Beyond Pangloss: Financial sector origins of inefficient economic booms

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Abstract

Government guarantees of banks, now ubiquitous, have a long history. Over time, bank sophistication has increased. We study a model where financial engineering increases banks’ ability to exploit government guarantees, fuelling inefficient economic booms. Driven by financial engineering, bank rent extraction creates a disconnect between lending decisions and borrower repayment prospects. In equilibrium, banks overextend and only break-even courtesy of trading book profit. Bank capital regulation mitigates the problem somewhat, but cannot fully restore efficiency. We argue that our mechanism is empirically relevant, implying that the Great Recession, partly, reversed a Great Distortion.

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1 Introduction

Governments all over the world guarantee a substantial fraction of bank debt. Such guarantees have existed, explicitly or implicitly, for around a century. In this time, the financial system has changed immensely. In particular, the period from the mid-1980s to the Global Financial Crisis (GFC) was characterised by lobbying-induced deregulation and associated financial innovation. We show in this paper that financial engineering designed to exploit such government guarantees can have substantial effects on the real economy. Our results suggest that the Great Recession may have been, at least partially, the reversing of a Great Distortion, and that a return to pre-crisis GDP trends is neither sustainable nor desirable.

We propose a model in which banks support their trading book activity with their banking book. Such trading is a form of risk-shifting which is lucrative because it exploits government guarantees. Maximising the associated rents requires an expansion of the banking book. This lending expansion creates a boom in economic activity, but this boom is inefficient. Strikingly, the inefficiency of the boom can be such that real investment never breaks even, even in the most favourable state of the world. More generally, the inefficiency need not be that extreme, but a key feature is that, in equilibrium, banks make losses on their loan portfolio even in the absence of a negative shock to the economy. So, our mechanism goes beyond the typical magnifying effect that financial frictions have on negative real shocks.

The magnitude of the distortion depends on the extent to which banks are able to exploit the guarantees. Broadly speaking, more stringent bank capital regulation make it harder for banks to exploit the guarantees, but financial sophistication, which captures banks' ability to use banking book assets as collateral, increases exploitability. Crucially, for any given stringency of capital requirement, there is a level of sophistication beyond which banks can exploit the guarantees, and the distortion to real economic activity arises.

In order to make our point in a transparent way, we build the intuition of results by gradually adding features to a relatively simple model. It has 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 agents act competitively. The key
ingredients of the baseline model are: (i) investment is risky because it must be com-
mited before the realisation of a shock to TFP; (ii) banks are exposed to real investment
risk; (iii) banks potentially benefit from government guarantees.

Starting in a world with no guarantees, no financial engineering, and no capital
regulation, the equilibrium corresponds to a Modigliani-Miller world. The introduc-
tion of government guarantees leads to distorted investment decisions: in equilibrium,
agents’ behaviour is based on valuations that correspond to the best possible outcome.
Krugman (1999) calls such valuations Panglossian. Even though financial incentives
are seriously distorted, the effects on the real economic outcome are relatively mild.

Introducing unrestricted financial engineering has a dramatic impact: it pushes
valuations beyond Pangloss. To capture financial engineering, we allow banks to trade
in a set of Arrow securities. We assume that Arrow securities are, in effect, senior to
deposits. This captures the real world feature that many financial trades (such as re-
pos and securitised products) are bankruptcy remote (see the discussion in Section 5).
However, government guarantees do not cover Arrow securities. So, given limited li-
ability, banks cannot credibly sell more of any Arrow securities then the total cash flows
it will receive (from loan repayment) in the corresponding state. Hence, when a bank
expands its banking book, this relaxes the limits it faces on its trading book. Such a
mechanism corresponds to the commonly suggested notion that banks use their bank-
ing book to support their trading activities. To fix ideas, we use the interpretation that
the banking book serves as collateral for the short positions in Arrow securities.

In equilibrium, banks use such trades to extract rent from the tax payer by mov-
ing revenue from the states where they default, to the states where they don’t. Since
the trades are lucrative, collateral is valuable, and banks produce more of it by lowering
their lending standards in order to aggressively expand their banking books. In
equilibrium, losses on banking books are just offset by profits on trading books.

We develop a direct measure of the magnitude of the distortion which we call im-
plied 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. Panglossian valuations reflect the best of all possible worlds. Beyond-Pangloss valuations reflect unattainable productivity outcomes. So, lending decisions appear completely disconnected from borrower repayment prospects: even in the most favourable state, the real investment associated with the marginal loan does not break even, and banks can only break even on the loan thanks to the associated trading book profit. We view this extreme outcome as a transparent illustration of the potential consequences of our key mechanism.

In our general model, we introduce ingredients that affect the exploitability of government guarantees in practice. This leads to more realistic, but still economically significant, outcomes and allows us to think of real world implications. In particular, we introduce capital requirements and a parameter that captures the extent to which banks are able to pledge their collateral to finance their rent-seeking trades. We find that the former impedes exploitability and the latter increases it. This is not surprising, but this allows us to revisit historical milestones in changes in bank regulation and supervision and in financial innovation through the lenses of the model. Accordingly, we argue that the US saw a significant increase in such exploitability in the two decades leading to the 2008 crisis (Acharya and Richardson, 2009) and, arguably, a dramatic reduction in the immediate aftermath of the crisis.

How surprising is it that financial sophistication adversely affects the real economy? Nobel laureate William Sharpe once told Paul Volcker that financial engineering contributed nothing to economic activity (Volcker and Harper, 2018, p.206). Our answer would differ; in the presence of government guarantees, financial engineering of the sort that took place before the Global Financial Crisis (GFC) actually boosts GDP. But, welfare decreases because GDP becomes inefficiently high. For all realisations of TFP, GDP is higher than it would have been absent the distortion. 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 con-
sumption. The novel implication of our analysis is that GDP becomes an increasingly poor indicator of welfare as financial engineering allows banks to increasingly exploit government guarantees.

Previous literature on the macroeconomic effects of government guarantees (which mainly focused on emerging markets) has shown that government guarantees may alleviate firm borrowing constraints and boost economic growth. Overall, the message is that government guarantees may allow emerging economies to converge faster (on average) with advanced economies, but at the cost of increased susceptibility to crisis (see McKinnon and Pill (1997), Schneider and Tornell (2004), and Ranciere et al. (2008)).

The trade-off between increased expected output and financial stability is also central to the literature on credit booms (e.g. in fire-sales models such as Lorenzoni (2008)).

A key mechanism is that when a negative shock occurs, asset prices fall, which tightens borrowers’ credit constraints and magnifies the impact of the shock. Agents do not internalise these effects ex-ante, and the resulting excessive borrowing leads to inefficiently severe downturns when bad shock occurs. Expected output is therefore inefficiently low. Instead, in our setup, expected GDP is inefficiently high. Furthermore, GDP can be too high, even when the realised shocks are positive.

We also stress is that capital regulation alone is not sufficient to counteract our distortion. While the distortion decreases with tougher capital requirements, for any level of capital requirements there is a level of financial sophistication such that banks are able to exploit the guarantees. This stands in contrast to Krugman’s (1999) notion that Panglossian valuation is a problem of under-regulated banking sectors. We show in a simple calibration of our model that even if capital requirements are very high (such as 50% of risk-weighted assets), a substantial Beyond-Pangloss distortion can occur. This suggests the need for policies that aim at curbing bank trading activities (such as the Volker Rule in the US).

Our paper relates to the broader literature on government guarantees to banks.

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1See also Shleifer and Vishny (2011) and Brunnermeier and Oehmke (2013) on fire sales; Bolton et al. (2016) on how a global saving glut may have contributed to fragility build up; and Korinek (2014) on financial innovation itself may generate the need for government guarantees in the first place.

2In a different class of models De Meza and Webb (1987) show that information asymmetries can also lead to over-investment.
While such guarantees are designed to help alleviate financial panic (Diamond and Dybvig, 1983), they distort bankers’ incentives and promote excessive risk-taking (see, e.g. Kareken and Wallace, 1978). Among the many ramifications, our work specifically relates to studies on the measurement of the burden to the taxpayer (e.g. Merton (1977) and Atkeson et al. (2019)), and on how capital requirements for banks can mitigate the problem (e.g. Rochet (1992), Repullo and Suarez (2012), and Malherbe (2020); see also Admati and Hellwig (2014)). Focusing on the Savings and Loans crisis, Akerlof and Romer (1993) show that government guarantees can lead to incentives for looting. Looting differs from risk-shifting in that shareholders drive the bank into bankruptcy with certainty, but after paying themselves fat dividends. The mechanism in our model is, instead, a risk-shifting one, in the sense that trades pay out in the states where the bank does not default. However, there is still a flavor of looting as the trades deplete the assets that should be used to repay the depositors, at a cost to the taxpayer.

Beyond our theoretical contribution, our model offers a new, coherent narrative that links deregulation, financial innovation, lowering of lending standards, and the relative performance of the banking and trading books to the behaviour of macroeconomic aggregates. Overall, our model has implications for how one should evaluate the level of GDP in the years around the GFC. Our analysis suggests a role for a decrease in the exploitability of guarantees in the apparent weakness of GDP in the aftermath of the crisis. To the extent that pre-crisis GDP growth reflected inefficiencies due to rent extraction by banks, a decline in GDP should actually be welcome.3

While we stress the role of exploitability as a novel driver of the dynamics, our narrative is consistent with existing empirical evidence. This includes both the finding that financial crises are associated with persistent declines in GDP (e.g., Jordà et al. (2013)), and with Adrian et al. (2019) who show that credit booms predict an increase in the volatility of GDP growth and a decline in its mean. There is also a literature on the GFC that emphasises the role of post-crisis deficient aggregate demand and insufficient fiscal stimulus (such as Hall (2011), Krugman (2012), Mian and Sufi (2014), or Summers

3Oulton (2013), Haldane et al. (2010) and others have studied whether GDP may be inflated, pre-crisis, by mismeasurement originating in the financial sector. In contrast, in our model, the financial sector is purely intermediary and has zero direct contribution to value added. However, distorted financial incentives generate inefficient real investment, and therefore inefficient value added in the real sector.
(2015)) in the weakness of GDP. However, taking our model results at face value, some of the decrease in GDP may have been desirable (corresponding, as we stated above, to higher NDP), therefore weakening the case for stronger demand stimulus. Given many channels are simultaneously at work, whether more or less stimulus was warranted is then an open empirical question.

To assess the strength of the capital distortion, we propose a simple, residual-based estimate; in our model, movements in the capital-output ratio not accounted for by other driving variables would reflect the Beyond-Pangloss distortion. Taking care to recognise that many factors unrelated to our distortion might drive the capital-output ratio, we calibrate a range of estimates for our distortion over time. Armed with these estimates, we calculate adjusted GDP series that strip out the distortion. This back of the envelope approach places the distortion between 3% and 8% of GDP before the financial crisis. This is sizeable given that a recession typically gives rise to an output gap of 1-3%. The gap between the measured GDP series and our counterfactual series began to increase during the late 1990s. The difference was largest before the GFC, and the while both measures of GDP 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. More generally, an important take-away is that such distortions complicate the real-time assessment of economic activity. This is particularly problematic after a crisis because pre-crisis data is a poor guide to the sustainable level of activity which economic policy should try to achieve.\footnote{The idea that our distortion masks underlying economic potential is similar in spirit to the notion in Summers (2014) that unsustainable finances masked underlying dynamics of secularly low long-term interest rates.}

\section{A baseline Panglossian model of inefficient booms}

In this section we introduce the simplest version of our model. There is a single period and 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:

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

where \(c\) is its consumption at the end of the period, and \(u(.)\) is increasing and concave. The household 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 \(i \in \{1, 2, \ldots\}\):

\[
\sum_i \theta^i p^i \leq x,
\]

where \(\theta^i\) denotes the holding of security \(i\), whose price is \(p^i\). The household 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 \(\tau\) 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:

\[
A k^\alpha n^{1-\alpha},
\]

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 ($r$), and to hire workers. Wages must be paid before any payment can be made to banks.\footnote{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.}

**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 consider two different Government regimes: one with, and one without guarantees. In the former, deposits are fully insured, at no premium. 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 model assumes banks exist and may benefit from guarantees. This keeps the analysis simple and highlights the main mechanisms in a transparent way.

**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.6

**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 be-

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6 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.
lieve 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.

**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:

\[
Y = AK^aN^{1-a},
\]

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:

\[
\begin{align*}
\alpha E[A]k^{a-1} &= E[\rho] \\
(1 - \alpha)E[A]k^a &= w
\end{align*}
\]
where $r$ 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. Hence, aggregating at the representative bank level, we have:

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

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

$$r(A_L, K) < 1 + r < r(A_H, K).$$

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 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 (e.g., 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 $^{7}$Competition and constant return to scale also imply a linear contract between to firm and the bank.
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:

\[ \mathcal{A}(K) \equiv \left\{ A \mid \alpha AK^{\alpha-1} = 1 + r \right\} \]

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

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

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. \( \mathcal{A}(K) \) will then provide us with a direct measure of equilibrium distortions: \( \mathcal{A} \) 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.

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:

$$\max_{k \geq 0} E \left[ \rho(A, K)k - k(1 + r) \right]^+,\tag{13}\label{eq13}$$

where $\rho(A, K)$ is the realised unit repayment on loans. The bank takes $K$ as given, so from the bank’s perspective, $\rho$ can only take two values in equilibrium, which we denote $\rho^L$ and $\rho^H$. Since the bank has no equity buffer, it is vulnerable to any adverse shock.\(^8^\) 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 (a marginal increase or decrease in losses is irrelevant to shareholders since they get 0 anyway) and, accordingly, maximising profits in the good state:

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

\(^8^\)Later, when we introduce capital requirements, the bank is vulnerable if the buffer is insufficient compared to the shock.
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:

\[ aA^H K_{p}^{\alpha-1} = 1 + r, \quad (3) \]

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:

\[ \mathcal{A}(K_p) = A^H. \]

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 is 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 our main results.

**Panglossian wages**

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

\[ w_P = (1 - a)A^H K_P > w_{MM} \]

There are two differences with respect to the benchmark. First, there is more capital \((K_P > K_{MM})\), which mechanically boosts the marginal product of labour. But we also have a factor \(A^H\) instead of \(E[A]\). The parallel with \(A(K_P)\) 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 \(A^H\).

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 \(AK^a\), which corresponds to gross domestic product (GDP). For any realisation of \(A\), GDP is increasing in \(K\). That is, more investment always means "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."
more output. However, in terms of investment efficiency, the relevant concept is expected net output, or *net domestic product* (NDP): $E [AK^a - K(1 + r)]$, because it accounts for capital depreciation.\(^\text{10}\) 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.

Of course, normative statements cannot be based on investment efficiency only. However, 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 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.\(^\text{11}\)

**Government guarantees may impair risk sharing**  Household face taxation risk. To assess welfare, we need to specify whether or not they have the means to hedge this risk. 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.

\(^\text{10}\)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.

\(^\text{11}\)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).
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). Overall, 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.\(^{12}\) Hence, in this case, government guarantees also impair risk sharing as banks refrain from passing the risk onto 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.\(^{13}\)

3 Beyond Pangloss: Financial engineering 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. Once they have means to do this, the key mechanism follows; the distortion from government guarantees is magnified by financial sophistication to the point that implied break-even productivity actually goes beyond Pangloss.

\(^{12}\)If households can short sell domestic bank equity, this restores perfect risk sharing, which corresponds to the case above.

\(^{13}\)A broadly overlooked stylised fact is that in the run up to the GFC in the US was marked by a divergence between gross and net domestic product. The ratio 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. This is, potentially, driven by factors including changes in the structure of the economy over long horizons, about which our model has nothing to say. In Appendix IV we explore the related movement in the capital-output ratio using numerous controls for confounders.
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 security $L$ in state $A^L$. These securities trade competitively in financial markets and are actuarially fairly priced (their prices are $q$ and $1 - q$, respectively). Here, for simplicity, we assume that the only constraint on the bank’s ex-ante trading position is that it must be self-financed.\footnote{In Section 4.1, we will introduce a parameter that allows the extent of this restriction to be varied.} 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). Note that in the next section, we explicitly introduce capital requirement and banking supervision. Both will affect the bank’s ability to use financial engineering to extract rent.

(ii) We continue to assume that labour is 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 given 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 $r^Lk$ 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 $A^L - (1 - a)A^H > 0$. If this condition 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, and the ability to trade is irrelevant.
**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:

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

In equilibrium, we get:

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

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 \(K_{BP}\)):

\[
\left( \rho_P^H - (1 + r) \right) k + \frac{(1-q)}{q} \rho_P^L k > 0,
\]

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:

\[
\left( \rho_{BB}^H - (1 + r) \right) k + \frac{(1-q)}{q} \rho_{BP}^L k = 0. \tag{6}
\]

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
Haldane and Alessandri (2009) document the growth of the trading book as a source of bank profits. They describe the period before the financial crisis as “an Alice in Wonderland world in which everybody had won and 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: A complete-disconnect result**

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

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

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. In fact, the implied equilibrium valuation corresponds to that in a fictitious economy where realised productivity is always impossibly high. Hence, we say that the equilibrium allocation is beyond Pangloss.

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. Nevertheless, this extreme outcome illustrates that financial engineering that is aimed at rent extraction from government guarantees can lead to a total

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\(^{15}\)Philippon (2015) documents the surge in the volume of intermediation and the overall increase in the income share of the finance industry.
disconnect between lending decisions and borrower repayment prospects: even in the most favourable state, the real investment associated with the marginal loan does not break even, and banks can only break even on the loan thanks to the associated trading book profit. Financial sophistication, therefore, generates an inefficiency in which expected economic surplus not only is lower, but is also ex-post inefficient in all possible states. This contrasts with models where the benefit of higher expected economic surplus comes at a cost of financial instability. This also contrasts with Korinek (2014) where financial engineering generates the need for bailouts of shareholders (not of depositors as in our model) in order to preserve ex-post production efficiency.

**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. \((1 - \alpha)A^H K_P\)), there are two effects that play in opposite direction. First, there is more capital \((K_{BP} > K_P)\), which tends to boost the wage. But there no longer is a direct Panglossian labour valuation effect \((E[A] \text{ appears on the right-hand-side instead of } A^H)\). 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.
3.3 The optimal trade in practice

We have considered a stylized trading environment, where banks can trade Arrow securities. In practice, existing trading opportunities do not span the full state space. Furthermore, the optimal trade constitutes blatant gambling with taxpayer money. It is more realistic to consider trades that can at least be disguised as legitimate ones. In this subsection, we show that the optimal trade can be implemented, under some conditions, through standard repo contracts.

We consider a repo contract through which the bank borrows against its banking book. In particular, the agreement specifies a notional interest rate $r$ (the risk free rate) and a haircut of $1 - \rho^H$. The size of its banking book is $k$, so the maximum amount the bank can borrow is $\frac{\rho^H k}{1+r}$.

In state $L$, the bank is in default. It can, therefore, not repurchase the collateral. So the counterpart keeps the collateral, which is worth $\rho^H k$, and (by construction, given the chosen value of the haircut) just breaks even. Now, assume that, in state $H$, the bank has enough cash to repurchase the collateral. The contractual price is $\rho^H k$, and the counterpart breaks even too.

Suppose that the bank uses the borrowed funds ($\frac{\rho^H k}{1+r}$) to pay a dividend at the beginning of the period.\(^{16}\) The lending problem of the bank then becomes:

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

Multiplying both terms by $\frac{1 + r}{q}$ and rearranging shows that the problem is equivalent to that considered in Lemma 3:

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

However, for such an implementation to be possible, the bank needs sufficient funds to repurchase the collateral in state $H$ (and, of course, to repay depositors). This

\(^{16}\)US and non-US banks had historically large dividend payouts in the pre-GFC period, and even for some quarters after the failure of Lehman Brothers (Acharya et al., 2011).
requires $k (\rho^H - (1 + r)) \geq \rho^L k$, that is:

$$\left(\rho^H - \rho^L\right) \geq (1 + r).$$

If this condition is not satisfied, the counterpart doesn’t break even under such a contract. A higher haircut is then needed, and the bank cannot fully exploit the guarantees (like it does in the Arrow securities set up).

This example illustrates that banks have incentives to innovate and engineer securities or trades that allow them to implement the optimal trade at a larger scale, but also suggests a role for bank supervision to prevent this. In the next section, we augment the model to capture these additional dimensions.

## 4 The exploitability of guarantees

We now introduce our general model, in which we show how the magnitude of the distortion depends crucially on the exploitability of government guarantees. Such exploitability decreases in the tightness of capital regulation and the intensity of 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 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 $\kappa$ must be at least a fraction $\gamma$ of lending. Given deposits are implicitly subsidised, the constraint will bind in equilibrium.\(^{17}\) We broadly interpret $\gamma$ 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 use a fraction $\phi$ of the proceeds from lending

\(^{17}\)In reality, capital requirement do not exactly bind, as banks would risk to breach them at the smallest negative shock, however there is fast growing evidence that they are essentially binding. See for instance Bahaj and Malherbe (2016) and Jiang et al. (2020).
as collateral. Accordingly, and for simplicity, we refer to $\phi$ 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 gambling with taxpayer money.

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

$$q \left( \rho^H k \left( 1 - (1 - \gamma)k (1 + r) + \frac{1 - q}{q} \phi^k k \right) \left( 1 + r \right) \right) - \gamma k (1 + r).$$  

(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 $\phi$ 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 $\gamma k$ 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 $\gamma$, and limited pledgeability $\phi$), the equilibrium capital stock, denoted $K_G$, is pinned down by the following

---

18In Section 3 above, we considered $\phi = 1$, which we interpreted as a self-financing condition for trades. Now we restrict $\phi \leq 1$ to capture more realistic limits on their trading activities due to supervision and counter-party risk concerns. In principle, we could allow $\phi > 1$, which should be interpreted as allowing banks to directly gamble with borrowed deposits. As long as there is a limit to this ($\phi < \infty$), our analysis remains directly valid. 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). In such a situation, we would have to explicitly model the limits of government fiscal capacity.
Corollary 4. In the general model, equilibrium implied break-even productivity is:

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

It is increasing in \( \phi \) and decreasing in \( \gamma \).

Again, \( \mathcal{A}(K) \) 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 (\( \phi \)). Intuitively, \( \mathcal{A}(K_G) \) increases with \( \phi \): 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 \( \mathcal{A}(K_G) \) 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 \( \gamma \) and \( \phi \). And:

\[
\begin{align*}
\mathcal{A}(K_G | \gamma = 0, \phi = 0) &= \mathcal{A}(K_P) \\
\mathcal{A}(K_G | \gamma = 0, \phi = 1) &= \mathcal{A}(K_{BP})
\end{align*}
\]

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

Remark 2. For all \( \phi \), there exist a \( \gamma \) 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, our model abstracts from some fundamental roles of banks. If we gave banks a role for liquidity provision (a la Diamond and Dybvig for instance), then a 100% capital requirement would be 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. This result provides foundation for regulation, such as the Volker Rule, that aims at curbing bank trading activities.

4.2 The scale of the capital distortion

We now explore the quantitative relevance of the distortion in a simple 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:

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

27
**Calibration**  The key parameters are those determining the exploitability of the guarantees ($\phi$ and $\gamma$). We shall consider a wide range of value for them, and we otherwise use a relatively standard calibration. The production function parameter, $a$, 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 $A^L - (1 - a)A^H > 0$ so that the firm can repay wages in full in state $A^L$.

**Results**  In Figure 1, 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 $\phi = 0.2$).\(^{19}\)

\(^{19}\)To understand our labels, recall that pledgeability increases with $\phi$ 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.
Figure 1: Model effects of varying pledgeability ($\phi$)

Notes: These figures show 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 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 1a shows the output distortion, and Figure 1b shows expected net output (the measure relevant for welfare). In each figure, we display benchmark curves and 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 increases the over-investment which therefore inflates GDP but lower welfare.

For instance, in Figure 1, our Pre-GFC regime ($\gamma = 0.04$ and $\phi = 0.9$) adds nearly 3% to GDP (compared to the MM economy) but 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 \((\gamma = 0.1 \text{ and } \phi = 0.2)\), the numbers are back to more modest level, not so far form the Panglossian outcome.

**4.3 The Role of Factor Supply Elasticity**

We have so far focused on the distortive effect on investment, and in the next subsection we will discuss the empirical relevance of the Beyond Pangloss channel. However, it is worth first making a general point on the role of production factors supply elasticity for how Panglossian distortions play out in equilibrium.

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

In our analysis, an environment with guarantees is necessary for a Panglossian distortion to operate. But, as highlighted in the previous section, sufficient exploitability is necessary for the associated inefficiency to be substantial. As just described, a tough regulatory environment can mitigate exploitability. So, banks have incentives to lobby against regulation and to innovate to circumvent it. 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 banks 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.

Pre-crisis growth of exploitability was 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.\(^2\)

In the aftermath of the GFC, government guarantees have, of course, not disappeared, though they may have become more limited (see, e.g. Berndt et al. (2020)). We do not want to argue there was 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 would mitigate 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.

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,

\(^2\)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).
2014). Or it could be fading memories of crises 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 The Beyond Pangloss distortion and the Great Distortion

The main message of the paper is that the Beyond-Pangloss distortion, driven by the exploitability of government guarantees in the financial system, can lead to inefficiently high GDP. A series of stylised facts about the behaviour of the US economy prior to the GFC are consistent with the predictions from our model. This includes the rise in the ratio of GDP to NDP, the growing importance of trading profits for financial firms, the loosening of lending standards and unusually large dividend payouts, as well as the behaviour of real wages, which seems to have grown strongly relative to productivity until 2000, and then stalled.

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, 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

\footnote{For instance, as shown by Bahaj and Malherbe (2020), since the implicit subsidy is state contingent, it may in fact make the bank \textit{undervalue} the marginal loan if its risk profile differs from that of the rest of the balance sheet.}
the economy since 2010 may relate to an unwinding of inefficiently high GDP before the GFC.

We propose a simple framework in the spirit of Solow (1957) to give a back-of-the-envelope estimate of the size of the distortion. The framework is described fully in Online Appendix IV. The idea is that, according to our model, the effects of the distortion could be measured by examining changes in the economy’s capital to output ratio. Of course, there are confounding factors affecting its behaviour. Over a long horizon, these include changes in the structure of the economy which make the investment to GDP ratio hard to compare. At short horizons, these include variation in productivity. Using available data to control for confounding factors leaves us with the residuals that cannot be explained in a frictionless model with a neoclassical production function that, taking to our model at face value, measure the distortion we have highlighted. We call these the Beyond-Pangloss Distortion (BPD).

In Figure 2 we plot an illustrative calculation from this approach as well as the upper and lower bounds that come from using different combinations of capital measures from different sources (e.g. BLS or BEA), different assumptions on confounding variables, and alternative detrending approaches. Based on the estimates, the distortion before the GFC is between 3% and 8% of GDP. This is sizeable given recessions typically give rise to a negative output gap of 1-3%.

It is important to recognise that this is only a back-of-the-envelope calculation but we have tried to control (in alternative ways) for many confounding variables. While it may be tempting to think that factors that we may not have controlled for adequately would reduce the scale of the distortion, that is not necessarily the case. As we described above, depending on the elasticity of supply of the investment goods, the Beyond Pangloss effects may not result in higher investment but rather would be seen in higher asset prices. This is consistent with the recent evolution of the relative price of

\[22\] We use independent measures of the evolution of these factors over time to filter out the effect a secular decline in interest rates affecting the cost of finance \(r_t\), the rate of depreciation \(\delta_t\) from BEA data on nominal capital consumption, and actual productivity relative to its expected value \((A_t/E_{t-1}[A_t])\) which we measure using capacity-utilisation-adjusted TFP estimates (Fernald (2012)) relative to a flexible time-series forecasting model. To account for other, unmeasured, confounding factors, especially over longer horizons, we remove different trends from the residuals to back out the part that is plausibly due to the (Beyond) Panglossian distortion.
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. There is evidence that structures increased in prices and in quantities in the run-up to the GFC (see e.g., Rognlie et al. (2018)). Our framework only examines the dimension of the distortion that is reflected in quantities, and so the impact of the distortion on prices is not captured. This suggests our BPD estimate is only a partial reflection of the overall distortion in reality.

The unwinding of the distortion has important implications for how one should evaluate the level of GDP in the years after the GFC.\textsuperscript{23} There are numerous papers evaluating the post-crisis behaviour of GDP. 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 (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

\textsuperscript{23}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).
the crisis, not the aftermath.

If we use our estimates to adjust the level of measured US GDP and to strip out the impact of the distortion, the gap between the measured GDP series and our counterfactual measure begins increasing during the late 1990s and is largest just before the GFC. The large difference suggests that the pre-crisis evolution of GDP was misleading. And while both measures suggest a significant decline 2009, the recovery of our adjusted series is 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 financial engineering that enables banks to exploit government guarantees fuels inefficient credit booms. The inefficiency can even occur in all states of the world. Rather than just reflecting greater financial instability, such inefficiency reflects a disconnect between lending decisions and borrower repayment prospects. The real investment associated with the marginal loan does not break even, and banks can only break even on the loan thanks to the associated trading book profit.

The second key message is that while capital regulation helps, other measures to reduce exploitability of government guarantees should go hand in hand. These could include the use of stress tests\textsuperscript{24} or other measures (such as the Volker Rule) that limit the use of loan books as collateral in financial trades.

We have argued that, along a number of dimensions, the US economy in the run up

\textsuperscript{24}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.
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.

While our discussion 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.
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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:
\[
\max_{n,k} E[\pi] = q \left[ A^H k^a n^{1-a} - nw - \rho^H k \right]^+ + (1 - q) \left[ A^L k^a n^{1-a} - nw - \rho^L k \right]^+, 
\] 
where \( \rho^s \) denotes the effective repayment from the representative firm in state \( s \).

In equilibrium, it must therefore be the case that:
\[
\begin{align*}
\rho^H k &= A^H k^a n^{1-a} - nw \\
\rho^L k &= A^L k^a n^{1-a} - nw
\end{align*}
\] 
(9)
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.

The bank solves:
\[
\max_{k} E = q \left[ \rho^H k - k(1 + r) \right]^+ + (1 - q) \left[ \rho^L k - k(1 + r) \right]^+. 
\] 
(10)
Free entry implies \( \rho^H, \rho^L \leq (1 + r) \), and condition 9 implies that \( \rho^L < \rho^H \). In turn, this implies that \( \rho^L < (1 + r) \), which establishes Lemma 2.

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25 For simplicity, we assume \( A^L \geq (1 - a)A^H \). 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.

26 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 \( \rho^H \)) 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 \( w \).
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 9, 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):

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

The FOCs (for firms that enter) are:

$$\begin{align*}
  a A^H k^n n^{1-a} &= 1 + r \\
  (1 - a) A^H k^n n^{-a} &= w.
\end{align*}$$

Given that $N = 1$, we get

$$a A^H K^H_0 = 1 + r, \tag{11}$$

which establishes Proposition 2, and, in turn,\textsuperscript{27}

$$w_P = (1 - a) A^H K^H_0, \tag{12}$$

which establishes Proposition 3.

To complete equilibrium characterisation, note that since $\rho^H_P = 1$ pins down $w_P$, and $\rho^L_P$ must adjust so that the firm zero-profit condition holds in equilibrium. That is, $\rho^L_P K_P = A^L K^H_0 - w_P$. Hence,

$$\rho^L_P = \left(1 - \frac{A^H - A^L}{\alpha A^H}\right) (1 + r). \tag{13}$$

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

$$\begin{align*}
  \tau_P (A^H) &= 0 \\
  \tau_P (A^L) &= - (A^L K^H_0 - (1 - a) A^H K^H_0 - K_P(1 + r)).
\end{align*} \tag{14}$$

\textbf{Proof of Proposition 4}

\textit{Proof.} First, $AK^a$ is strictly increasing in $K$. Second, expected net output, which is given 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.

\textsuperscript{27}On the one hand, if $w_P < a A^H K^H_0$, firms make strictly positive profit. On the other hand, if $w_P > a A^H K^H_0$, it is not possible for firms to be profitable enough to make a unit repayment to banks in the good state.
by $E[AK^a - K(1 + r)]$, reaches a global maximum in $K_{MM} < K_P$. 

**Proof of Proposition 5**

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

$$v_p = w_P - E[\tau_P] + x(1 + r).$$

Substituting for $w_P$ and $\tau_P$ (which are given by equations 12 and 14), we get:

$$v_p = E[A]K_a^a - K_P(1 + r) + x(1 + r).$$

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:

$$
\begin{aligned}
\rho^H k &= A^H k^a n^{1-a} - nw \\
\rho^L k &= A^L k^a n^{1-a} - nw 
\end{aligned}
$$

(15)

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

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

(16)

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

$$E[A]K_a^a_B = w_{BP} = q(1 + r)K_{BP}.
$$

(17)

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

$$w_{BP} = (1 - \alpha)E[A]K_a^a_B,
$$

(18)
which establishes proposition 7. Finally, together, equations 17 and 18 yield

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

Given that \( E[A] > qA^H \), this establishes proposition 6. \( \square \)

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 \( \rho^L \) and \( \rho^H \) from conditions 15 and \( w_{BP} \) from the analogous equation to 18, and rearranging, gives the result. \( \square \)