt the interpretation that the bank uses its loan portfolio as collateral for its financial trades. Inspired by financial innovation before the GFC, this captures the essence of the case where the bank can use loan it has originated as bankruptcy-remote collateral for financial trades.
(iii) Finally, for what follows, we assume $A^L - (1-\alpha)A^H > 0$. If this condition

[11] Korinek (2015) explores the role of financial innovation to extract maximum bailout benefits for shareholders.

[12] Otherwise, banks could make infinite profits by issuing deposits and buying one of the securities (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.

is not satisfied, the firm cannot even repay wages in full in state A^L, and the bank receives no cash flow at all in the low state, hence it does not leave any money on the table to start with.

Definition 3. We refer to the economy with government guarantees, no capital requirement, and financial trades as the Beyond Pangloss economy (with associated subscript BP for equilibrium variables).

3.2 Beyond Pangloss equilibrium

Optimal trading strategy

Lemma 3. *Given an amount of lending k, and firm repayments $\rho^L < \rho^H$, the optimal trade for the bank is given by $l = -\rho^L k$ and $h = \frac{(1-q)}{q}\rho^L k$.*

Proof. For a given amount of lending k, the maximum amount the representative bank can credibly commit to repay in state A^L is $\rho^L k$. The natural interpretation is that the bank faces a collateral constraint: $-l \leq \rho^L k$. Selling security L increases the losses of the bank in the low state. But this does not directly affect its expected profits because of limited liability (based on Lemma 2, we take for granted that the bank fails in state A^L). Hence, 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 honoured by taxpayers). The strategy that maximises trading profit directly follows: sell as much as possible of the L security, and use the proceeds to buy the H security. Since the securities are fairly priced, this allows the bank to buy $h = \frac{(1-q)}{q}\rho^L k$ of the H security. □

Optimal lending in the presence of trading Lemma 3 establishes the optimal trading strategy for a given k. In the good state, the bank receives a payment equal to h. Hence, its lending problem can be rewritten:

$$\max_{k\geq 0} \left(\rho^H_{\text{BP}} k - (1+r)\right) k + \underbrace{\frac{(1-q)}{q}\rho^L_{\text{BP}} k}_{=h}.$$

In equilibrium, we get:

$$\rho^H_{\text{BP}} + \frac{1-q}{q}\rho^L_{\text{BP}} = 1 + r \tag{4}$$

The second term on the left-hand side captures that more lending helps relax the collateral constraint and allows the bank to buy more of the security that pays in the good state. The first order conditions of the firm yield (5) below.

Financial trading magnifies over investment

Proposition 6. *The Beyond Pangloss equilibrium allocation is pinned down by:*

$$\alpha A^H K_{BP}^{\alpha-1} + \frac{1-q}{q}\alpha A^L K_{BP}^{\alpha-1} = 1+r. \tag{5}$$

So, investment is even higher (and more inefficient) than in the Panglossian equilibrium ($K_{BP} > K_P$).

To get the intuition, evaluate the objective function at the *Panglossian* level of lending K_{P} (as opposed to *Beyond Panglossian* level K_{BP}):

$$\underbrace{\left(\rho_{\mathrm{P}}^H - (1+r)\right)k}_{=0} + \underbrace{\frac{(1-q)}{q}\rho_{\mathrm{P}}^L k}_{>0} > 0,$$

and notice that banks just break even on loans in the good state (this is captured by the first term), but make strictly positive profit on trading in that state. Hence, K_{P} cannot be an equilibrium as profits trigger entry. Or, seen slightly differently, from the individual bank's point of view, profits are proportional to collateral. Hence, it is profitable to issue more loans. However, in the aggregate, the marginal return to lending is decreasing. The equilibrium will be reached when banks' expected profits are nil, that is when the expected loss from the banking book are just offset by the profits form the trading book:

$$\underbrace{\left(\rho_{\mathrm{BP}}^H - (1+r)\right)k}_{\text{lending losses}} + \underbrace{\frac{(1-q)}{q}\rho_{\mathrm{BP}}^L k}_{\text{trading profit}} = 0. \tag{6}$$

Stylised facts: Trading book profits and lending standards Equation 6 suggests a novel interpretation to the well-documented decrease in lending standards in the run up to the crisis in the US and other countries (see, e.g., Keys et al. (2010) and Bassett et al. (2014)), and for the sharp increase in the importance of trading activities for bank profits. In particular, an 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.[13] Haldane and Alessandri (2009) document the growth of the trading book as a source of bank profits. They describe

[13]Philippon (2015) documents the surge in the volume of intermediation and the overall increase in the income share of the finance industry.

the period before the financial crisis as "an Alice in Wonderland world in which everybody had won and all had prizes." When the financial crisis came, they highlight that trading book losses were sizeable. Atkeson et al. (2019) decompose movements in the ratio of banks' market value of equity over book value of equity into franchise value and the value of government guarantees. This ratio grew strongly prior to the financial crisis and then declined sharply. Our model is consistent with their interpretation of this phenomenon, as they emphasise the role of banks' efforts to "increase leverage and exposure to losses in credit crisis states" as a primary driver of the time-variation of the value of government guarantees (Atkeson et al., 2019). In our model, however, we additionally emphasise the importance of competitive forces and, in the next section, we will also formalise the role of the exploitability of guarantees in determining the size of the distortion.

Beyond Pangloss: the implied break-even productivity interpretation

Corollary 3. *In the Beyond Pangloss economy, even in the high state, investment does not break even:*

$$\boldsymbol{\mathcal{A}}(K_{BP}) = A^H + \frac{1-q}{q} A^L > A^H.$$

In the Panglossian equilibrium, banks value loans based on implied productivity A^H. With financial trading, banks value loans based on an even higher implied productivity. Hence, we say that the equilibrium allocation is *beyond Pangloss.* In fact, the implied equilibrium valuation corresponds to that in a fictitious economy where realised productivity is always impossibly high.

Of course, such an outcome is extreme and somewhat unrealistic. In practice, banks face restrictions on their on- and off-balance-sheet risk exposure and are subject to supervision. We examine the impact of these in limiting the trading activity of banks in Section 4.1.

Equilibrium wage

Proposition 7. *In the Beyond Pangloss economy, the equilibrium wage is:*

$$w_{BP} = (1-\alpha) E[A] K_{BP}.$$

Compared to the Panglossian wage (i.e. $(1-\alpha)A^H K_{\text{P}}$), there are two effects that play in opposite direction. First, there is more capital ($K_{\text{BP}} > K_{\text{P}}$), which tends to boost the wage. But there no longer is a direct Panglossian labour valuation effect ($E[A]$ appears on the right-hand-side instead of A^H). The intuition from the proof is that banks, and therefore firms, now care about the repayment to capital in the low state $(\rho^L k)$ since it is what serves as collateral. This means that labour productivity in *both* states matter and there is no reason to bid up wages based on the high state productivity level only.

Remark 1. In both the Panglossian and the Beyond Panglossian economy, equilibrium wages are higher than in the Modigliani-Miller economy. However, the comparison between wages in the Pangloss and Beyond Pangloss outcome is ambiguous. Interestingly, in Online Appendix II, we show that in the initial run up to to GFC, real wages increased above TFP growth but real wages then stagnated. This narrative would be consistent with a timeline in which an economy goes from Modigliani-Miller, to Pangloss, to Beyond-Pangloss.

4 The exploitability of guarantees

We now introduce our general model, in which we show that the magnitude of the distortion depends crucially on the exploitability of government guarantees. Such exploitability decreases in the tightness of capital regulation and bank supervision, and increases in the sophistication of the banking sector. Armed with these additional insights, we will then be in a position to discuss the economic relevance, both theoretically and empirically, of the distortion.

4.1 Capital requirements, financial innovation, and supervision

First, assume that banks face a capital requirement of the form: $\kappa \geq \gamma k$, that is equity κ must be at least a fraction γ of lending. Given deposits are implicitly subsidised, the constraint will bind in equilibrium. We broadly interpret γ as the tightness of prudential regulation (which, in practice, involves different risk-weights for different assets and several tiers of capital requirements).

Second, assume that banks can only pledge a fraction ϕ of the proceeds from lending as collateral. Accordingly, and for simplicity, we refer to ϕ as pledgeability. However, the reader shall keep in mind that what we aim to capture is both a measure of financial innovation, or bank sophistication, also the extent to which financial supervisors tolerate (or are unable to detect) the use financial trades for a gambling with taxpayer money.

Assuming the bank still fails in the low state (which, as we show below, will be the case unless γ is sufficiently high and ϕ sufficiently low), the bank expected profit is:

$$\underbrace{q\left(\rho^H k - \underbrace{(1-\gamma)k(1+r)}_{\text{deposit repayment}} + \underbrace{\frac{1-q}{q}\phi\rho^L k}_{=h}\right)}_{\text{payoff in the high state}} - \underbrace{\gamma k(1+r)}_{\text{cost of equity}}. \tag{7}$$

The first term differs in two ways compared to the previous section. First, only $(1-\gamma)$ deposits can be used per unit of lending, which affects the due repayment. Second, only a fraction ϕ of the low-state cash flow can be used has collateral, which affects the trading profit h. The second term appears because the bank now has to raise an amount γk in equity upfront (and shareholders' opportunity cost of funds is $1+r$).

Dividing across by q gives the realised profit in state H. Note that a unit repayment of $\frac{1+r}{q}$ is needed for shareholders to compensate their losses in the low state (where they are wiped out). In contrast, as before, depositors accept a promised repayment of $1+r$ because they are always made whole courtesy of the taxpayer.

The equilibrium conditions (first order, zero profit, and market clearing) yield (using subscript G to denote equilibrium variable in the general model):

Proposition 8. *In the general model (with guarantees, trading, capital requirement γ, and limited pledgeability ϕ), the equilibrium capital stock, denoted K_G, is pinned down by the following condition:*

$$\alpha K_G^{\alpha-1}\left(A^H + \frac{(1-q)}{q}\phi A^L\right)\left(\frac{q}{q+\gamma(1-q)}\right) = (1+r).$$

Corollary 4. *In the general model, equilibrium implied break-even productivity is:*

$$\boldsymbol{\mathcal{A}}(K_G) = \left(A^H + \frac{(1-q)}{q}\phi A^L\right)\left(\frac{q}{q+\gamma(1-q)}\right).$$

It is increasing in ϕ and decreasing in γ.

Again, $\boldsymbol{\mathcal{A}}(K)$ provides a direct measure of the magnitude of the distortion in equilibrium. Here, it is made up of two parts that interact. The first part is the Beyond Pangloss effect described in Section 3, adjusted for the limit on loan cash flows pledgeability (ϕ). Intuitively, $\boldsymbol{\mathcal{A}}(K_G)$ increases with ϕ: the higher the pledgeability (which, again, should be interpreted as a higher sophistication of the financial sector and/or looser supervision), the higher the distortion.

The second part reflects that $\boldsymbol{\mathcal{A}}(K_G)$ decreases with the capital requirements. Since shareholders lose money in the bad state, they will only enter up to the point where the profit they make in the good state just offsets (in expectation) their losses in the bad state. Lower entry means a decrease in the equilibrium level of investment and mitigates the distortion.

Implications of Exploitability The MM, Panglossian, and Beyond Panglossian economies are special cases of the general model. In particular, in the absence of guarantees, the MM allocation ensues, irrespective of γ and ϕ. And:

$$\begin{cases} \boldsymbol{\mathcal{A}}\left(K_G \mid \gamma = 0, \phi = 0\right) = \boldsymbol{\mathcal{A}}\left(K_P\right) \\ \boldsymbol{\mathcal{A}}\left(K_G \mid \gamma = 0, \phi = 1\right) = \boldsymbol{\mathcal{A}}\left(K_{BP}\right) \end{cases}$$

As mentioned above, and shown in the calibration below, if γ is high enough and ϕ low enough, the bank cannot default in equilibrium. Then, there is no distortion, and MM outcome also ensues. This begs two remarks:

Remark 2. For all ϕ, there exist a γ large enough that the bank never fails. For instance, for $\phi = 1$, we need $\gamma = 1$. That is, we need bank a bank funded 100% with equity. However, as we stressed in Section 2, for the sake of simplicity, we are ignoring here some fundamental roles of banks. In particular, microfounding liquidity demand (a la Diamond and Dybvig for instance) would make the imposition of a 100% capital requirement costly for households (see Online Appendix Section I for a more detailed argument).

Remark 3. Conversely, for all $\gamma < 1$, there exists a $\phi \leq 1$ such that the bank fails in equilibrium. The interpretation is striking: no matter how stringent capital requirement are (excluding $\gamma = 1$), there exists a sophistication level for the financial sector at which Beyond Pangloss effects more than offset the mitigating impact of capital regulation.

4.2 The scale of the capital distortion

We now explore the quantitative relevance of the distortion in a calibration exercise in order to show that the theoretical channel is capable of generating economically meaningful distortions. The takeaway is that, for reasonable calibrations, even at high capital requirements, pledgeability gives rise to a substantial magnification of the basic Panglossian inefficiency induced by guarantees.

Measures of over-investment and inflated GDP We calibrate the model to provide a range of measures for the distortion. As argued in Section 2.5, the welfare costs of the distortion ultimately materialise as a decrease in expected consumption for the household (and, arguably, an increase in its volatility). We proceed in two steps. First, to fix ideas, we focus on the visible symptoms: over-investment and inflated GDP. Then, we translate this into a corresponding measure of decreased expected consumption.

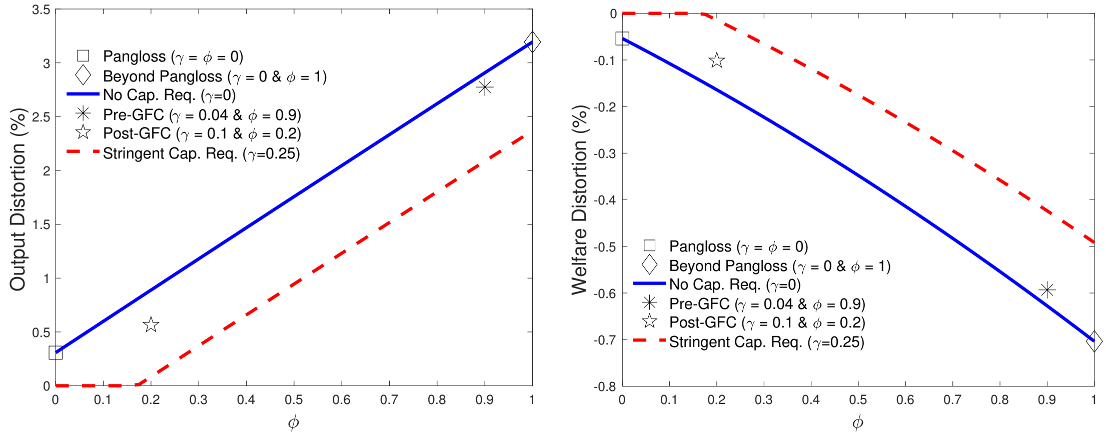
Since we are interested in the relative magnification effect of the channel we highlight, we compare our general model to the MM economy. From Propositions 1 and 8, we get:

$$\frac{K_{\mathrm{G}}(\gamma,\phi)}{K_{\mathrm{MM}}} = \left(\frac{\boldsymbol{\mathcal{A}}(K_{\mathrm{G}}(\gamma,\phi))}{E[A]}\right)^{\frac{1}{1-\alpha}} ; \text{ and } \frac{Y_{\mathrm{G}}(\gamma,\phi)}{Y_{\mathrm{MM}}} = \left(\frac{\boldsymbol{\mathcal{A}}(K_{\mathrm{G}}(\gamma,\phi))}{E[A]}\right)^{\frac{\alpha}{1-\alpha}} . \quad (8)$$

Calibration The key parameters are those determining the exploitability of the guarantees (ϕ and γ). We shall consider a wide range of value for them, and we use a relatively standard calibration. The production function parameter, α, is set to 0.38 and the real interest rate r to 2%. We calibrate the states of the world as a relatively infrequent but large shock. We assume that there is a 10% productivity loss in the low state ($A^H = 1$ and $A^L = 0.9$); the low state only occurs about once every 20 years ($q = 0.95$). This calibration satisfies the requirement that $A^L - (1-\alpha)A^H > 0$ so that the firm can repay wages in full in state A^L.

Results In Figure 2, we plot, as a benchmark, the effects for $\gamma = 0$ (no capital requirement) and $\gamma = 0.25$ (extremely stringent capital requirements; given real world typical average risk-weights of 50%, this value corresponds to a capital requirement of 50% of risk-weighted assets), for all possible pledgeability values, i.e. $\phi \in [0, 1]$. As explained, the Panglossian environment corresponds to $\phi = \gamma = 0$ and the Beyond Pangloss environment corresponds to $\gamma = 0$ and $\phi = 1$. To fix ideas, we also examine two more realistic environments: a low regulation, high pledgeability regime which we label Pre-GFC ($\gamma = 0.04$ and $\phi = 0.9$); and a high regulation, moderate pledgeability which we label

Post-GFC ($\gamma = 0.1$ and $\phi = 0.2$).[14]



(a) Effect of ϕ on the output distortion

(b) Effect of ϕ on the welfare

Figure 2: Model effects of varying pledgeability (ϕ)

Notes: These figures shows a calibration of the general model in section 4.1. The outcome variable (on the vertical axis) is plotted for different values of pledgeability between 0 and 1 for the the cases of no capital requirements (blue solid line) and stringent capital requirements (red, dashed line). The markers highlight the four specific environments as described in the text.

Figure 2a shows the output distortion, and Figure 2b shows expected net output (the measure relevant for welfare). In each figure, we display benchmark curves and we mark the four economic environments described above, and compare them to the MM economy (which corresponds to a zero distortion). In the Panglossian economy ($\phi = \gamma = 0$), output is greater (than in the MM economy) by 0.3% and welfare is lower by 0.05%. These are modest numbers, in terms of economic significance, and especially compared to what follows. Furthermore, raising capital requirements reduce them further (e.g., a 4% requirement reduce them by almost a half). That capital regulation can easily eliminate the distortion (in this case, i.e. with $\phi = 0$) speaks to Krugman's (1999) point that the Panglossian distortion is a phenomenon to be associated with under-regulated economies.

However, accounting for financial trades, the story is quite different: sophistication in the financial sector and supervisory forbearance can lead to an impressive magnification of Panglossian implied valuations. Put differently, the banks' ability to engage in what is essentially gambling with tax-payer money can (much) more than offset the effect of regulation. Greater pledgeability in-

[14] To understand our labels, recall that pledgeability increases with ϕ and that $\gamma = 0.04$ corresponds to the Basel I pre-crisis 8% regulatory requirement, and $\gamma = 0.1$ to a conservative upper bound for post-GFC requirements (Basel III requirements are in the double digits of risk-weighted assets, but below 20%). See Online Appendix III for a 3D plot of all possible combinations in an even wider range.

creases the over-investment which therefore inflates GDP but lower welfare.

For instance, in Figure 2, our Pre-GFC regime ($\gamma = 0.04$ and $\phi = 0.9$) adds nearly 3% to GDP (compared to the MM economy) and the expected loss of net GDP welfare is 0.5%. For context, this is an order of magnitude larger than Lucas's (1987) welfare cost of business cycles. In contrast, in our Post-GFC regime ($\gamma = 0.1$ and $\phi = 0.2$), the numbers are back to more modest level, not so far form the Panglossian outcome.

5 Exploitability in practice: Milestones in the US financial sector since the 1990s

In our analysis, an environment with guarantees is necessary for Panglossian (and beyond) inefficient booms. But, as highlighted in the previous section, sufficient exploitability is necessary for the largest amplification of the inefficiency. The extent of the exploitability depends importantly on the interaction of both financial sophistication and aspects of bank regulation (such as capital regulation). As just described, a tough regulatory environment can 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 exploitability, and a dramatic reduction in the crisis aftermath.

In terms of the pre-crisis increase in exploitability, we argue that both weakening of regulation and financial innovation may have been important. Engineering trades that resemble the optimal positions in Arrow securities in the model require several ingredients. An essential one, was to make such trades effectively senior to deposits (like the Arrow securities of our model). In practice, this mainly happened with the creation of new financial products (e.g. collateralised loan obligations, or *CLOs*) and contracts (e.g. repurchase agreements, or *repos*) that were structured in a way that made them bankruptcy remote (which means that even the most senior claimants in the bankruptcy cannot touch the proceeds). Another important ingredient was to be able (and allowed) to lend more in the aggregate. Again, financial innovation helped to extend credit to new classes of borrowers (e.g. in the sub-prime segment), but removal of regulation also enabled aggressive increases in lending volume in such segments. Finally, a mix of regulatory capture and forbearance arguably contributed to making guarantees more exploitable (as we have described).

It is therefore clear, in our view, that any pre-crisis growth of exploitability must have been somewhat gradual as such changes in regulation and sophistication happened over time. As an illustration, we provide a selected list of important milestones which increased 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 securities 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 harbour protection (i.e. bankruptcy remoteness) for securitisation.

2004 The SEC removes leverage restriction on investment banks.

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

Moreover, all banks did not improve their sophistication (and therefore their ability to exploit the guarantees) at the same time. In the early years, due to limited competition, it may have been the case that trading book profit was not offset by expected losses on lending. More generally, monopoly rents work as a franchise value, which decreases the appeal of gambling.[15]

In the aftermath of the GFC, government guarantees have, of course, not disappeared, though they may be more limited (see, e.g. Berndt et al. (2020)). We do not want to argue there is no residual effect of guarantees, but rather that the regulatory crackdown that followed the crisis contributed to a decrease in banks' ability to exploit the guarantees. This, therefore, mitigated the impact of guarantees on economic activity. For example, 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 rules out Panglossian valuation (and beyond), and could also explain a reversion to a lower but more efficient and sustainable level of GDP.

[15] The more complete answer that William Sharpe gave Paul Volcker, discussed in the introduction, was that financial engineering "just moves the [economic] rents in the financial system" and "it's a lot of fun" (Volcker and Harper, 2018, p.206).

A large literature discusses the political economy aspects of financial regulation (see, for example, Wolfson and Epstein, 2013). This includes discussion of the idea that regulation could be cyclical (Dagher, 2018; Almasi et al., 2018). Such cycles of tougher and more lenient financial regulation could result from time variation in the bargaining power of politicians, policy makers and the financial industry (Calomiris and Haber, 2014). Or it could be fading memories of the varies that contribute to such regulatory cycles (Reinhart and Rogoff, 2009, p.287). And the decade since the GFC has, predictably, been marked by moves to relax some of the post-GFC regulatory environment. Volcker colourfully describes the period as being characterised by "scurrying lobbyist chipmunks nibbling away in the name of efficiency and simplification (good, in itself), but with the ultimate aim of weakening the new safeguards"(Volcker and Harper, 2018, p.209). And new financial innovation may serve the purpose of circumventing regulation. Such efforts, though gradual, would be expected to increase exploitability. In our model, this would be associated with an increase in GDP as the economy moves, once again, to a distorted level of output.

6 Empirical Relevance

The main message of the paper is that the Beyond Panglossian distortion, driven by the exploitability of government guarantees in the financial system, can lead to inefficiently high GDP.

Even though attempts at quantifying the implicit subsidy generated by government guarantees go back a long way (e.g. Merton (1977)), its economic significance was typically downplayed until the GFC. Since then, however, many papers have documented sizeable amounts for both ex-ante subsidies and ex-post bailouts (see, e.g. Acharya et al. (2016), Atkeson et al. (2019), Kelly et al. (2016)). Such quantification exercises are challenging. Measuring the associated distortions in the real economy is even more challenging[16], and an econometric estimation of the distortion is beyond the scope of this paper. Still, we hope to convince readers that some of the persistent weakness of the economy since 2010 may relate to an unwinding of inefficiently high GDP before the GFC.

First, as we have shown above, a series of stylised facts about the behaviour of the US economy prior to the GFC are consistent with the predictions from our

[16]For instance, as shown by Bahaj and Malherbe (2020), since the implicit subsidy is state contingent, it may in fact make the bank *undervalue* the marginal loan if its risk profile differs from that of the rest of the balance sheet.

model. This includes the rise in the ratio of GDP to NDP, the growing importance of trading profits for financial firms, and loosening of lending standards, as well as the behaviour of real wages, which seems to have grown strongly relative to productivity until 2000, and then stalled.

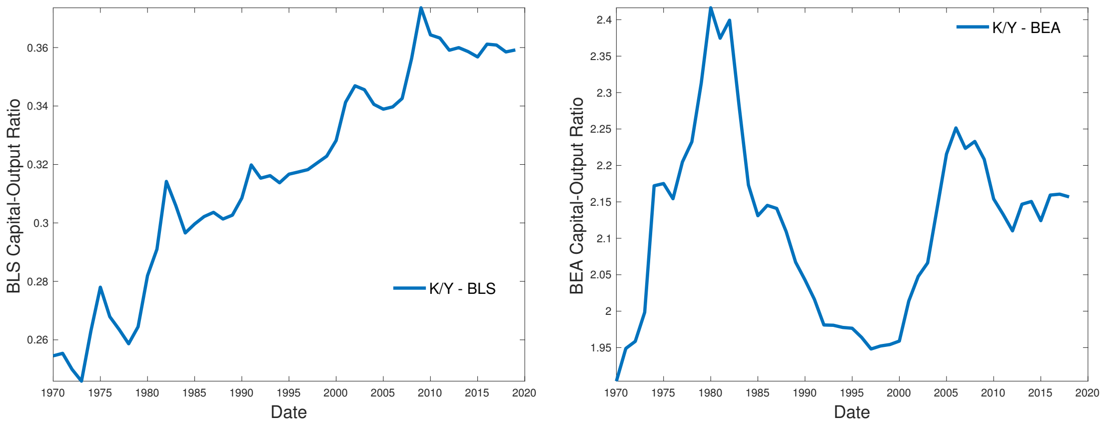
In this section, we go further and focus the behaviour of investment. Through the development of a Solow-inspired approach, we examine the evolution of the capital-output ratio that cannot be explained by other, measurable confounding factors. In our model, these capital-output residuals (KYR_t) are directly related to the distortion. But, to set the stage, we first discuss the data on the capital-output ratio, and clarify the extent to which additional investment demand would be expected to be detected in quantities or prices (depending on the elasticity of supply of the investment goods).

6.1 Beyond Pangloss Effect on Capital-Output Ratio

As γ goes down and ϕ increases, one of the main Beyond Pangloss effects we would expect to observe in macroeconomic data is an increase in capital stock relative to output (which would here reflect over-investment). There are two sources of data measuring the US capital stock. The Bureau of Labor Statistics (BLS) produce a capital services index and the Bureau of Economic Analysis (BEA) report a measure of capital stock in its fixed-assets tables. The BLS measure aggregates capital stocks using estimated rental prices which makes it a more appropriate measure of the capital input into production (a closer match to our model) while the BEA measure is a better measure of wealth (Gourio and Klier, 2015).

Figure 3a shows the BLS measure for non-Farm business sector as a ratio to sectoral value-added. This measure has been trending up since the 1970s. Figure 3b shows the nominal capital-output ratio from the BEA. It is the stock of private fixed assets excluding consumer durables and intellectual property. This measure of wealth shows a different behaviour; having been falling steadily from the end of the 1970s, the capital to output ratio started to increase again in the mid-1990s.

In the next subsection, we will filter out potential confounding factors and assess the extent to which this ratio went up in the run up to the GFC, and down subsequently. However, let us first make a general point on how production factors supply elasticity matters for how Panglossian distortions play out in equilibrium.



(a) Using BLS data

(b) Using BEA data

Figure 3: Capital-Output Ratio

Notes: This figure shows (a) the ratio of nominal capital services in the private nonfarm business sector to nominal real value-added output in that sector using BLS data and (b) the ratio of nominal private non-consumer durables capital stock to nominal GDP using BEA data. The shaded area represents our benchmark years of 1994-1995.

In our models, there is only one type of capital and it is supplied perfectly elastically. As a result, Panglossian and Beyond Panglossian effects exclusively materialise in equilibrium quantities (i.e. through increased investment). In contrast, labour is supplied perfectly inelastically, and the effects materialise exclusively in equilibrium prices (i.e. the wage).

In the real world, there are several types of capital, with differing supply elasticities. An interesting question is how the predictions of our model would be modified if we accounted for this. The answer is simple and intuitive: generally speaking, Panglossian and Beyond Panglossian effects will materialise mainly on equilibrium quantities for production factors that are supplied elastically, and on equilibrium prices for those that are supplied inelastically.

In Online Appendix I.2, we present an alternative model in which we introduce two types of capital. An elastically-supplied capital, provided on the international market (think of business equipment for instance), will behave as in the economies examined so far: Panglossian and Beyond Panglossian effects will materialise in increased equilibrium quantities. On the other hand, inelastically-supplied capital, such as land and structures, cannot easily increase in quantity and, therefore, Panglossian effects will give rise to inflated asset prices. Furthermore, land and structures are easier to collateralise. We formalise this in the model and show that Beyond Panglossian effects reinforce asset price inflation. This is consistent with the recent evolution of the relative price of investment; in aggregate, it has been on a well-documented secular downward trend since the 1970s but this is made up of equipment goods prices declining while the prices of residential and particularly non-residential structure prices grew strongly for many years before the crisis.[17]

6.2 Quantifying the scale of the Beyond Pangloss distortion

We now propose a simple framework in the spirit of Solow (1957) to empirically assess changes in the exploitability of government guarantees. We show that, according to our model, the effects should be measurable by examining changes in the economy's capital to output ratio. Of course, there are potential confounding factors. Directly controlling for those that are measurable, will leave us with residuals that can be interpreted in different ways. Taking our model at face value, these residuals measure the distortion we have highlighted. To account for other, unmeasured, confounding factors, we remove different trends from the residuals to back out the part that is plausibly due to the (Beyond) Panglossian distortion.

6.2.1 Framework

Our model is static. To make it suitable for time series analysis, we need to make three minor adjustments to it. First, we now use subscripts to denote the passage of time rather than to distinguish between environments (as we only consider the general model) Second, we assume that capital depreciates at a (possibly) time-varying rate δ_t, rather than having full depreciation. Finally, since the expected TFP evolves over time, the relevant notion of the distortion is no longer $\boldsymbol{\mathcal{A}}_t$, but instead:

$$\frac{\boldsymbol{\mathcal{A}}_t}{E_{t-1}[A_t]}.$$

Accordingly, we can write the capital output ratio at date t as:

$$\frac{K_t}{Y_t} = \frac{\boldsymbol{\mathcal{A}}_t}{A_t}\left(\frac{\alpha}{\delta_t + r_t}\right).$$

Multiplying by $\frac{E_{t-1}[A_t]}{E_{t-1}[A_t]}$ and comparing the current period t to a set of base years indicated by use of a tilde over the variable, we get:

$$\frac{K_t/Y_t}{\widetilde{K/Y}} = \frac{\widetilde{A}/E_{t-1}[\widetilde{A}]}{A_t/E_{t-1}[A_t]} \frac{(\boldsymbol{\mathcal{A}}_t/E_{t-1}[A_t])}{\left(\widetilde{\boldsymbol{\mathcal{A}}}/E_{t-1}[\widetilde{A}]\right)} \frac{\widetilde{\delta} + \widetilde{r}}{\delta_t + r_t}. \tag{9}$$

[17] There actually is evidence that structures increased in prices and in quantities in the run-up to the GFC (see e.g., Rognlie et al. (2018)).

As discussed above, the capital-to-output ratio is increasing in the distortion in our model. However, equation (9) highlights well-understood confounding factors. Define the Capital-to-Output residuals (KYR_t) as the deviation of the capital output ratio from the baseline years that cannot be explained by the confounding factors:

$$\underbrace{\ln\left(\text{KYR}_t\right)}_{\text{residuals}} \equiv \underbrace{\ln\left(\frac{K_t/Y_t}{\widetilde{K/Y}}\right)}_{\text{KY ratio}} \underbrace{-\ln\left(\frac{\widetilde{\delta}+\widetilde{r}}{\delta_t+r_t}\right)-\ln\left(\frac{\widetilde{A}/E_{t-1}[\widetilde{A}]}{A_t/E_{t-1}[A_t]}\right)}_{\text{confounding factors}} = \underbrace{\ln\left(\frac{\boldsymbol{\mathcal{A}}_t/E_{t-1}[A_t]}{\widetilde{\boldsymbol{\mathcal{A}}}/E_{t-1}[\widetilde{A}]}\right)}_{\text{KY Distortion}} \quad (10)$$

We now use independent measures of the evolution of these factors over time to filter out their effect. This leaves us with the residuals that cannot be explained in a frictionless model with a neoclassical production function.

6.2.2 Base years and confounding factors

In equation (10), the KYR_t measure is relative to base year(s) indicated by the tilde variables. We choose the average of 1993 to 1995 as the base. These were years sufficiently into the recovery from the recession ending in 1991, and yet before the 1996 reinterpretation of the Glass-Steagall Act (discussed above). Of course, the choice of base years is essentially a normalisation; changing base years would alter the level of the measured residuals but not their dynamics.

The confounding factors from equation (10) are the user cost of capital comprised of the cost of finance (r_t) and the rate of depreciation (δ_t), and actual productivity relative to its expected value ($A_t/E_{t-1}[A_t]$). Here, we will briefly describe the time-series that we us to measure each factor; in Online Appendix IV we provide a more extensive description.

There is a large literature that suggests there has been a secular decline in interest rates over the last 25 years (e.g. Summers (2014)). To measure the debt component of the real user cost, one candidate is a nominal, BAA-rated corporate bond yield series suitably adjusted for inflation. For simplicity, we calculate an ex-post real interest rate; it trends down between 1985 and 2019. Of course, bond yields miss the cost of equity which is typically a lot higher. Rognlie (2015) backs out an implied measure of the real cost of funds from financial markets by comparing 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.

However, the Rognlie calculation yields estimates of the real return in the range 12-15%. These are, aspointed out by Solow (2015), unreasonably high. Since we are not interested in higher frequency variation, and both measures have trended downward over the period since 1985[18], our baseline estimate of the real cost of finance is a weighted combination of the two series. Specifically, we use $r_t = \psi.r_t^{\text{BAA}} + (1-\psi).r_t^{\text{Rognlie}}$ where $\psi = 0.7$. This downweights the Rognlie estimates.

Higher average depreciation increases the user cost of capital which will, ceteris paribus, reduce the capital-output ratio. To account for this, we compute an estimate of depreciation using BEA data on nominal capital consumption $(\delta_t K_t)$, which uses fixed depreciation rates for each capital type multiplied by the composition of capital accounted for by that type of capital.

Finally, in the absence of distortions in the model, decisions about capital investment are based on expectations of productivity. Realised productivity that is above (below) the expected level bias down (up) the realised capital-output ratio. In order to adjust for this, we can use capacity-utilisation-adjusted TFP estimates provided by Fernald (2012). For the expected value, we use a 4th-order polynomial trend estimated on data from 1947 to 2019.

6.2.3 From KYR_t to estimates of Beyond Pangloss Distortion (BPD_t)

Armed with estimates of δ_t, r_t and $(A_t/E_{t-1}[A_t])$, we use equation (10) to derive an estimate of KYR_t. In Figure 4 we present estimates of the KYR_t residuals separately for BLS and BEA data. To slightly-differing degrees, both residuals show a downward trend until the base years which then flattens initially before rebounding and then resuming a downward trend at the onset of the GFC. Under some alternative assumptions on the confounding factors, the broad pattern of the residuals is unaffected.[19]

Solving for the Beyond-Pangloss Distortion (BPD_t**)** We are interested in the distortion to output from the exploitability of government guarantees which we label the Beyond Pangloss Distortion (BPD_t). As per equation (10), in our model the calculated residuals capture the relative $\boldsymbol{\mathcal{A}}(K)$ term which is the key

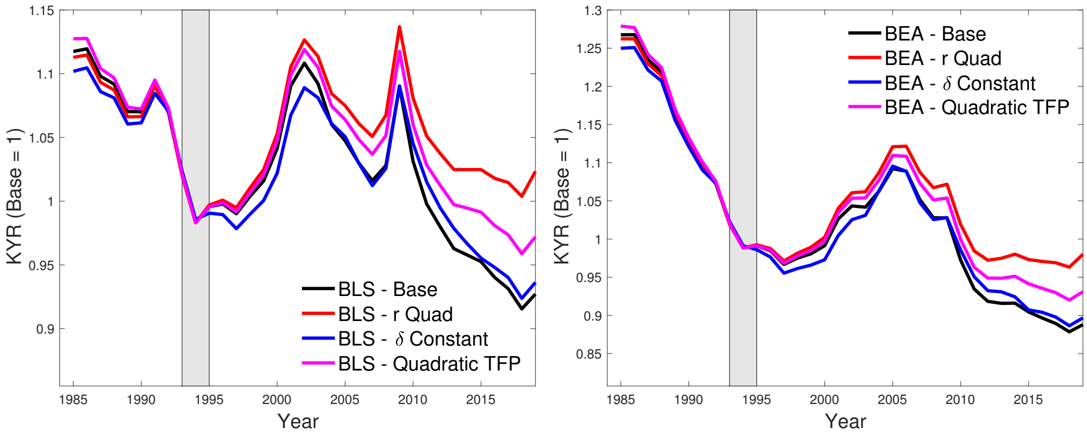
[18]We update the linear trend from Rognlie (2015) to get estimates to 2019.

[19]The alternative assumptions are:

i) Using the quadratic trend for real costs of finance from Rognlie. This has the implication that r_t is rising rather than falling in the period from 2015-2019.

ii) Rather than time-varying, we set δ_t to a constant value of 5% which is higher than the standard BEA capital consumption data indicate.

iii) The TFP trend is calculated using a quadratic, rather than a 4th-order polynomial, trend.



(a) BLS Capital-Output Measure: Alternatives

(b) BEA Capital-Output Measure: Alternatives

Figure 4: Alternative KYR_t estimates

Notes: These figures display alternative estimates of the KYR_t series making different assumptions on the confounding factors. The shaded area indicates the base years. Estimates are shown using both BLS (panel (a)) and BEA (panel (b)) capital series.

determinant of the distortion in equilibrium. Therefore, we should calculate the magnitude of the output distortion using $BPD_t = (KYR_t)^{\frac{\alpha}{1-\alpha}}$.

But there are other economic developments which could boost the KY ratio, especially at lower frequencies. These include, for example, the shift from capital intensive manufacturing to services (downward pressure on the KY ratio and KYR_t), increasing importance of ICT in all sectors (upward pressure) and automation (upward pressure). To not overstate the effect of our distortion, we purge the estimated residuals (KYR_t) of a trend which we denote KYR_t^* . The remaining, unexplained residuals are, we argue, plausibly due to the (Beyond) Panglossian distortion which we call distortion-related residuals $\left(KYR_t^D\right)$. The distortion is then given by:

$$BPD_t = \left(KYR_t^D\right)^{\frac{\alpha}{1-\alpha}} = \left(\frac{KYR_t}{KYR_t^*}\right)^{\frac{\alpha}{1-\alpha}} \tag{11}$$

We consider four alternative approaches to calculate KYR_t^* trends:

Trend A - we extrapolate a pre-1996 trend. This attributes all of the changing trend after 1996 to our distortion.

Trend B - we assume variation before 1996 is due to other factors ($KYR_t^* = KYR_t$ before 1996), and then set $KYR_t^* = 0$ after 1996. This allocates variation in KYR_t since 1996 to our distortion.

Trend C - we fit a quadratic trend over sample excluding observa-

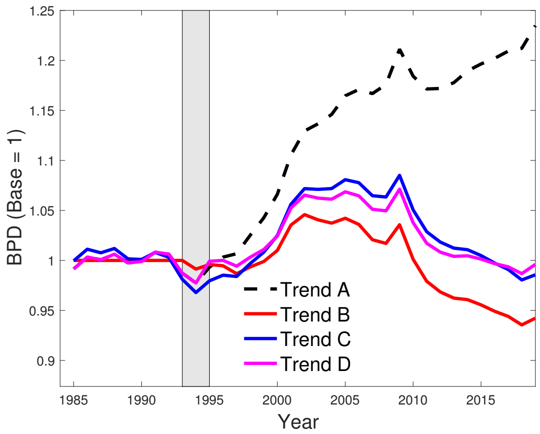


Figure 5: Estimates of the Beyond Pangloss Distortion - BPD_t
Notes: These figures display alternative estimates of the BPD_t series making different assumptions about how to detrend the KYR_t. The shaded area indicates the base years.

tions from 1996 to 2010 (inclusive). This captures the idea that the other forces act consistently via a quadratic trend, but our Beyond Pangloss Distortion caused deviations away from this trend in the period 1996 to 2010.

Trend D - we calculate piecewise, (log)linear trends before and after 1995 (inclusive), but excluding the key distortion years of 1996-2010. Trend D is similar to Trend C but use linear trends that other factors may have caused to shift post-1996.

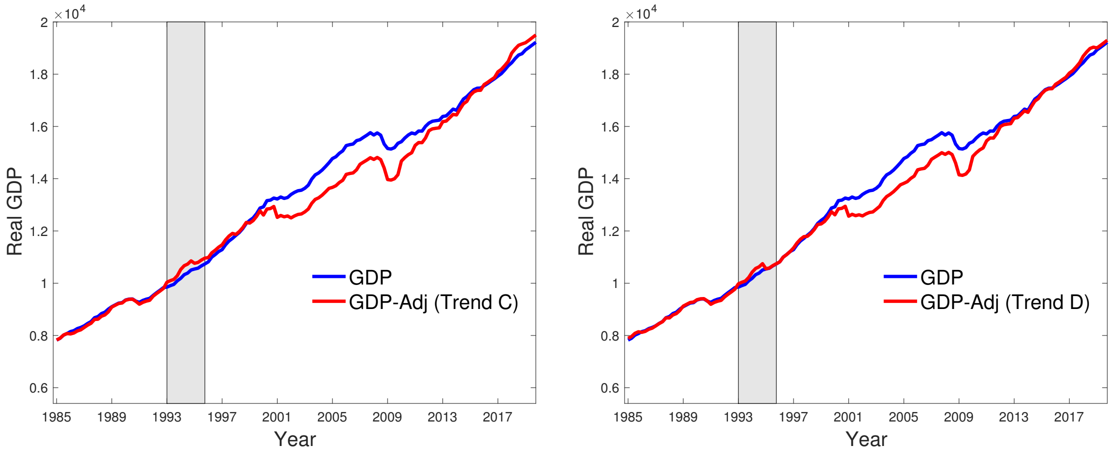
In Figure 5 we plot the estimated BPD_t under each of these alternative and, for ease of presentation, using the average between the baseline KYR_t for BEA and BLS residuals for each year (as in Figure 4). Trend A clearly over-states the size of the distortion. Trend B, C and D give rise to similar distortion estimates during the pre-GFC period; they differ in their behaviour after the GFC because of how they treat the post-2010 trend in the KYR_t.[20]

6.3 The Great Distortion

Our analysis has implications for how one should evaluate the level of GDP in the years after the GFC.[21] There are numerous papers on this. For example, Bianchi et al. (2019) argue that supply has weakened because shocks to equity financing have persistent effects on TFP through R&D investment. Fernald

[20] In Online Appendix V, we show the finding is robust to using all the combinations of measures (e.g. BLS), assumptions on confounding variables, and detrending approaches.

[21] While our focus is not on cycles per se, the macro-financial analysis relates it to the financial cycles literature (see e.g. Borio 2014, Schularick and Taylor 2012, and Jordà et al. 2016).



(a) Counterfactual GDP based on Trend C (b) Counterfactual GDP based on Trend D

Figure 6: Counterfactual paths for US GDP using BPD_t

Notes: This figure shows that our adjusted path for GDP is much below measured GDP in the pre-financial crisis period. This reflects our analysis that the distortion is meaningful in this period.

(2015) argues that the TFP slowdown is separate to the financial disruption and instead it had already slowed before the Great Recession. de Ridder (2019) focuses on the effect of crises on intangible capital. 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 (Fatas and Summers 2018,Crafts 2019). The novel feature of our analysis is that it focuses on factors that distort the behaviour of GDP in the run-up to the crisis, not the aftermath.

Based on the estimates above, the distortion before the GFC is between 3% and 8%. This is sizeable given recessions typically give rise to a negative output gap of 1-3%. We use these estimates to adjust the level of measured US GDP and to strip out the impact of the distortion. In Figure 6 we plot counterfactual paths for GDP under the assumption that there was not a Beyond Pangloss Distortion (using the distortions based on Trend C and D).

The gap between the measured GDP series and either of the counterfactual lines shows the effect of the distortion. It began increasing during the late 1990s. The large difference between the lines before the GFC suggests that the pre-crisis evolution of GDP was misleading. And while both measures suggest a significant decline 2009, the recoveries of the adjusted series are faster. This suggests that some of the Great Recession may have been the reversing of a Great Distortion. This has implications for how we assess the amount of demand stimulus that is warranted. Papers that stress deficient aggregate demand (for example, Hall (2011), Krugman (2012), Mian and Sufi (2014), or Summers (2015)) conclude that fiscal policy did not respond enough. If the decline in GDP is actually an unwinding of a distortion, no fiscal stimulus is warranted. But, to the extent that *some* of the slowdown reflects such unwinding, this casts doubt on the notion that further fiscal stimulus would have been desirable.

7 Conclusion

Our central message is that the distortionary effects of government guarantees are not simply a worry for emerging market economies liberalising their current accounts. In fact, our analysis suggests that the distortionary effects get magnified by more sophisticated financial systems in which the banks can exploit more fully the government guarantees. In this regard, our analysis sounds a cautionary note about the use of such guarantees.

The second key message is that while capital regulation helps, other measures to reduce exploitability should go hand in hand. These could include the use of stress tests[22] or other measures that limit the use of loan books as collateral in financial trades. Easing financial regulations in a pro-cyclical manner will only contribute further to the volatility of the financial and business cycle.

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. 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). Our analysis suggests that the amplitude of the financial cycle and its impact on the business cycle could increase with financial sophistication. Accordingly, policymakers may want to shift their attention to preventing inefficient economic booms, rather than mitigating the eventual output losses.

We have shown that, along a number of dimensions, the US economy in the run up to the GFC behaved in a manner that is consistent with the predictions of our model. And our quantification of the distortion suggests a substantial role for our mechanism during that period. From that viewpoint, the great recession can look more like the reversing of a great distortion.

[22] Taken at face value, if a bank passes a stress test, it means that, even in the most adverse scenario, it will not go bust. In the model, this eliminates any distortion.

References

ACHARYA, V., D. ANGINER, AND J. WARBURTON (2016): "The End of Market Discipline? Investor Expectations of Implicit Government Guarantees," mimeo.

ALMASI, P., J. C. DAGHER, AND C. PRATO (2018): "Regulatory cycles: A political economy model," mimeo.

ATKESON, A. G., A. D'AVERNAS, A. L. EISFELDT, AND P.-O. WEILL (2019): "Government Guarantees and the Valuation of American Banks," *NBER Macroeconomics Annual*, 33, 81–145.

BAHAJ, S. AND F. MALHERBE (2020): "The Forced Safety Effect: How Higher Capital Requirements Can Increase Bank Lending," *The Journal of Finance*, forthcoming.

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.

BERNDT, A., J. D. DUFFIE, AND Y. ZHU (2020): "The Decline of Too Big to Fail," mimeo.

BIANCHI, F., H. KUNG, AND G. MORALES (2019): "Growth, slowdowns, and recoveries," *Journal of Monetary Economics*, 101, 47 – 63.

BORIO, C. (2014): "The financial cycle and macroeconomics: What have we learnt?" *Journal of Banking & Finance*, 45, 182 – 198.

CALOMIRIS, C. W. AND S. H. HABER (2014): *Fragile by Design: The Political Origins of Banking Crises and Scarce Credit*, Princeton University Press.

CLYMO, A. (2017): "Heterogeneous Firms, Wages, and the Effects of Financial Crises," Economics Discussion Papers 20572, University of Essex, Department of Economics.

CRAFTS, N. (2019): "The Fall in Potential Output due to the Financial Crisis: A Much Bigger Estimate for the UK," *Comparative Economic Studies*, 61, 625–635.

DAGHER, J. (2018): "Regulatory Cycles: Revisiting the Political Economy of Financial Crises," IMF Working Papers 2018/008, IMF.

DE RIDDER, M. (2019): “Investment in Productivity and the Long-Run Effect of Financial Crises on Output,” DP 1630, Centre for Macroeconomics.

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. (1984): “Financial Intermediation and Delegated Monitoring,” *The Review of Economic Studies*, 51, 393–414.

DIAMOND, D. W. AND P. H. DYBVIG (1983): “Bank Runs, Deposit Insurance, and Liquidity,” *Journal of Political Economy*, 91, 401–419.

FATAS, A. AND L. H. SUMMERS (2018): “The permanent effects of fiscal consolidations,” *Journal of International Economics*, 112, 238 – 250.

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,” in *NBER Macroeconomics Annual 2014, Volume 29*, University of Chicago Press, 1–51.

GOURIO, F. AND T. H. KLIER (2015): “Recent Trends in Capital Accumulation and Implications for Investment,” *Chicago Fed Letter*, 344.

HALDANE, A. AND P. ALESSANDRI (2009): “Banking on the state,” *BIS Review*, 139, presentation delivered at the Federal Reserve Bank of Chicago 12th Annual International Banking Conference on "The International Financial Crisis: Have the Rules of Finance Changed?", Chicago, 25 September 2009.

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,” *The Quarterly Journal of Economics*, 129, 61–103.

KAREKEN, J. H. AND N. WALLACE (1978): “Deposit insurance and bank regulation: A partial-equilibrium exposition,” *Journal of Business*, 413–438.

KELLY, B., H. LUSTIG, AND S. VAN NIEUWERBURGH (2016): “Too-systemic-to-fail: What option markets imply about sector-wide government guarantees," *American Economic Review*, 106, 1278–1319.

KEYS, B. J., T. MUKHERJEE, A. SERU, AND V. VIG (2010): "Did Securitization Lead to Lax Screening? Evidence from Subprime Loans," *The Quarterly Journal of Economics*, 125, 307–362.

KORINEK, A. (2015): "Financial Innovation for Rent Extraction," mimeo.

KRUGMAN, P. (1999): "What Happened to Asia," in *Global Competition and Integration*, ed. by R. Sato, R. V. Ramachandran, and K. Mino, Boston, MA: Springer US, 315–327.

——— (2012): "Economics in the Crisis," *New York Times*, March 5.

LUCAS, R. E. (1987): *Models of business cycles*, vol. 26, Basil Blackwell Oxford.

MALHERBE, F. (2020): "Optimal Capital Requirements over the Business and Financial Cycles," *American Economic Journal: Macroeconomics*, 12, 139–74.

MCKINNON, R. I. AND H. PILL (1997): "Credible Economic Liberalizations and Overborrowing," *American Economic Review*, 87, 189–193.

MERTON, R. C. (1977): "An analytic derivation of the cost of deposit insurance and loan guarantees An application of modern option pricing theory," *Journal of Banking & Finance*, 1, 3 – 11.

MIAN, A. AND A. SUFI (2014): "What Explains the 2007?2009 Drop in Employment?" *Econometrica*, 82, 2197 – 2223.

MODIGLIANI, F. AND M. H. MILLER (1958): "The cost of capital, corporation finance and the theory of investment," *The American Economic Review*, 48, 261–297.

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, 59–65.

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*, Harvard University Press.

REINHART, C. M. AND K. S. ROGOFF (2009): *This Time Is Different: Eight Centuries of Financial Folly*, Princeton University Press.

——— (2014): "Recovery from Financial Crises: Evidence from 100 Episodes," *American Economic Review*, 104, 50–55.

REPULLO, R. AND J. SUAREZ (2012): "The Procyclical Effects of Bank Capital Regulation," *The Review of Financial Studies*, 26, 452–490.

ROCHET, J. (1992): "Capital requirements and the behaviour of commercial banks," *European Economic Review*, 36, 1137–1170.

ROGNLIE, M. (2015): "Deciphering the Fall and Rise in the Net Capital Share," *Brookings Papers on Economic Activity*, 46, 1–69.

ROGNLIE, M., A. SHLEIFER, AND A. SIMSEK (2018): "Investment Hangover and the Great Recession," *American Economic Journal: Macroeconomics*, 10, 113–153.

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.

SOLOW, R. M. (1957): "Technical Change and the Aggregate Production Function," *The Review of Economics and Statistics*, 39, 312–320.

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.

VOLCKER, P. AND C. HARPER (2018): *Keeping At It: The Quest for Sound Money and Good Government*, PublicAffairs.

VOLTAIRE (1759): *Candide: ou, L'optimisme*, Paris.

WEITZMAN, M. L. (1976): "On the welfare significance of national product in a dynamic economy," *The Quarterly Journal of Economics*, 156–162.

WOLFSON, M. H. AND G. A. EPSTEIN (2013): *The handbook of the political economy of financial crises*, New York, NY: Oxford University Press.

Appendix

A Proofs

A.1 The MM equilibrium

Proof of Proposition 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 will provide a risk premium in equilibrium. Hence, irrespective of its liability structure, the expected marginal cost of funds for the representative bank is $1 + r$, as is the economy's expected marginal return to capital. □

A.2 The Panglossian equilibrium

Proof of Lemma 1

Proof. The lemma follows directly from the reasoning in the text. □

Proof of Lemma 2 and Propositions 2 and 3.

Proof. First, note that because of constant return to scale, equilibrium repayment by firms must be linear in k. Hence, the firm solves:

$$\max_{n,k} E[\pi] = q \left[A^H k^\alpha n^{1-\alpha} - nw - \rho^H k\right]^+ + (1-q)\left[A^L k^\alpha n^{1-\alpha} - nw - \rho^L k\right]^+,$$

where ρ^s denotes the effective repayment from the representative firm in state s.

In equilibrium, it must therefore be the case that:[23]

$$\begin{cases} \rho^H k = A^H k^\alpha n^{1-\alpha} - nw \\ \rho^L k = A^L k^\alpha n^{1-\alpha} - nw \end{cases} \tag{12}$$

This is because: i) firm free entry implies these relationships hold with $\geq$ signs; and ii) firm shareholder limited liability imply they hold with $\leq$ signs.

[23]For simplicity, we assume $A^L \geq (1-\alpha)A^H$. If this is not satisfied, the firm would, in equilibrium, partially default on wages in state L. Given that labour is supplied inelastically, nothing material would change.

The bank solves:

$$\max_k E = q\left[\rho^H k - k(1+r)\right]^+ + (1-q)\left[\rho^L k - k(1+r)\right]^+ . \tag{13}$$

Free entry implies $\rho^H, \rho^L \leq (1+r)$, and condition 12 implies that $\rho^L < \rho^H$. In turn, this implies that $\rho^L < (1+r)$, **which establishes Lemma 2**.[24]

Then, if $\rho^H < (1+r)$, banks make strictly negative profits in all states of the world, which is ruled out by assumption; in our general model with capital requirements, this would prevent banks from raising any equity and, therefore, could not occur in equilibrium. Hence, it must be the case that $\rho_H = (1+r)$ and $\rho_L < (1+r)$.

From 12, we have that firm limited liability binds in the low state. Focusing on the high state, the firm, in effect, solves (taking w and $\rho^H = 1$ as given):

$$\max_{n,k} \pi^H \equiv \left[A^H k^\alpha n^{1-\alpha} - nw - k(1+r)\right]^+ .$$

The FOCs (for firms that enter) are:

$$\begin{cases} \alpha A^H k^{\alpha-1} n^{1-\alpha} = 1+r \\ (1-\alpha) A^H k^\alpha n^{-\alpha} = w \end{cases} .$$

Given that $N = 1$, we get

$$\alpha A^H K_{\mathrm{P}}^{\alpha-1} = 1+r, \tag{14}$$

which establishes Proposition 2, and, in turn,[25]

$$w_{\mathrm{P}} = (1-\alpha) A^H K_{\mathrm{P}}^\alpha, \tag{15}$$

which establishes Proposition 3.

To complete equilibrium characterisation, note that since $\rho_{\mathrm{P}}^H = 1$ pins down w_{P}, and ρ_{P}^L must adjust so that the firm zero-profit condition holds in equilib-

[24] We do not restrict the contract between banks and firms to take a specific form. Notably, however, a standard debt contract (with gross interest rate ρ^H) replicates the allocation that would obtain under an optimal contract offered to firms by the banks specifying a production plan $\{n, k\}$ and contingent repayments per unit of capital $\{\rho^L, \rho^H\}$. Under such a contract, banks maximise expected profit given w and ensure that producers break even in all states. There is no possible profitable deviation for a bank-firm pair. Through this contract, banks effectively compete for workers and end up making zero expected profit in equilibrium.

[25] On the one hand, if $w_P < \alpha A^H K_P^\alpha$, firms make strictly positive profit. On the other hand, if $w_P > \alpha A^H K_P^\alpha$, it is not possible for firms to be profitable enough to make a unit repayment to banks in the good state.

rium. That is, $\rho_{\mathrm{P}}^{L} K_{\mathrm{P}} = A^{L} K_{\mathrm{P}}^{\alpha} - w_{\mathrm{P}}$. Hence,

$$\rho_{\mathrm{P}}^{L} = \left(1 - \frac{A^{H} - A^{L}}{\alpha A^{H}}\right)(1+r). \tag{16}$$

Finally, the tax required for the government to break even in all states is given by:

$$\begin{cases} \tau_{\mathrm{P}}\left(A^{H}\right) = 0 \\ \tau_{\mathrm{P}}\left(A^{L}\right) = -\left(A^{L} K_{\mathrm{P}}^{\alpha} - (1-\alpha) A^{H} K_{\mathrm{P}}^{\alpha} - K_{\mathrm{P}}(1+r)\right) \end{cases} \tag{17}$$

□

Proof of Proposition 4

Proof. First, AK^{α} is strictly increasing in K. Second, expected net output, which is given by $E\left[AK^{\alpha} - K(1+r)\right]$, reaches a global maximum in $K_{\mathrm{MM}} < K_{\mathrm{P}}$. □

Proof of Proposition 5

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, $E\left[\sum_i \theta_{\mathrm{P}}^{i} R^{i}\right] = x(1+r)$. Hence, household expected wealth is given by:

$$v_{\mathrm{P}} \equiv w_{\mathrm{P}} - E[\tau_{\mathrm{P}}] + x(1+r).$$

Substituting for w_{P} and τ_{P} (which are given by equations 15 and 17), we get:

$$v_{\mathrm{P}} = \underbrace{E[A] K_{\mathrm{P}}^{\alpha} - K_{\mathrm{P}}(1+r)}_{E[\mathrm{NDP}_{\mathrm{P}}]} + x(1+r).$$

The result then directly follows from Proposition 4. □

A.3 The Beyond Pangloss equilibrium

Proof of Proposition 6 and 7

Proof. Note that Lemma 1 still applies (the bank does not issue equity), CRS still implies linear contracts between the bank and the firm, and we still get the same equilibrium conditions from the firm problem:

$$\begin{cases} \rho^H k = A^H k^\alpha n^{1-\alpha} - nw \\ \rho^L k = A^L k^\alpha n^{1-\alpha} - nw \end{cases} \tag{18}$$

However, now, taking the optimal trading strategy as given, the lending problem of the bank reads:

$$\max_k E[v_{\text{BP}}] = q\left[\rho^H k - k(1+r) + \left(\frac{1-q}{q}\right)\rho^L k\right]^+ + \underbrace{(1-q)\left[\rho^L k - k(1+r) - \rho^L k\right]^+}_{=0}. \tag{19}$$

The FOC yields: $E[\rho_T] = q(1+r)$, which is the key difference with the Panglossian equilibrium. The rest directly follows: given free entry, banks will lend up to the point where

$$E[A]K_{\text{BP}}^\alpha - w_{\text{BP}} = q(1+r)K_{\text{BP}} \tag{20}$$

At the same time, facing $E[\rho_{\text{BP}}] = q$, firms will hire labour up to the point where

$$w_{\text{BP}} = (1-\alpha)E[A]K_{\text{BP}}^\alpha, \tag{21}$$

which establishes proposition 7. Finally, together, equations 20 and 21 yield

$$\alpha E[A]K_{\text{BP}}^{\alpha-1} = q(1+r).$$

Given that $E[A] > qA^H$, **this establishes proposition** 6. □

A.4 The equilibrium in the general model

Proof of Proposition 8

Proof. The logic for the proof is the same as for proposition 6. The only difference is that the no-entry condition for banks now yields the following zero profit condition:

$$q\rho^H - q(1-\gamma)(1+r) + (1-q)\phi\rho^L - \gamma(1+r) = 0.$$

Substituting for ρ^L and ρ^H from conditions 18 and w_{BP} from the analogous equation to 21, and rearranging, gives the result. □

Online Appendix for *Beyond Pangloss: Financial sector origins of inefficient economic booms* (F. Malherbe and M. McMahon)

I Model Extensions

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

I.1 Liquidity provision, bank runs, and regulatory response

In the models developed in the main text, we abstracted from important dimensions of banking and took as given the existence of the guarantees (except in the MM economy, of course). In this extension, we give two additional economic role to banks (next to credit provision to firms): they now also provide liquidity and diversification services 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.

I.1.1 Augmenting the model

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

$$E[u\left((1-\beta_j)c_{\text{aft}}+\beta_j c_{\text{eve}}\right)],$$

where $u(.)$ is as before but $\beta_j \in \{0,1\}$, with $\Pr(\beta_j = 0) = j$, 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^α arises to firms in the early afternoon (with $a \leq A^L$). It is used to pay wages. The remainder can be repaid to the bank and, in turn, be used to repay early depositors. The risky part of the payoff ($(A - a)k^\alpha$) arises in the evening, and goes to the bank.[26]

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 in the main text. However, international financial markets can only settle at night. We normalise the risk-free rate to 0.

Definition. In a *first best allocation*, production is set at the efficient level, where the expected marginal productivity of capital is 1 (this corresponds to the MM allocation in the main text), and there is perfect insurance. That is, irrespective of their type agents consume the same (as long as $aK_M^\alpha \geq je$, there is enough resource to provide for afternoon households; we assume this is the case). Hence, the full expected economic surplus from production is equally split among households. They therefore consume:

$$e + (E[A]K_{\text{MM}}^\alpha - K_{\text{MM}}) = e + (1-\alpha)E[A]K_{\text{MM}}^\alpha = e + w_{\text{MM}}$$

I.1.2 Sketch of the analysis and discussion

Without guarantees, the following decentralised arrangement can implement the first best. Household deposit their endowment with the bank 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 K_{MM}, and hedges production risk with the rest of the world (any excess deposit is lent at the zero risk free rate). As a result, total resources available to the bank through the day is simply e.

[26]For simplicity we abstract here from contractual considerations between the firm and the bank.

Bank runs Now, consider a coordination failure, where *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 proceeds from the second payoff are not collected in full. Hence, evening depositors that anticipate a run are indeed better off running, and a run can be self-fulfilling.

Deposit insurance As usual, deposit insurance (with ex-post lump-sum taxes on evening households) prevents the coordination failure (Diamond and Dybvig, 1983). 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 financial trades to shift the risk onto the taxpayer as we described in section 3.

Exploitability of guarantees and ban on financial trades As in our general model capital requirements can help (i.e. the distortion is decreasing in γ), but the more exploitable the guarantees are (i.e. the larger ϕ) the more overinvestment is exacerbated. However, here, banning financial trades (which corresponds to $\phi = 0$) is no panacea. This is because in this extension financial trades are potentially useful since they allow bank to hedge domestic risk and provide full insurance to households. In particular, the first best allocation is not attainable if $\phi = 0$.

Stress-tests Note that, in the Beyond Pangloss model, 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. This is 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.

I.2 Asset price inflation

We introduce here 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:

$$K = \left(Q^{\xi} + S^{\xi}\right)^{\frac{1}{\xi}},$$

where $\xi \in (0,1)$ is the elasticity of substitution between Q and S. Q denotes equipment and S stands for structures (and land). For simplicity, equipment is imported, at an exogenous unit price $p_e > 0$, and structures are in perfectly-inelastic supply, with $S = 1$.[27] The firm buys structures from households at the beginning of the period at an endogenous competitive price p_s.

Because we want to be able to account for possible secular trends in the economy, we parametrise capital depreciation. In particular, we assume that, at the end of the period, equipment and structures can be converted into consumption goods at rates $p_e(1-\delta)$ and $p_s(1-\delta)$, respectively, with $\delta \in (0,1]$. Finally, rather than the proceeds from lending, here we assume it is the capital itself that is collateralised. But we restrict this to structures allowing the bank to pledge up to a share $\phi \in [0,1]$ of the structures to outside investors (equipment is not collateralisable).

Equilibrium with government guarantees As in the Beyond Pangloss economy, the representative bank will maximise rent extraction, which gives (stars indicate equilibrium values):

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

Accordingly, the lending problem of the representative bank can formalised, with a slight abuse of notation (we are directly using aggregate variables for the representative bank, which still takes factor prices as given), as:

$$\max_{N,Q,S} q\left(A^H N^{1-\alpha}\left(Q^{\xi} + S^{\xi}\right)^{\frac{\alpha}{\xi}} - Nw - q_e(\delta + r)Q - q_s(\delta + r)S + \phi\frac{1-q}{q}(1-\delta)S\right).$$

[27] An alternative would be to have structures built with a combination of land, labour, and equipment. This would complicate the analysis without adding much further insight.

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

$$Q^* = S^* \left(\frac{p_s(\delta + r) - \phi \frac{1-q}{q}(1-\delta)}{p_e(\delta + r)} \right)^{\frac{1}{1-\xi}}. \tag{22}$$

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

$$\begin{cases} (1-\alpha)\, A^H \left(\left(\frac{q_s(\delta+r) - \phi \frac{1-p}{p}(1-\delta)}{q_e(\delta+r)} \right)^{\frac{\xi}{1-\xi}} + 1 \right)^{\frac{\alpha}{\xi}} = w \\ \alpha A^H \left(\left(\frac{p_s(\delta+r) - \phi \frac{1-q}{q}(1-\delta)}{p_e(\delta+r)} \right)^{\frac{\xi}{1-\xi}} + 1 \right)^{\frac{\alpha}{\xi}} = p_s(\delta + r) - \phi \frac{1-q}{q}(1-\delta) \end{cases}, \tag{23}$$

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

Results This system can be solved numerically. It is easy to check that to obtain the equilibrium conditions of the corresponding MM economy of the extended model, one must substitute $E[A]$ for A^H and set ϕ to 0 in System 23 and Equation 22 above.

Compared to the MM economy, in this extended model, the economy with guarantees exhibits a series of symptoms similar as those in the Beyond Pangloss economy: (i) higher GDP and lower expected NDP; (ii) inflated wage; (iii) over investment in capital (materialising through an increase in Q^*); and (iv) a higher capital to output ratio. However, it also features new distortions:

Inflated asset prices In particular, q_s^*, the price of structures, is increasing in A^H and ϕ. Figure A.1 shows that the relative price of investment, which has, in aggregate, been on a well-documented secular downward trend since the 1970s actually increased slightly before the financial crisis (black dashed line). While equipment goods prices continued to decline (yellow line), the prices of residential and particularly non-residential structure prices grew strongly for many years before the crisis (green and purple lines). These trends are consistent with the predictions of our extended model.

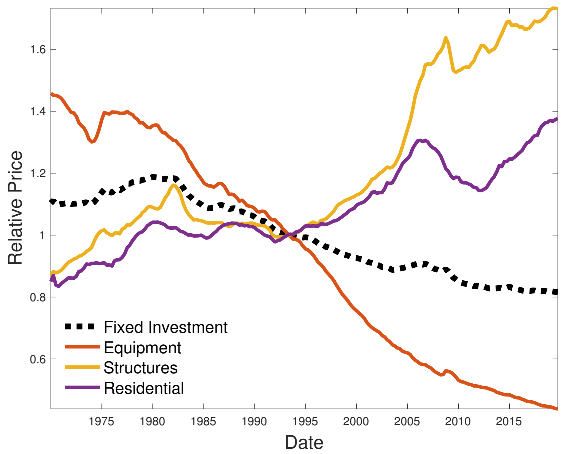


Figure A.1: Relative Price of Capital Investment (Index, 1994=100)

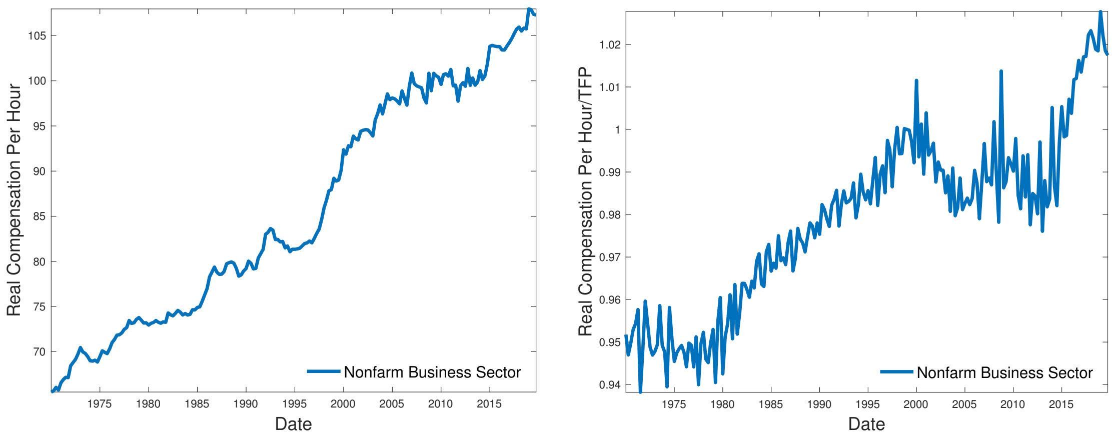
Notes: This figure shows Bureau of Economic Analysis (BEA) data on the investment good deflators as a ratio to the GDP deflator series. The evolution of the index describes the behaviour of the *relative* price of that type of investment good.

Ambiguous changes in the share of fixed asset income in GDP In particular, $\sigma^* \equiv \frac{Q^* p_e}{S^* p_s}$ is increasing in A^H, but decreasing in ϕ. That is, 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 labour, then equipment. This prediction speaks to the literature on the medium to long term trends for production factor shares of income (see e.g. Karabarbounis and Neiman 2013 and Piketty 2014), but fully studying such ramifications is beyond the scope of this paper.

II Real wage developments

The Panglossian model predicts that the period in advance of the crash would also have been marked by significant real wage growth. However, the Beyond Pangloss equilibrium generates a more nuanced prediction. The increase in investment boosts wages but banks' concern about the collateral value in the low state restrains competition for workers and tends to decrease the wage. The net effect is ambiguous.

Figure A.2a shows the index of real compensation per hour in the non-farm business sector. This begins to accelerate from around 1998 until the financial crisis. Between 2009 and 2014, real wages were virtually stagnant.[28] However, relative to TFP (Figure A.2b), measured using Fernald's utilisation-adjusted TFP measure, real wages have a much more mixed performance; they grew in late 1990s but then largely stagnated over the next 15 years.



(a) Real Wages per Hour (b) Real Wages per hour relative to TFP

Figure A.2: Real Wages

Notes: This figure shows the index of non-farm business sector real compensation per hour. The index is set to 100 in 2009. Figure (a) shows the raw index while figure (b) shows the index relative to utilisation-adjusted TFP.

[28] Clymo (2017) provides evidence that real wages were gradually adjusted down in the US (as well as in the UK) after the crash.

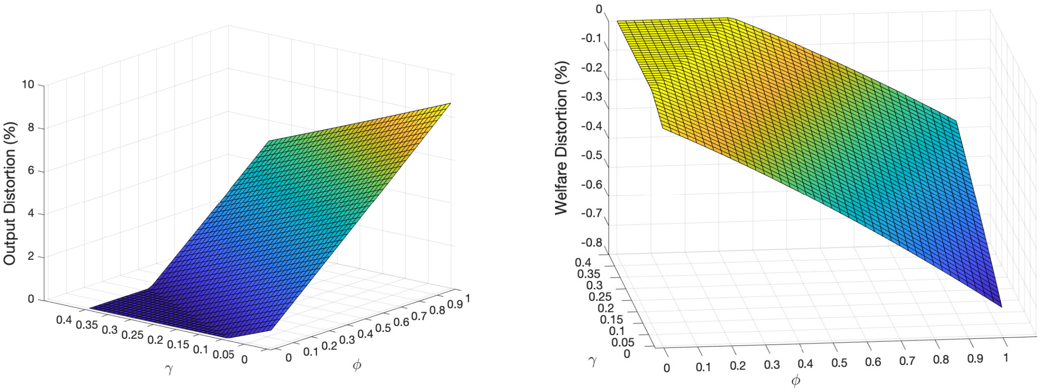
III Calibration of the General Model

In the main text we explore a number of calibrations of the general model to highlight the implications of pledgeability for the distortion of output and reduction of welfare. In this section, Figure A.3 plots the model results for a whole range of values for ϕ and γ. This exercise uses the same calibration parameters as presented in the main text and reported in Table 1.

Concept	Parameter	Values
Pledgeability	ϕ	$[0, 1]$
Capital Regulation	γ	$[0, 0.4]$
Persistence of H State	q	0.95
Capital Share	α	0.38
High State Productivity	A^H	1.0
Low State Productivity	A^L	0.9
Real Interest Rate	r	0.02

Table 1: Calibration for Quantitative Exploration of the Model
Notes: This table shows the calibration values used in the quantitative evaluation of the distortions in the general model.

Figure A.3 reinforces the two messages in the main text. First, the distortion in the Panglossian equilibrium is modest ($\phi = \gamma = 0$) and regulation can easily neutralise it as per Krugman (1999); holding fixed $\phi = 0$, the effect of tightening capital regulation is to quickly return the outcome of the MM economy (no distortion). Second, high pledgeability quickly overcomes the effects of regulation; when $\phi = 0.175$, stringent regulation (for example, $\gamma = 0.25$ as used in the main text) is no longer enough to neutralise the distortion which grows with the degree of pledgeability.



(a) Effect of ϕ and γ on output distortions

(b) Effect of ϕ and γ on welfare

Figure A.3: Effect of Pledgeability (ϕ) and capital regulation (γ)

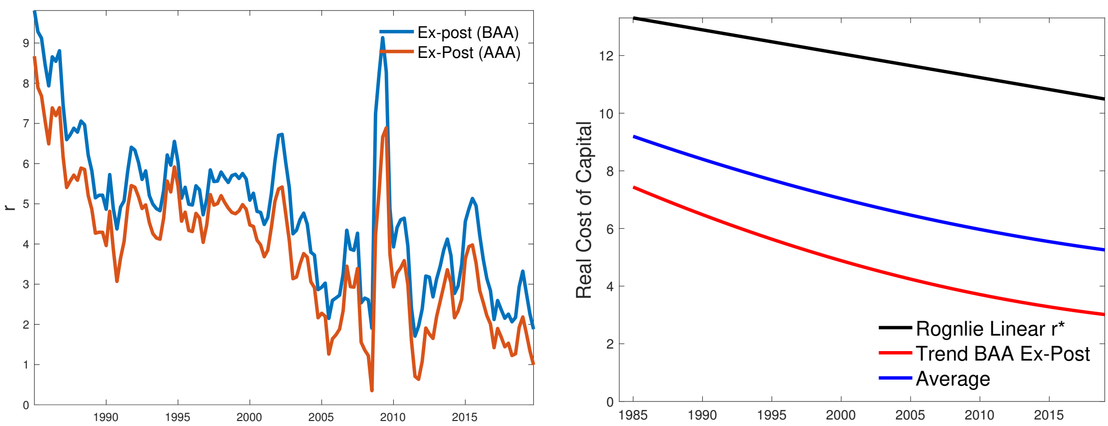
Notes: This figure repeats the simulation of the general model in section 4.1 as used in Figure 2 but for a wider range of parameters.

IV Data Description: Confounding factors for the residual calculation

In section 6 in the main text, we construct a Solow-inspired, back-of-the-envelope estimate of the size of the distortion. Here we provide a more-complete description of the data used for confounding factors for equation (10).

Real cost of capital The main component of the user cost of capital in (10) is the cost of finance. There is a large literature that suggests there has been a secular decline in interest rates over the last 25 years (for example Summers (2014)). There are many series that could be used to capture the real user cost.

One candidate series to measure the cost of finance is a bond yield series. These series, at least with a long enough time-series, are nominal and therefore need to be adjusted for inflation expectations to be comparable to the model driving variable. For simplicity, we use a measure of ex-post real interest rate. Figure shows the ex-post AAA and BAA bond yields since 1985; using ex-post measures between 1972 and 1985 is problematic as inflation was highly variable making ex-post measures extremely volatile. The ex-post bond yields show a clear secular decline over the period.



(a) Ex-post real bond yields (b) Trends in real costs of funds

Figure A.4: Secular trends in real costs of funds: ex-post real bond yields

Notes: This figure shows the trends for the real cost of funds provided in by ex-pot bond yield measures and the estimates from Rognlie (2015). The red line shows the weighted average that we use to control for declining real interest rates.

Of course, bond yields miss the cost of equity which is typically a lot higher. Rognlie (2015) backs out an implied measure of the real cost of funds from financial markets by comparing 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. However, the Rognlie calculation yields a very high value of the real return (the estimates are in the range 12-15%[29]).

Rognlie estimates the trends over the period 1947 to 2013 (in Figure 7 of Rognlie, 2015); we update the linear trend to get estimates of the annual cost of finance to 2019. As with the ex-post real yields, the Rognlie measure has declined. Figure A.4b shows the adjusted trend values for r from 1985 to 2019, as well as the BAA ex-post measure and its trend. While the trends in both series are similar, we choose to use a baseline estimate of the overall real cost of finance that is a weighted combination of the two series. Specifically, the blue line in Figure A.4b is $r_t = \psi.r_t^{BAA} + (1-\psi).r_t^{Rognlie}$ where $\psi = 0.7$.

In the model, r is exogenous. One concern may be that the distortion causes 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. Unclear on how to adjust for this effect, we proceed without further adjustment of the cost of funds.

Depreciation Higher average depreciation increases the user cost of capital which will, ceteris paribus, reduce the capital-output ratio. Using BEA data on nominal capital consumption $(\delta_t K_t)$, which uses fixed depreciation rates for each capital type multiplied by the composition of capital accounted for by that type of capital, we derive an estimate of average depreciation in each period.[30] Given that computers depreciate more quickly than other assets, it is often assumed that the average rate of depreciation rose in the last quarter of a century. In principle, this makes it important to control for δ_t (as increases in δ lower the capital to output ratio, which would cause us to understate the distortion). However, as we show in Figure A.5, after having sharply increased in the 1970s,

[29] 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).

[30] There is no equivalent BLS measure of depreciation.

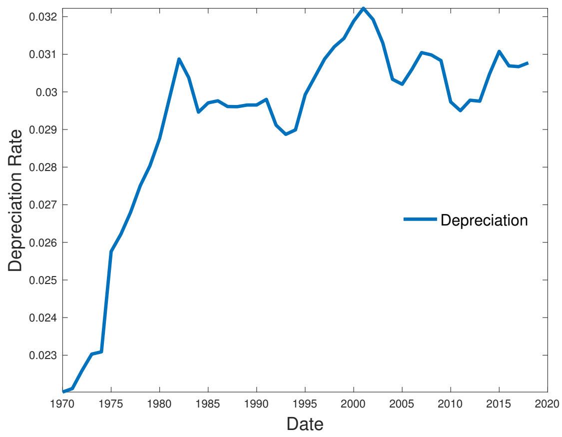


Figure A.5: Depreciation Rate Implied by BEA Capital Consumption
Notes: This figure shows the implied nominal depreciation rate obtained by dividing nominal consumption of fixed capital by the capital stock using BEA data. The shaded area represents our base years of 1993-1995.

depreciation does not really show a trend since the 1980s.

TFP In the absence of distortions in the model, decisions about capital investment are based on expectations of productivity. Realised productivity that is above (below) the expected level bias down (up) the capital-output ratio as it means that the pre-determined level of capital stock generates more (less) output than was expected; this drives the denominator up (down).

In order to adjust for this, we can use capacity-utilisation-adjusted TFP estimates provided by Fernald (2012). To measure the expected value, we use a 4th-order polynomial trend estimated over the entire sample from 1947 to 2019. Figure A.6 shows our estimates of both the level of TFP and our estimate of the trend. In the calculation, we use the deviations of TFP from this trend.

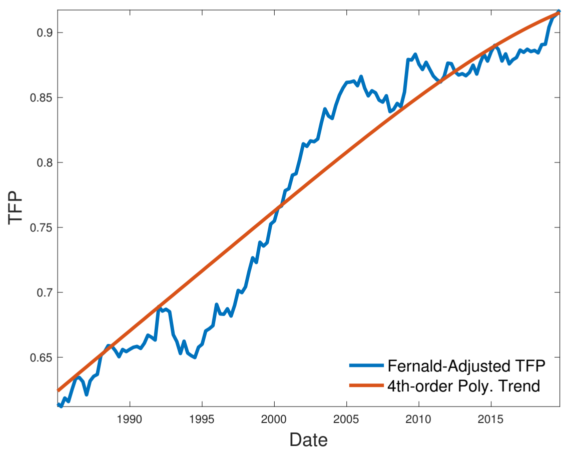


Figure A.6: Fernald's Capacity-Utilization Adjusted TFP and Trend
Notes: This figure shows the time series of Fernald's capacity-utilisation adjusted TFP index. It is plotted alongside 4th-Degree Polynomial trend.

V Robustness of BPD_t Estimates

In the main text, we present a number of different estimates of the KYR_t residuals under alternative assumptions concerning the treatment of the confounding variables. We also discussed a number of different ways to calculate KYR_t^* in order to estimate the Beyond-Pangloss Distortion (BPD$_t$); trend B– D measures all seemed at least somewhat reasonable. Finally, we can estimate KYR_t separately for each of the of the measures of the capital to output ratio (BLS and BEA), and also take the average KYR_t between the estimates. For robustness, we explore every possible combination of these choices.

In Figure A.7, we plot the range (dotted lines) as well as the baseline Trend C and D measures reported in the main text.

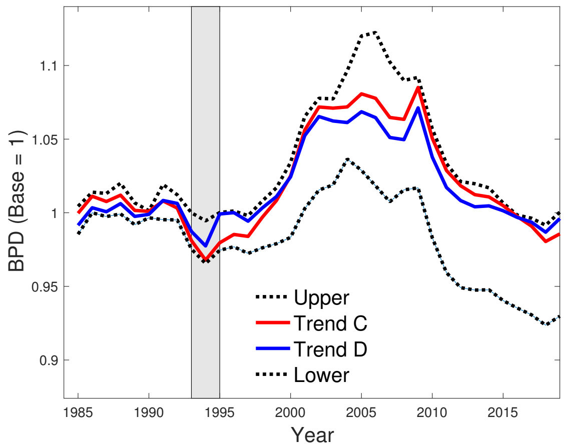


Figure A.7: BPD_t Range

Notes: These figures display the range of alternative estimates of the BPD_t series using different capital stock measures, different assumptions on the confounding factors and different assumptions about how to detrend KYR_t.