The Costs of Buyer Counterparty Risk in Long-Term Contracts

Online Appendix

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OA.1 Numerical Illustration

In this section, we calibrate the model to the Spanish electricity market, focusing on solar PV projects that started operating in 2022, and thus on investment decisions taken in 2021.[1] The goal is to illustrate the magnitude of the effects uncovered in this paper.

We compute the contract-market equilibrium under the assumption that all these projects, together with those that could have been built, compete for long-term contracts. We then quantify the effects of counterparty risk on prices, investment, and welfare, and how they are distributed between buyers and sellers, as well as the impact of public guarantees.

In the model, plants differ only in their investment cost, with capacity and output normalized to one. In practice, plants also differ in size and location-specific resource availability, so that average costs and risk premia vary across plants. We abstract from differences in capacity and focus on the heterogeneity in average costs and risk premia driven by differences in output due to local irradiation conditions.

OA.1.1 Estimating Contract Supply

We proceed in three steps. First, we recover the distribution of average costs of all potential plants. Second, we compute the expected profits that each plant would obtain in the spot market and under a fixed-price contract. Third, we compute the minimum

[1] For context, the volume of disclosed PPA deals in Spain in 2022 and 2023 was 3.9 GW and 4.67 GW, respectively (Pexapark, 2024).

contract price at which each plant breaks even and earns at least as much as in the spot market.

The supply of renewable capacity. We collect data from the Spanish official registry of renewable power plants (PRETOR, 2025) on all solar PV projects that began operating in 2022, including their capacity and location (panel (a) of Figure 1). We exclude plants in the Spanish islands, which are not connected to the mainland electricity network. Using irradiation data at each location (Pfenninger and Staffell, 2025), we compute the expected lifetime production of each of the 59 projects in our sample, assuming a lifetime of 25 years. Investment costs are taken from IRENA (2023)'s estimates for Spain in 2021, and a plant's average cost is the ratio of its total investment and operation and maintenance costs to its expected lifetime production. Differences in irradiation result in average costs ranging from €21/MWh to €24/MWh.[2]

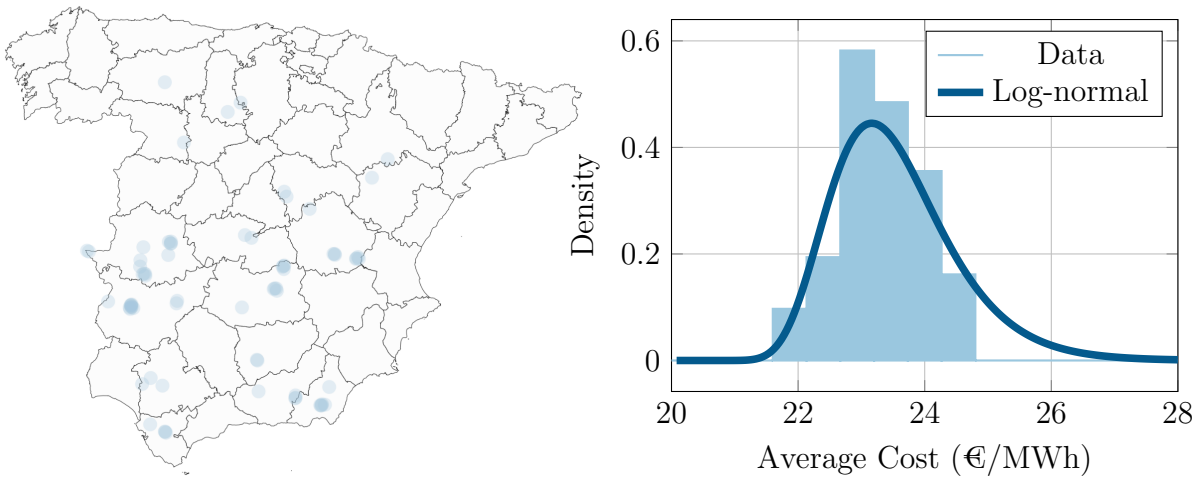
Since only profitable projects are built, the observed costs are a selected sample. To recover the distribution of all potential plants, we assume that average costs follow a log-normal distribution with a minimum of €20/MWh, truncated at the highest observed cost, €24/MWh, for the realized projects (panel (b) of Figure 1). In each of 100 simulations, we take 100 draws from this distribution, each corresponding to a plant with a capacity of 50 MW,[3] and we report average outcomes together with their range across simulations.

Spot and contract profits. Solar plants are paid the hourly spot price at the time of production. To capture uncertainty about future capture prices, we assume that they range between €0/MWh and €60/MWh, with an expected value of €24/MWh. This corresponds to a capture rate of 60% and an expected spot price of €40/MWh, in line with electricity futures traded in 2021 (OMIP, 2026).

Given this price distribution, we compute sellers' expected revenues under fixed-price contracts for $\gamma \in [0, 0.8]$. Sellers have mean-variance preferences, as in Proposition 2(ii),

[2]This range is in line with the winning bids in the renewable energy auction held by the Spanish regulator in January 2021. The minimum and maximum winning bids for solar PV were €14.89/MWh and €28.90/MWh, with a weighted average price equal to €24.47/MWh. The contract duration was 12 years, thus covering only about half of the plants' lifetimes.

[3]This capacity is particularly relevant in the Spanish market, as it corresponds to the threshold under which administrative authorization is carried out at the regional level. For higher capacities, a national authorization is also required. For this reason, in the data, we observe significant bunching at 50 MW. See Cuberes et al. (2025) for further details.



(a) New solar PV plants in Spain (2022) **(b)** Average Costs of Solar PV Plants

Figure 1: Solar PV Plants in Spain and their Average Cost Distribution

Notes: Panel (a) shows the locations of solar PV plants that began operating in Spain in 2022. Panel (b) plots the distribution of plants' average costs (in €/MWh), constructed by mapping solar irradiation at each plant's geographic location into costs using IRENA (2023)'s cost parameters for Spain in 2021. The figure also overlays a log-normal approximation to the distribution of average costs, including both realized plants (truncated at the highest cost observed in the data) and projects that were not built.

so that the risk premium of a plant with lifetime production q_i is $r_i = r_0 \text{Var}(p) q_i^2$. Since this premium is convex in production, normalizing all plants to 50 MW ensures that risk premia do not differ materially across plants.[4] We calibrate r_0 so that only 5% of the plants would invest profitably in the absence of long-term contracts.[5] For these plants, the risk premium is below €1.81/MWh, or 7.5% of the expected capture price. Table 1 summarizes the parameters and targets.

Figure 2 shows the resulting contract supply curves. Consistent with Lemma 3, they shift up as γ increases, and the shift is larger at higher prices, where the feedback loop is stronger. As a result, a higher γ both raises the price required to attract a given level of investment and reduces the scale of investment that the contract market can support.

[4]If plants had heterogeneous capacities, and therefore widely different production levels, the average cost ranking across plants could mechanically change with γ: a large plant that is more profitable than a smaller one at low γ could become less profitable at higher γ when risk premia matter more. Such rank reversals would be an artifact of scale in the risk-premium calculation, and are unlikely to hold in practice.

[5]This low share of profitable projects under spot-market trading is consistent with anecdotal evidence from industry practitioners. For instance, *"Having a PPA with a client committed to purchasing the plant's output in advance is a necessary condition to obtain a credit loan"* (El Mundo, 2025).

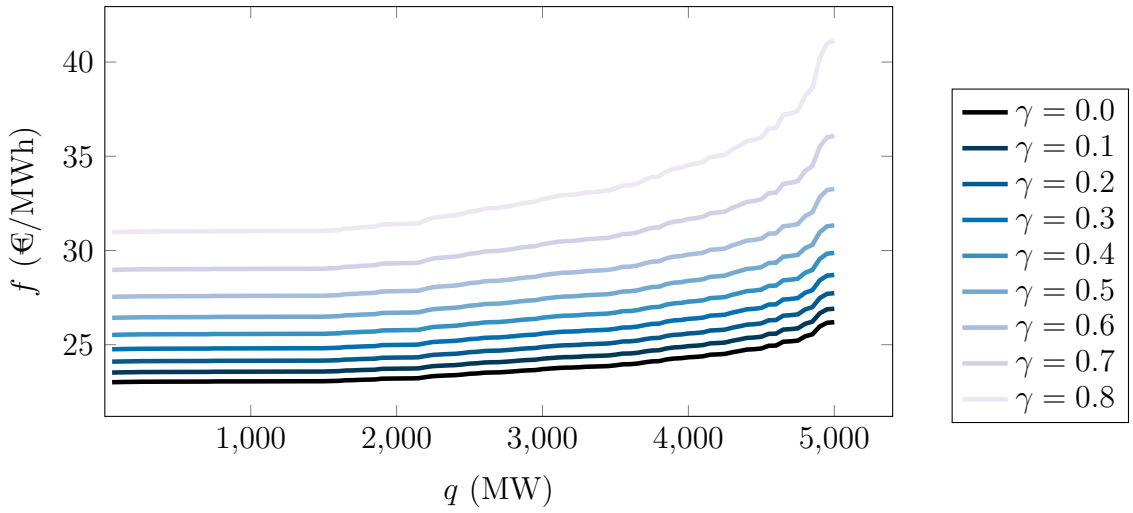


Figure 2: Contract Supply Curves

Notes: This figure shows the contract supply curves for different values of $\gamma \in [0, 0.8]$. Contract prices are expressed in €/MWh, and contract quantities are in MW. The case with $\gamma = 0$ corresponds to perfect contract enforceability. As γ goes up, the supply curves shift inwards, leading to higher prices and potentially constrained investment in equilibrium.

Parameters	**Target Values**
Plant size	50 MW
Number of simulations	100
Number of draws per simulation	100
Distribution of average costs	Log-normal($\mu = 1.23$, $\sigma = 0.27$), shift $a = 20$
Solar PV price distribution	$p = 60 \times x$, $x \sim$ Beta$(2, 3)$; $E(p) =$€24/MWh
Proportion of profitable plants	5% at spot prices, with $r_0 = 5.557783 \times 10^{-9}$
Cost of public funds (λ)	$[0, 0.1]$

Table 1: Parameter and Target Values

OA.1.2 Results: Baseline

We compute equilibrium outcomes for four levels of contract demand, and report them relative to the no-contract benchmark in Figure 3.

Long-term contracts generate substantial welfare gains, between €29M and €149M depending on θ and γ, or between €18,000 and €53,000 per MW of contracted capacity. These gains are severely eroded by counterparty risk: they fall by 78–80% as γ rises from 0 to 0.8 (panel (e)).[6] This is partly due to the feedback loop multiplier (panel

[6]Recall that we are abstracting from positive externalities arising from renewable investment. To the extent that the increase in γ reduces investment, the welfare reduction would be stronger in the presence of these externalities.

(f)), which amplifies the direct price effect by a factor of between 1 (in the absence of counterparty risk) and 1.17 (when counterparty risk is high but the market still clears).[7] The average contract price rises from about €23–24/MWh to €32/MWh (panel (a)), but the market adjusts mostly along the quantity margin (panel (b)). For low values of γ, contract demand is fully met when $\theta \leq 3{,}000$, and investment reaches the first-best level in some draws when $\theta \geq 3{,}500$ and $\gamma = 0$. Once γ is high enough for rationing to emerge, investment falls below contract demand. The welfare loss thus reflects both the contraction in investment and the higher risk premium borne on all contracts.

The distributional effects follow Proposition 6 (panels (c) and (d)). While the market clears, sellers pass the cost of counterparty risk on to buyers through higher prices, so that seller surplus is unaffected and buyers bear the full welfare loss. Once demand is rationed, the price extracts all buyer surplus, and further increases in γ reduce investment and seller surplus. Counterparty risk thus harms buyers collectively: total welfare falls, and buyers capture a progressively smaller share of it.

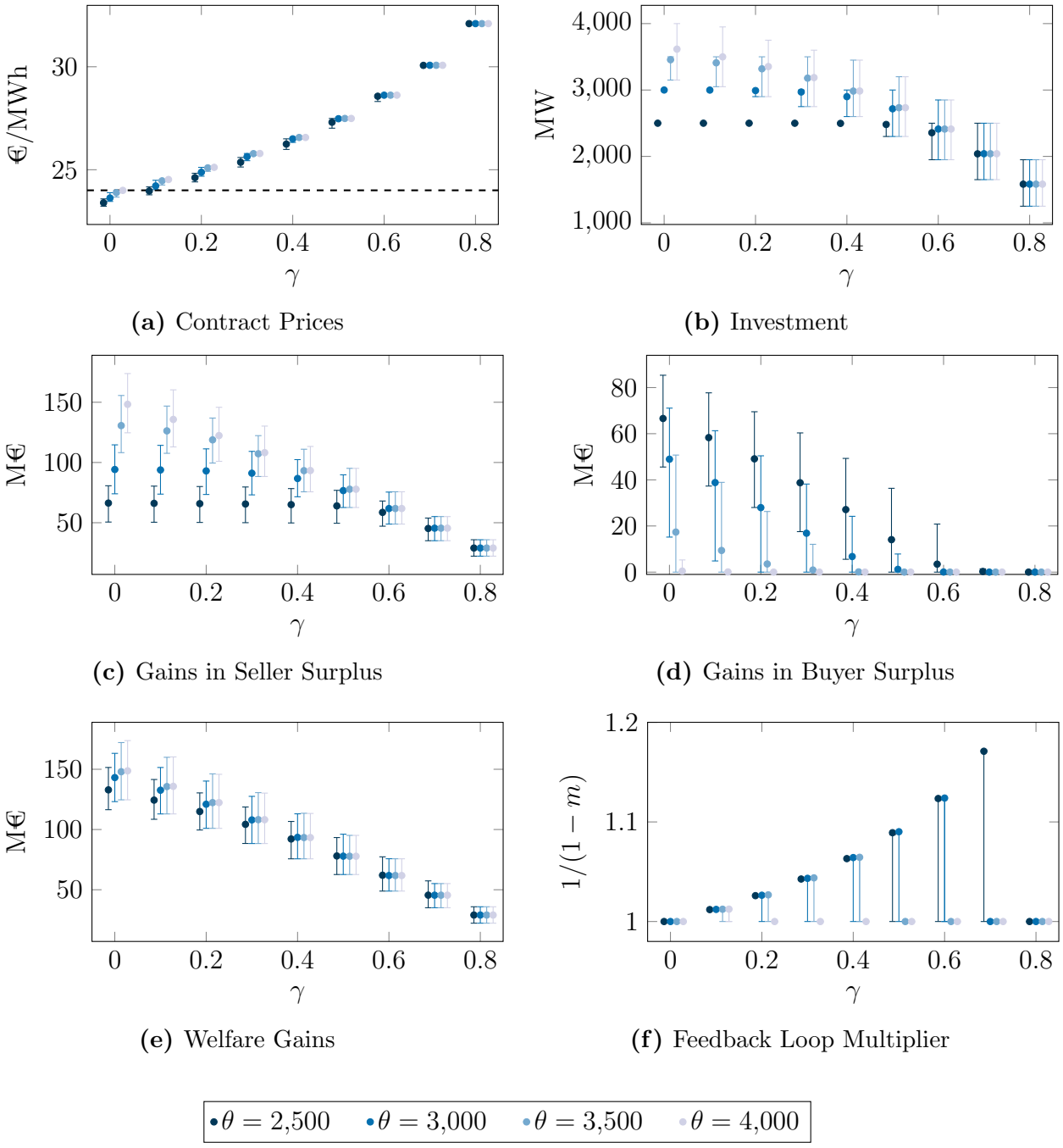
Finally, the simulations illustrate the limits of promoting contract demand (Section 3.3). For low values of γ, welfare increases with θ, but this ranking reverses for $\gamma \in [0.6, 0.8]$. Figure 4 shows that, for $\gamma = 0.3$, welfare is non-monotonic in contract demand, and that further increases in θ become ineffective once they systematically result in rationing ($\theta > 3{,}500$).

OA.1.3 Results: Public Guarantees

We now quantify the effects of public guarantees relative to the no-intervention baseline. We decompose the welfare effects into three components: the change in buyer surplus, which includes the cost of financing the policy, as is common in practice through surcharges on electricity bills; the change in seller surplus, which includes the reduction in risk premia; and the distortion due to the shadow cost of public funds.

Figure 5 shows that, with $\lambda = 0.1$, guarantees raise average welfare by up to €45M. The gains are largest when counterparty risk is high and contract demand is limited. In that case, guarantees mostly lower contract prices, so that the reduction in counterparty risk is passed on to buyers, who capture most of the gains net of the financing cost. As demand increases, guarantees mostly expand investment, the price reduction becomes

[7] Recall that, when there is contract rationing, the adjustment is through investment. Since expected payments are fixed at $E(p)$, there is no amplification through prices.



(a) Contract Prices **(b)** Investment

(c) Gains in Seller Surplus **(d)** Gains in Buyer Surplus

(e) Welfare Gains **(f)** Feedback Loop Multiplier

Figure 3: The Contract Market Equilibrium in the Baseline Scenario

Notes: These figures report equilibrium outcomes in the no-intervention scenario for four levels of contract demand (2,500 MW, 3,000 MW, 3,500 MW, and 4,000 MW), across values of $\gamma \in [0, 0.8]$ for the average of one hundred simulations, as well as the range across simulations, capturing variation from the cost draws. The case $\gamma = 0$ corresponds to perfect contract enforceability. As γ increases, contract prices in panel (a) rise. Investment in panel (b) is constant in γ up to $\hat{\gamma}$, the threshold above which contract rationing arises for a given demand level; for $\gamma > \hat{\gamma}$, investment declines. Seller surplus, buyer surplus, and welfare are net of their corresponding values in the no-contracts case. Seller surplus in panel (c) is constant up to $\hat{\gamma}$ and falls thereafter, while the opposite holds for buyer surplus in panel (d). Welfare in panel (e), defined as the sum of buyer and seller surplus, declines monotonically in γ and is strictly below the first-best except in some draws when $\theta \geq 3{,}500$ and $\gamma = 0$. Welfare is higher for higher demand levels when γ is low, but this ranking reverses for $\gamma \in [0.6, 0.8]$, although the differences become very small. Panel (f) reports the feedback loop multiplier $1/(1-m)$, which equals one at $\gamma = 0$ and under rationing, where there is no amplification, and otherwise increases with γ.

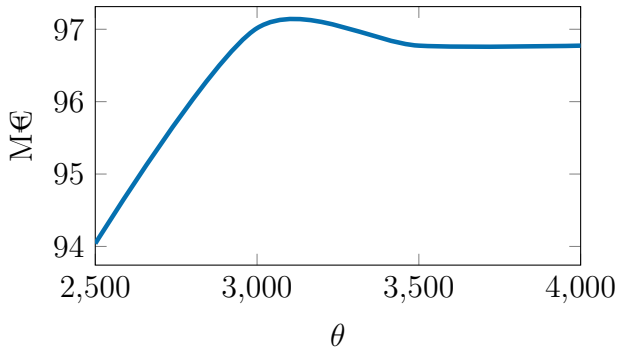


Figure 4: Average Welfare as a Function of Contract Demand for $\gamma = 0.3$

smaller, and the gains shift towards sellers, while buyers finance a larger volume of guarantees. When $\theta = 4{,}000$, guarantees can induce overinvestment, and buyers end up worse off. Moreover, average welfare gains hide heterogeneity across cost draws: when γ is low and $\theta = 4{,}000$, guarantees reduce welfare in some draws (Figure 6).

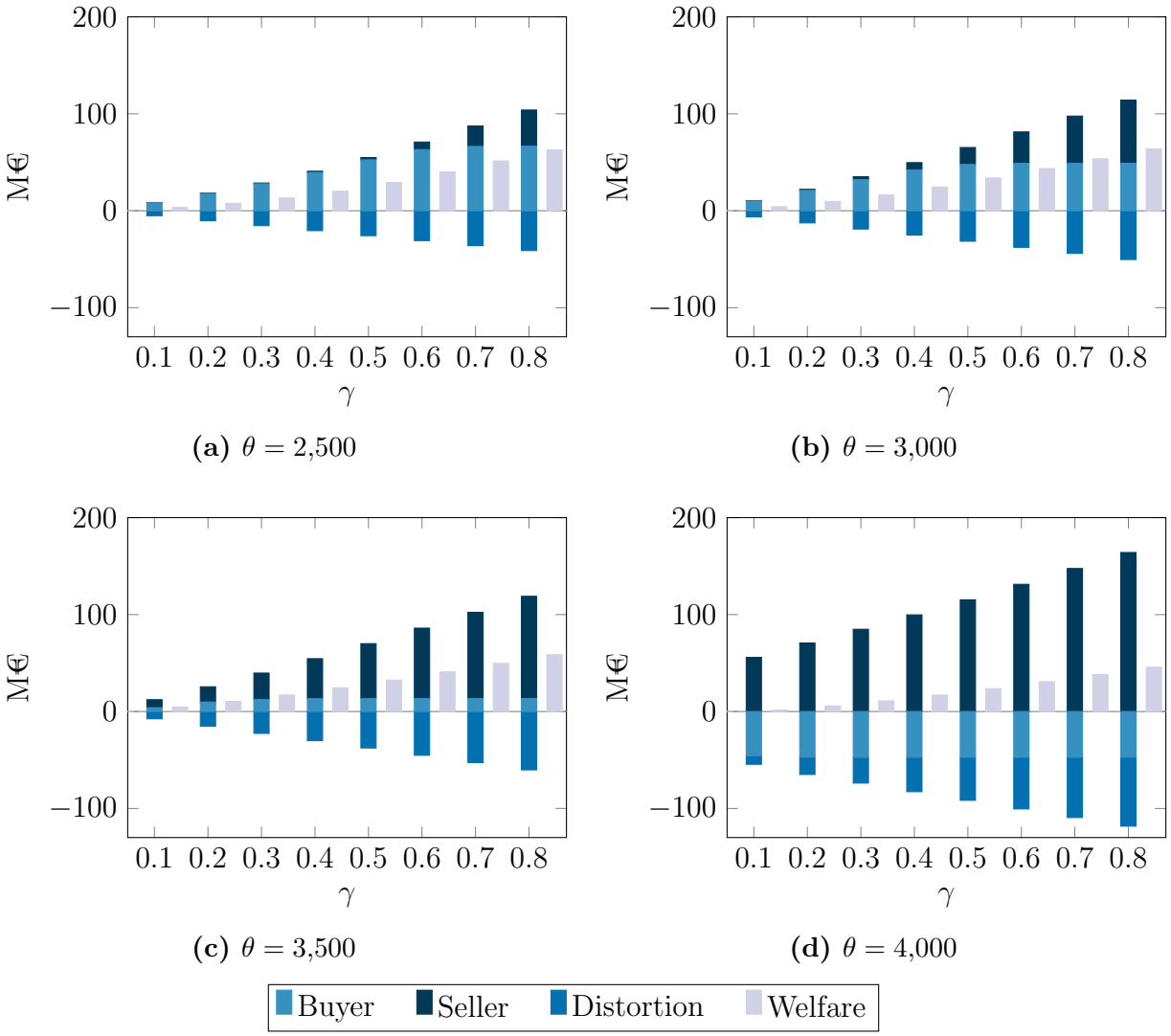
OA.2 A Microfoundation Based on Financial Frictions

As in the baseline model, consider a seller who needs to invest an amount c to build one unit of capacity. This capacity produces one unit of output that is sold using a fixed-price contract. This contract yields a revenue of f if it is honored by the buyer, but with probability γ it can be renegotiated by the buyer.

The investment can be financed with debt, B, or using equity from its investors. The seller is subject to limited liability. Financiers are competitive. After the market revenue has been realized, the firm is required to return an amount D so that financiers break even in expected terms.

In the spirit of Gale and Hellwig (1985), we assume that the revenue of the seller is not observable to the financier. The financier needs to pay an amount K if it wants to verify the revenue of the seller. Hence, the financier will pay K if and only if the seller defaults. Clearly, a financing contract must result in $D \leq f$ or else the seller will always default. This means that the expected verification cost is $K\gamma\Phi(D)$.

Investment takes place in the first period, while the output and debt repayment occur in the second period. We normalize the financier's discount rate to 0. In line with papers like Darmouni et al. (2026), we assume that equity holders discount the future at a rate $\delta > 0$. This assumption makes equity costlier for the seller and makes debt preferable if

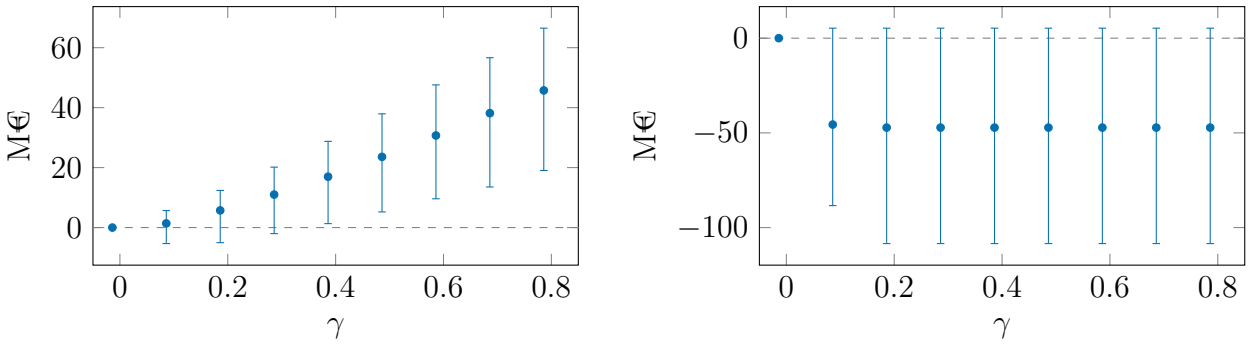


(a) $\theta = 2{,}500$ **(b)** $\theta = 3{,}000$

(c) $\theta = 3{,}500$ **(d)** $\theta = 4{,}000$

Figure 5: Welfare Effects of Public Guarantees

Notes: For each level of contract demand, the figures report the effect of public guarantees on average welfare (gray bars) and decompose it into three components: the effect on buyer surplus net of transfers to sellers when guarantees are exercised (light blue bars), seller surplus (dark blue bars), and the welfare loss from the distortionary cost of public funds (medium blue bars), computed assuming $\lambda = 0.1$. The effects are computed relative to the no-intervention baseline.



(a) Welfare **(b)** Buyers' Profits

Figure 6: Welfare and Buyer Surplus Changes under Public Guarantees for Different Values of γ

Notes: Panels (a) and (b) show the change in welfare and buyers' profits, with the corresponding range for $\theta = 4{,}000$, relative to the no-intervention scenario.

the verification cost is sufficiently low.

The break-even condition of the financier implies that

$$B = D(1 - \gamma\Phi(D)) + \gamma \int_0^D p\phi(p)dp - K\gamma\Phi(D).$$

The first term is the expected repayment when the revenue of the seller is above D and the financier is repaid in full. The second term is the revenue of the seller that the financier can recover upon default. Verification costs are deducted from these two flows.

Since financiers obtain zero profits, the objective function of the seller can be written as

$$\Pi_S = -(c - B) + \frac{1}{1+\delta}\left[P(f,\gamma) - D(1 - \gamma\Phi(D)) - \gamma \int_0^D p\phi(p)dp\right],$$

since in the second period it obtains the revenue flow from the contract, $P(f,\gamma)$, net of the amount that the financier recovers with and without default. Replacing B, we obtain

$$\Pi_S = P(f,\gamma) - \frac{\delta}{1+\delta}\left(P(f,\gamma) - D(1 - \gamma\Phi(D)) - \gamma \int_0^D p\phi(p)dp\right) - K\gamma\Phi(D) - c.$$

Let us write

$$C(f,\gamma,D) = \frac{\delta}{1+\delta}\left(P(f,\gamma) - D(1 - \gamma\Phi(D)) - \gamma \int_0^D p\phi(p)dp\right) + K\gamma\Phi(D),$$

and define

$$R(f,\gamma) \equiv \min_{D \leq f} C(f,\gamma,D). \tag{OA.1}$$

Two possibilities need to be considered. First, if f is sufficiently low, $D^* = f$. Otherwise, under basic regularity conditions,[8] it results from the following first-order condition,

$$-\frac{\delta}{1+\delta}(1-\gamma\Phi(\hat{D})) + K\gamma\phi(\hat{D}) = 0.$$

This first-order condition reflects the trade-off that the seller faces when choosing the face value of debt. Raising D allows the seller to marginally replace expensive equity with debt. Since the financier only collects this additional unit when the seller does not default, which happens with probability $1-\gamma\Phi(D)$, the marginal benefit is $\frac{\delta}{1+\delta}(1-\gamma\Phi(D))$, namely, the equity premium saved on the additional funds raised. However, a higher D also enlarges the set of states in which the seller defaults. Since default can only occur when the contract is renegotiated and the spot price falls below D, the marginal increase in the probability of default is $\gamma\phi(D)$, and each additional default requires the financier to incur the verification cost K. The optimal level of debt, $\hat{D}(\gamma)$, equates these two margins. An increase in γ reduces the marginal benefit, as fewer states yield full repayment, and raises the marginal cost, as default becomes more likely. Both effects lead the seller to rely less on debt and more on equity, the more expensive source of financing. This is a key channel through which buyer counterparty risk raises the seller's cost.

We summarize the optimal debt decision as $D^* = \min\left\{f, \hat{D}(\gamma)\right\}$. As a result, we can write the function

$$R(f,\gamma) = \begin{cases} K\gamma\Phi(f) & \text{if } f \leq \hat{D} \\ \frac{\delta}{1+\delta}\left[P(f,\gamma) - \hat{D}(1-\gamma\Phi(\hat{D})) - \gamma\int_0^{\hat{D}} p\phi(p)dp\right] + K\gamma\Phi(\hat{D}) & \text{otherwise.} \end{cases}$$

Proposition OA.1. *The function $R(f,\gamma)$ satisfies Properties 1 to 3.*

Proof. First, notice that $R(f,\gamma)$ is a continuously differentiable function with derivatives

$$\frac{\partial R}{\partial f}(f,\gamma) = \begin{cases} K\gamma\phi(f) & \text{if } f \leq \hat{D} \\ \frac{\delta}{1+\delta}\left[1-\gamma\Phi(f)\right] & \text{otherwise,} \end{cases}$$

and

$$\frac{\partial R}{\partial \gamma}(f,\gamma) = \begin{cases} K\Phi(f) & \text{if } f \leq \hat{D} \\ -\frac{\delta}{1+\delta}\int_{\hat{D}}^{f}\Phi(p)dp + K\Phi(\hat{D}) & \text{otherwise.} \end{cases}$$

It is immediate that $\frac{\partial R}{\partial f}(f,\gamma) > 0$.

Regarding Property 1, differentiability has been established above. If $f = 0$, $D^* = 0$ and $R(0,\gamma) = K\gamma\Phi(0) = 0$. If $\gamma = 0$, it is optimal to choose $D^* = f$, implying $R(f,0) = 0$.

[8] In particular, we require that $K\phi(0) < \frac{\delta}{1+\delta}$ and that $\frac{\delta}{1+\delta}\phi(D) + K\phi'(D) > 0$ for all $D \in [0,1]$.

Finally, if $f = 1$ and $\gamma = 1$, the seller always obtains the spot price and it incurs the same cost as if no contract existed,

$$R(1,1) = r \equiv \frac{\delta}{1+\delta}\left(\int_{\hat{D}(1)}^{1}(p - \hat{D}(1))\phi(p)dp\right) + K\Phi(\hat{D}(1)).$$

Regarding Property 2, it has already been established that $\frac{\partial R}{\partial f}(f,\gamma) > 0$. Regarding the derivative of the seller's profit, notice that when $D^* = \hat{D}(\gamma)$, $\frac{\partial \Pi_S}{\partial f}(f,\gamma) = \frac{1}{1+\delta}(1 - \gamma\Phi(f)) > 0$. When $D^* = f$,

$$\frac{\partial \Pi_S}{\partial f}(f,\gamma) = 1 - \gamma\Phi(f) - K\gamma\phi(f).$$

Since from the FOC, at $D^* = f$,

$$-\frac{\delta}{1+\delta}(1 - \gamma\Phi(f)) + K\gamma\phi(f) \leq 0,$$

we conclude that

$$\frac{\partial \Pi_S}{\partial f}(f,\gamma) \geq \frac{1}{1+\delta}(1 - \gamma\Phi(f)) > 0.$$

Finally, regarding Property 3, we need to show that

$$(1 - \gamma\Phi(f))\frac{\partial R}{\partial \gamma} + \left[\int_0^f (f - p)\phi(p)dp\right]\frac{\partial R}{\partial f} > 0.$$

When $D^* = f$, this expression is positive because both $\frac{\partial R}{\partial \gamma}$ and $\frac{\partial R}{\partial f}$ are positive. When $D^* = \hat{D}(\gamma)$, this expression becomes $(1 - \gamma\Phi(f))\left[\frac{\delta}{1+\delta}\int_0^{\hat{D}}\Phi(p)dp + K\Phi(\hat{D}(\gamma))\right] > 0$. □

OA.3 Additional Analyses

In this section, we extend some of the results reported in the paper.

OA.3.1 Increasing Marginal Cost of Pre-existing Capacity

In the baseline model, the spot price does not depend on investment. In section 5.5, we allow the pre-existing capacity to have an increasing marginal cost, so that new investment, which displaces the most expensive existing units, lowers spot prices. We argue that the main results carry over, and that endogenous spot prices strengthen the risk externality. Here we provide the technical details of this analysis.

Buyers' total demand is one unit, and the pre-existing capacity has a linear merit order with stochastic intercept. With new capacity q, the existing capacity serves residual demand $1 - q$, and the spot price is

$$p = p_0 + \beta(1 - q),$$

where $\beta \geq 0$ is the slope of the merit order and p_0 is distributed according to $\Phi(p_0)$ on the unit interval, with expectation $E(p_0)$. The baseline model corresponds to $\beta = 0$. Investment thus shifts the spot price distribution down, $E(p|q) = E(p_0) + \beta(1-q)$. The marginal social value of the q-th unit of new capacity is the expected cost of the existing unit it displaces, $E(p|q)$, which is decreasing in q. All agents are atomistic and take equilibrium investment q^* as given when forming expectations about spot prices.

We assume that the risk premium is invariant to deterministic shifts in the seller's payoff, as under mean-variance preferences. For any contract price f, let $x \equiv f - \beta(1-q)$ denote the contract price relative to the level of spot prices. Since renegotiation occurs when $p < f$, that is, when $p_0 < x$, the buyer's expected payment and the seller's risk premium are

$$P(f, \gamma \,|\, q) = P(x, \gamma) + \beta(1-q), \qquad R(f, \gamma \,|\, q) = R(x, \gamma),$$

where P and R denote the baseline objects computed with the distribution of p_0. As a result, a contract price f with investment q is equivalent to a baseline contract price x for a seller with *effective cost* $c - \beta(1-q)$. In particular, the probability of renegotiation at a given contract price, $\gamma\Phi\big(f - \beta(1-q)\big)$, increases with investment. Let $\bar{f}(\gamma)$, $\tilde{\gamma}(c)$, and $m(x, \gamma)$ denote the baseline maximum price, contracting threshold and dissipation rate, and define the effective cost of the marginal investor as

$$\tilde{c}(q) \equiv G^{-1}(q) - \beta(1-q),$$

which is strictly increasing in q. First-best investment satisfies $\tilde{c}(q^{FB}) = E(p_0)$, and investment without contracts satisfies $\tilde{c}(q^0) = E(p_0) - r$. To focus on the new effects, we assume in line with Assumption 1 in the main text that $\theta > q^0$, so that all investment is contracted in equilibrium.

Proposition OA.2. *Let $\hat{\theta}(\gamma)$ be defined by $\tilde{c}\big(\hat{\theta}(\gamma)\big) = E(p_0) - R\big(\bar{f}(\gamma), \gamma\big)$.*

(i) [Equilibrium] *If $\theta \leq \hat{\theta}(\gamma)$, equivalently $\gamma \leq \hat{\gamma} \equiv \tilde{\gamma}\big(\tilde{c}(\theta)\big)$, the market clears at $q^* = \theta$. The equilibrium price is $f^* = x^* + \beta(1-\theta)$, where x^* solves $P(x^*, \gamma) - R(x^*, \gamma) = \tilde{c}(\theta)$, and an increase in γ raises f^* as in equation (7). Otherwise, demand is rationed, $q^* = \hat{\theta}(\gamma) < \theta$, at $f^* = \bar{f}(\gamma) + \beta(1-q^*)$, and an increase in γ reduces investment and raises the contract price.*

(ii) [Risk externality] *If* $\theta < \hat{\theta}(\gamma)$,

$$\frac{dW^*}{d\theta} = E(p \,|\, \theta) - P(f^*, \gamma \,|\, \theta) - \theta \, \frac{m(x^*, \gamma)}{1 - m(x^*, \gamma)} \left[\frac{1}{g(c^*)} + \beta \right]. \tag{OA.2}$$

For $\gamma \in (0, 1)$, *there exists* $\tilde{\theta}(\gamma) < \hat{\theta}(\gamma)$ *such that welfare is strictly decreasing in* θ *on* $\big(\tilde{\theta}(\gamma), \hat{\theta}(\gamma)\big)$, *and constant for* $\theta > \hat{\theta}(\gamma)$.

(iii) [Distributional effects] *If* $\gamma \leq \hat{\gamma}$, *an increase in* γ *leaves seller profits unchanged and reduces buyer profits. If* $\gamma > \hat{\gamma}$, *it reduces both seller and buyer profits.*

Part (i) shows that the characterization of the equilibrium carries over. The only difference is that the equilibrium in the contract market must be determined jointly with the spot price distribution, which depends on q^*. When demand is rationed, the marginal investor satisfies $G^{-1}(q^*) = E(p|q^*) - R\big(\bar{f}(\gamma), \gamma\big)$, so

$$\frac{dq^*}{d\gamma} = -\frac{g(c^*)}{1 + \beta g(c^*)} \, \frac{dR\big(\bar{f}(\gamma), \gamma\big)}{d\gamma} < 0.$$

The term $\beta g(c^*)$ reflects the fact that lower investment raises spot prices, which partly offsets the fall in investment.

Part (ii) formalizes the discussion in Section 5.5. Relative to equation (12), the risk externality in (OA.2) contains an additional term, proportional to β. Attracting an additional investor requires the contract price to rise relative to spot prices, for two reasons. First, the marginal investor has a higher cost, $1/g$, as in the baseline. Second, the additional investment lowers spot prices by β. Lower spot prices both reduce the seller's revenue upon renegotiation and make renegotiation more likely at any given contract price. Both effects are amplified by the feedback loop and are borne by all inframarginal contracts. Hence, promoting contract demand is less effective when the merit order is steeper.[9]

Part (iii) shows that endogenous spot prices change the distributional effects of counterparty risk in one respect. In the baseline, buyers are unaffected by counterparty risk when demand is rationed (Proposition 6), since they obtain no surplus from contracting. Here, the fall in investment raises spot prices, which harms all buyers, whether they

[9]The same logic applies to any family of spot price distributions $\Phi(p|q)$ that is decreasing in q in the sense of first-order stochastic dominance. Following the steps in the proof, the last term in (OA.2) becomes $\theta\big[m/g + \partial R/\partial q - m\,\partial P/\partial q\big]/(1-m)$, with partial derivatives evaluated at f^*. Since $\partial P/\partial q \leq 0$, the additional term is positive whenever lower spot prices (weakly) raise the risk premium at a given contract price, $\partial R/\partial q \geq 0$.

contract or not. With an upward-sloping merit order, counterparty risk instead harms buyers in both configurations.

Proof of Proposition OA.2. (i) A seller with cost c earns $\Pi_S = P(x,\gamma) - R(x,\gamma) - \big(c-\beta(1-q)\big)$ under a contract, and $E(p_0) - r - \big(c-\beta(1-q)\big)$ in the spot market. Buyers accept f if and only if $P(f,\gamma|q) \le E(p|q)$, that is, $x \le \bar{f}(\gamma)$. Given q^*, the contract market is therefore the baseline market in terms of x and effective costs. The market clears at $q^* = \theta$ if and only if the marginal seller, with effective cost $\tilde{c}(\theta)$, breaks even at some $x \le \bar{f}(\gamma)$. Since $\tilde{c}$ is increasing, this holds if and only if $\theta \le \hat{\theta}(\gamma)$, equivalently $\gamma \le \tilde{\gamma}\big(\tilde{c}(\theta)\big)$ by Corollary 1. Otherwise, $x^* = \bar{f}(\gamma)$, and since $P(\bar{f}(\gamma),\gamma) = E(p_0)$, the marginal investor satisfies $\tilde{c}(q^*) = E(p_0) - R\big(\bar{f}(\gamma),\gamma\big)$, so $q^* = \hat{\theta}(\gamma)$. This is unique since $\tilde{c}$ is strictly increasing. The comparative statics in γ follow from those of x^* in the baseline (Proposition 3). In the rationed case, $R\big(\bar{f}(\gamma),\gamma\big)$ is increasing in γ (Proposition 3(ii)), so q^* falls and $f^* = \bar{f}(\gamma) + \beta(1-q^*)$ rises.

(ii) Welfare is the value of the displaced production, net of investment costs and of the risk premia borne on contracts:

$$W^* = \int_0^{q^*} E(p|s)\,ds - \int_0^{G^{-1}(q^*)} c\,dG(c) - q^* R(x^*,\gamma).$$

If the market clears, $q^* = \theta$, and differentiating gives $dW^*/d\theta = E(p|\theta) - G^{-1}(\theta) - R(x^*,\gamma) - \theta\,(\partial R/\partial x)\,dx^*/d\theta$. By the break-even condition, $G^{-1}(\theta) + R(x^*,\gamma) = P(x^*,\gamma) + \beta(1-\theta) = P(f^*,\gamma|\theta)$. Differentiating the break-even condition gives $dx^*/d\theta = \big(1/g + \beta\big)/\big[(1-m)\,\partial P/\partial x\big]$. Using $\partial R/\partial x = m\,\partial P/\partial x$ yields (OA.2). As $\theta \to \hat{\theta}(\gamma)$, $x^* \to \bar{f}(\gamma)$ and $P(f^*,\gamma|\theta) \to E(p|\theta)$, so the first two terms cancel. The last term remains strictly negative, since $m(\bar{f}(\gamma),\gamma) > 0$ for $\gamma \in (0,1)$. The existence of $\tilde{\theta}(\gamma)$ follows by continuity. For $\theta > \hat{\theta}(\gamma)$, the equilibrium does not depend on θ.

(iii) If $\gamma \le \hat{\gamma}$, the marginal seller breaks even, so a seller with cost c earns $G^{-1}(\theta) - c$, which is independent of γ. Buyers pay $P(f^*,\gamma|\theta) = G^{-1}(\theta) + R(x^*,\gamma)$, which increases in γ by Property 3, as in the proof of Proposition 4. If $\gamma > \hat{\gamma}$, a seller with cost $c \le c^*$ earns $c^* - c$, which falls with q^*. All buyers expect to pay $E(p|q^*) = E(p_0) + \beta(1-q^*)$, which rises as q^* falls. □

OA.3.2 Public Guarantees with Partial Coverage

In Section 4.2, we show that a guarantee with full coverage and actuarially fair fees implements the perfect-enforcement outcome for any seller preferences (Corollary 3), and that, if fees fall short of the expected payout, full coverage is not optimal when public funds are costly (Proposition 9). In this section, we characterize guarantees with partial coverage under mean-variance preferences, and quantify the effects of partial coverage.

We use the notation of Section 4.2. The guarantee covers a share $\kappa \in [0,1]$ of the shortfall $f - p$ upon default, and the seller pays a fee that recovers a share $\psi \in [0,1]$ of the expected payout. Contract demand is unchanged, with maximum price $\bar{f}(\gamma)$. The expected shortfall per contract is $f - P(f,\gamma)$, so the expected payout is $\kappa(f - P(f,\gamma))$ and the expected net fiscal cost per contract is $(1-\psi)\kappa(f - P(f,\gamma))$.

The seller's payoff is $y_\kappa = f-(1-\kappa)(f-y)$, where y is its payoff without the guarantee. Under mean-variance preferences, $\mathrm{Var}(y_\kappa) = (1-\kappa)^2\mathrm{Var}(y)$, so the risk premium becomes $R^{PG}(f,\gamma,\kappa) = (1-\kappa)^2 R(f,\gamma)$, and seller profits are

$$\Pi_S^{PG}(f,\gamma,c) = P(f,\gamma) - (1-\kappa)^2 R(f,\gamma) + (1-\psi)\kappa(f - P(f,\gamma)) - c. \tag{OA.3}$$

The *insurance* component removes a share $1-(1-\kappa)^2$ of the risk premium. The *subsidy* component transfers the unrecovered expected payout, $(1-\psi)\kappa(f-P(f,\gamma))$, to the seller. Fees affect only the latter. Correspondingly, the dissipation rate becomes

$$m^{PG}(f,\gamma) \equiv \frac{(1-\kappa)^2\,\partial R/\partial f}{\partial P/\partial f + (1-\psi)\kappa\gamma\Phi(f)}.$$

Proposition OA.3. *Suppose sellers have mean-variance preferences. A guarantee with coverage κ and fee share ψ has the following effects:*

(i) It weakens the feedback loop, $m^{PG}(f,\gamma) \le (1-\kappa)^2 m(f,\gamma)$, with equality if $\psi = 1$. The loop is switched off only if $\kappa = 1$.

(ii) It induces overinvestment if and only if $\theta > G(E(p))$ and

$$(1-\psi)\kappa\big(\bar{f}(\gamma) - E(p)\big) > (1-\kappa)^2 R\big(\bar{f}(\gamma),\gamma\big).$$

In particular, there is no overinvestment if fees are actuarially fair, $\psi = 1$.

Part (i) shows that partial coverage weakens the feedback loop rather than disabling it. However, since the risk premium is quadratic in the uncovered share, partial coverage

removes most of it. With $\kappa = 0.8$, as in the schemes discussed in Section 4.2, the risk premium on every contract falls by 96% at a given price, while the expected payout falls by 20%.

Part (ii) shows that overinvestment stems from the subsidy component. Because buyers do not bear the full price in the event of default, they are willing to pay $\bar{f}(\gamma) > E(p)$. A guarantee that transfers the resulting expected shortfall to sellers lets those with $c > E(p)$ invest. Lower coverage and higher fees both shrink this transfer, and actuarially fair fees eliminate it. This provides an alternative to the price cap discussed in Section 4.2.

Under mean-variance preferences, the logic behind Proposition 9 in the main text is particularly transparent. The residual risk premium is quadratic in the uncovered share, whereas the fiscal cost and the overinvestment induced by the subsidy component are linear in coverage. With $\psi < 1$, the last units of coverage therefore barely reduce the risk premium, but they raise the fiscal cost and overinvestment at a constant rate.

Two caveats apply. First, an actuarially fair fee requires the guarantor to price the buyer's default risk. Under adverse selection (Section 5.4), a uniform fee would cross-subsidize opportunistic buyers. Second, defaults are perfectly correlated across contracts, since they all occur when spot prices fall. The guarantor therefore bears aggregate risk. Our assumption that the government is risk-neutral, bearing only the cost λ of its expected net disbursements, is what makes it a better risk-bearer than sellers. It also explains why private insurers, who cannot diversify this risk away, may fail to provide such guarantees.

Numerical illustration. To quantify these effects, we solve the model numerically using the same parametrization as in Section OA.1 of this Appendix, for the free guarantee ($\psi = 0$) and coverage levels $\kappa \in \{0.7, 0.8, 0.9, 1\}$. Figure 7 reports the contract price, the cost of public funds and welfare under partial coverage relative to full coverage, for four demand levels θ and default probabilities $\gamma \in \{0.2, 0.4, 0.6, 0.8\}$. Welfare is net of the cost of the public funds used to pay out the guarantees when buyers default. In all these cases the market clears, and when $\theta \leq 3{,}500$ investment equals θ regardless of coverage.

Lower coverage raises contract prices. With full coverage, the contract price equals its level under perfect enforcement: the guarantee removes the risk premium, and the

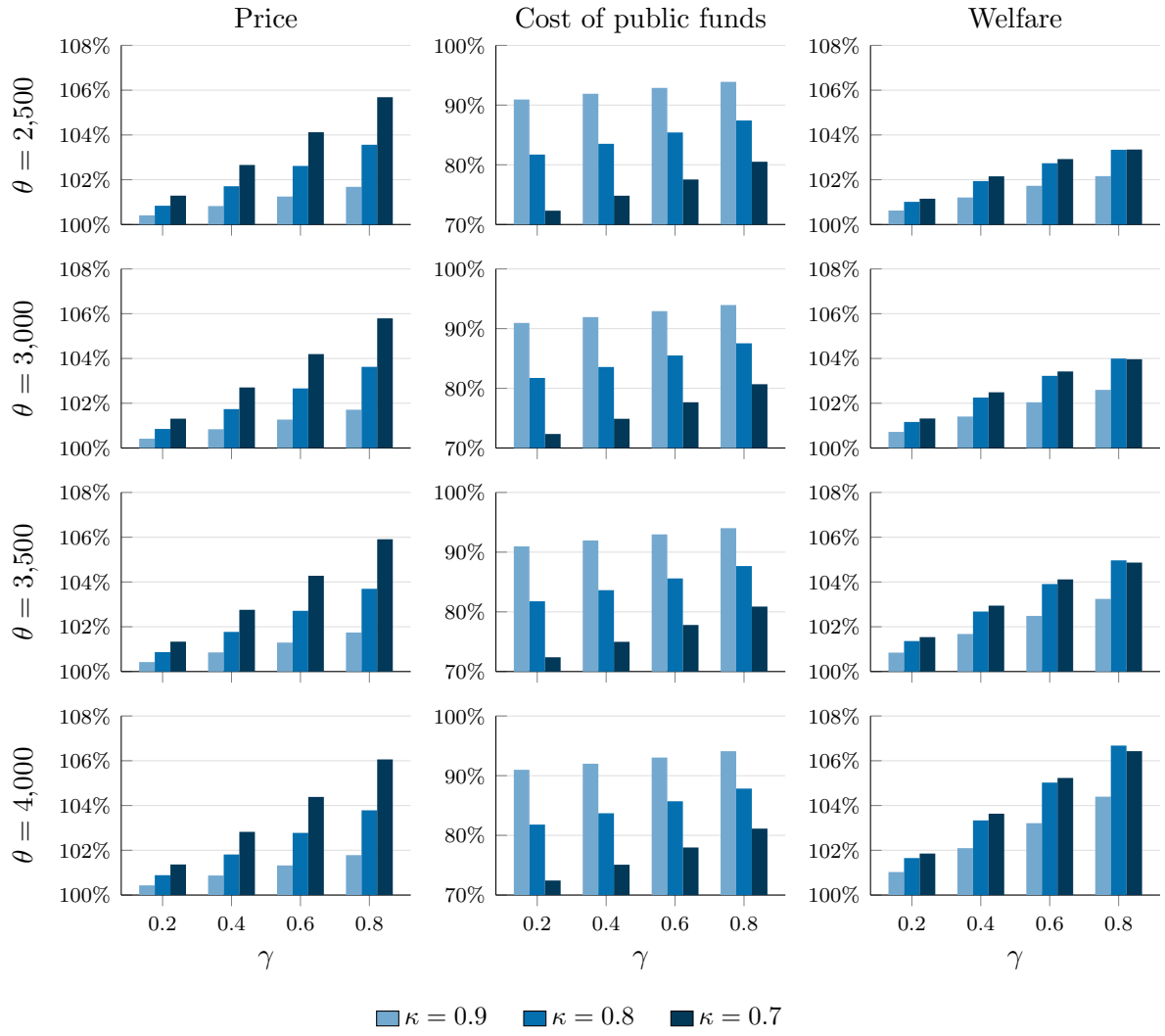


Figure 7: Effects of Partial Coverage Relative to Full Coverage ($\kappa = 1$)

Notes: Each bar shows the outcome with coverage κ as a percentage of the outcome with full coverage, $\kappa = 1$ (100%). The left column shows the contract price. The middle column shows the cost of the public funds used to pay out the guarantees when buyers default. The right column shows welfare, net of that cost. Rows correspond to demand levels θ. The guarantee is free ($\psi = 0$), and the remaining parameters are as in Section OA.1.

subsidy component exactly offsets the expected shortfall. With partial coverage, sellers bear part of the risk and receive a smaller transfer, so they require a higher price. The increase is moderate. It grows with γ and with the uncovered share, ranging from 0.4% to 1.8% when $\kappa = 0.9$ and from 1.3% to 6.1% when $\kappa = 0.7$.

Lower coverage also reduces the cost of public funds, to between 82% and 88% of its full-coverage level when $\kappa = 0.8$. This cost falls by less than coverage because the higher contract price raises the shortfall that the guarantee covers upon default. Despite higher prices, net welfare is higher under every partial-coverage level we consider than under full coverage, as predicted by Proposition 9 in the main text. Moving from $\kappa = 1$ to $\kappa = 0.8$ raises net welfare by between 1.0% and 6.7%. These gains are larger when default risk is higher and when demand is larger, because the fiscal savings scale with the expected payout, $\kappa\theta\gamma\big(f - E(\tilde{p})\big)$. The residual risk premium, in contrast, is only $(1-\kappa)^2 = 4\%$ of its level without the guarantee.

Lowering coverage from 0.8 to 0.7 raises welfare further when $\gamma \leq 0.6$, but not when $\gamma = 0.8$. At that level, the gains vanish for $\theta = 2{,}500$ and turn into losses for higher demand. As default risk rises, the risk premium that partial coverage leaves to sellers grows, which pushes optimal coverage up. Within the coverage levels we consider, welfare is maximized at $\kappa = 0.7$ when $\gamma \leq 0.6$ and at $\kappa = 0.8$ when $\gamma = 0.8$ (except for $\theta = 2{,}500$). Optimal coverage is therefore well below one, as in the guarantee schemes observed in practice.

Proof of Proposition OA.3. (i) From (OA.3), $\partial\Pi_S^{PG}/\partial f = \partial P/\partial f + (1-\psi)\kappa\gamma\Phi(f) - (1-\kappa)^2\partial R/\partial f$, since the derivative of the expected shortfall, $f - P(f,\gamma)$, with respect to f is $1 - \partial P/\partial f = \gamma\Phi(f)$. Since the denominator of m^{PG} is at least $\partial P/\partial f$, with equality if $\psi = 1$, $m^{PG} \leq (1-\kappa)^2 m$. Moreover, since $m < 1$, Π_S^{PG} is increasing in f.

(ii) Since Π_S^{PG} is increasing in f, investment is maximal at $f = \bar{f}(\gamma)$, where $P = E(p)$, so the expected shortfall is $\bar{f}(\gamma) - E(p)$. By (OA.3), the marginal investor at this price has cost $c^{PG} = E(p) + (1-\psi)\kappa\big(\bar{f}(\gamma) - E(p)\big) - (1-\kappa)^2 R\big(\bar{f}(\gamma), \gamma\big)$. Investment exceeds $G(E(p))$ if and only if $c^{PG} > E(p)$ and $\theta > G(E(p))$. □

OA.3.3 Public Subsidies

We now analyze an alternative policy not considered in the main text. Suppose that the regulator can resort to public subsidies, a common policy instrument for addressing

inefficiencies caused by underinvestment. Unconditional subsidies—i.e., transfers paid to all investors regardless of whether they sign a fixed-price contract or not—encourage investment, but they do not directly improve contract liquidity or address the distortions generated by counterparty risk.[10] For this reason, we focus on *uniform and conditional* subsidies $T \geq 0$, paid only to sellers who sign a fixed-price contract. As with guarantees, we assume that financing this policy entails a per-unit social cost of public funds, $\lambda \geq 0$.

A conditional subsidy relaxes sellers' participation constraint. A seller with cost c signs a contract if $\Pi_S(f, \gamma, c) + T \geq \max\{\Pi_S^0(c), 0\}$, so that the minimum price it is willing to accept, $\underline{f}(\gamma, c, T)$, decreases with T in both regions of the supply curve. As a result, the threshold $\hat{\gamma}(T)$ below which the market clears, with $\hat{\gamma}(0) = \hat{\gamma}$, is increasing in T.

If $\gamma \leq \hat{\gamma}(T)$, the market clears at $q^* = \theta$, and the equilibrium price $f^*(T)$ is pinned down by the break-even condition of the marginal seller, $c^* = G^{-1}(\theta)$,

$$\Pi_S(f^*, \gamma, c^*) + T \;=\; 0. \tag{OA.4}$$

By the Implicit Function Theorem,

$$\frac{\partial f^*}{\partial T} = -\frac{1}{1 - m(f^*, \gamma)} \frac{1}{\partial P / \partial f},$$

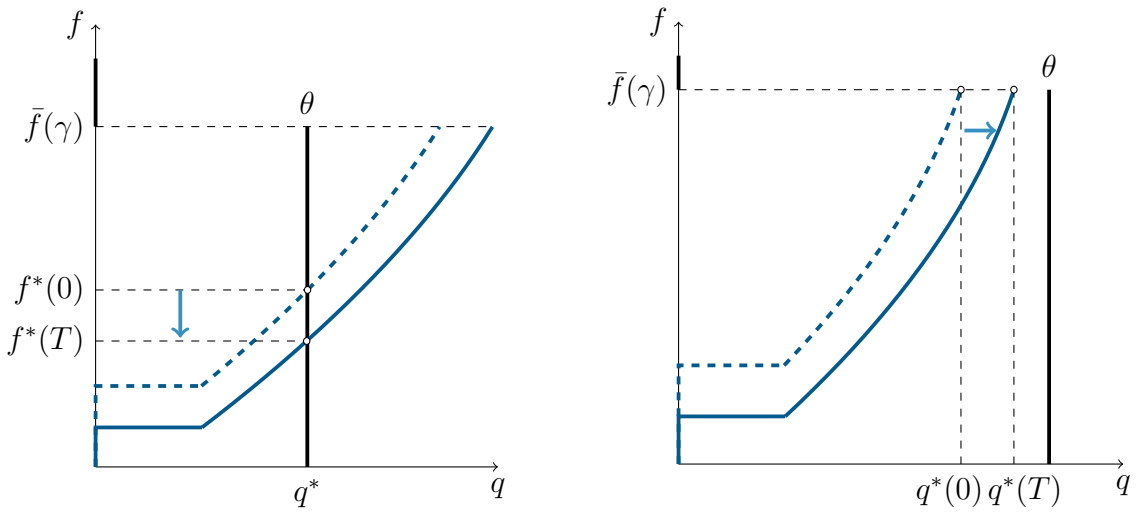
so the feedback loop now works in reverse: by lowering the contract price, the subsidy reduces the probability of renegotiation and the risk premium, which lowers the price further. Unlike guarantees, however, subsidies do not disable the loop; they only weaken it by lowering the price. If $\gamma \leq \hat{\gamma}(0)$, so that the market clears with and without subsidies (Figure 8(a)), the welfare change is

$$W^{PS}(\gamma, T) - W^*(\gamma) = \theta \left[R(f^*(0), \gamma) - R(f^*(T), \gamma) - \lambda T \right].$$

The subsidy lowers the risk premium on all contracts, at the cost of the public funds disbursed.

If instead $\gamma > \hat{\gamma}(T)$, demand is rationed with and without subsidies, and the price remains at $f^* = \bar{f}(\gamma)$ (Figure 8(b)). The subsidy then only affects investment: since $P(\bar{f}(\gamma), \gamma) = E(p)$, the marginal investor has cost $c^*(T) = E(p) - R(\bar{f}(\gamma), \gamma) + T$, and

[10] Unconditional subsidies are widespread. For example, in the US, renewable producers receive a Production Tax Credit (PTC) per unit of renewable output, or investment subsidies, regardless of whether output is backed by long-term contracts (Aldy et al., 2023; Chen, 2025).



(a) Low γ **(b)** High γ

Figure 8: The Effect of Public Subsidies

Notes: In panel (a), $\gamma \leq \hat{\gamma}(0)$, so the market clears with and without subsidies, which reduce the contract price from $f^*(0)$ to $f^*(T)$ without affecting investment. In panel (b), $\gamma > \hat{\gamma}(T)$, so demand is rationed with and without subsidies. Subsidies raise investment from $q^*(0)$ to $q^*(T)$, while the contract price remains at the maximum price that buyers are willing to pay, $\bar{f}(\gamma)$. The dashed lines represent supply without subsidies.

the welfare change is

$$W^{PS}(\gamma, T) - W^*(\gamma) = \int_{c^*(0)}^{c^*(T)} \big(E(p) - R(\bar{f}(\gamma), \gamma) - c\big) g(c)\, dc - q^*(T)\lambda T < 0.$$

The subsidy attracts sellers whose cost exceeds the social value of their output net of the risk premium, $c > E(p) - R(\bar{f}(\gamma), \gamma)$, so it reduces welfare even when public funds are costless.

In the remaining intermediate case, $\gamma \in (\hat{\gamma}(0), \hat{\gamma}(T)]$, the subsidy restores market clearing, combining the price effect with an expansion of investment.

In sum, subsidies are a second-best policy: they do not address the fundamental source of inefficiency, namely counterparty risk, and they improve welfare only insofar as they lower contract prices, and with them the risk premium on all contracts. When demand is rationed, they merely expand investment at a price that leaves the risk premium unchanged, which reduces welfare. A subsidy large enough to drive the contract price to zero would eliminate renegotiation altogether, since $\Phi(0) = 0$, and would implement the equilibrium without counterparty risk (Proposition 1) when $\theta < G(E(p))$, but at the cost of paying $T = G^{-1}(\theta)$ on every contract, which is only worthwhile if public funds are costless.

Subsidies thus compare unfavorably with guarantees. In particular, a guarantee that charges an actuarially fair fee dominates any conditional subsidy, while involving no expected fiscal cost.

Corollary OA.1. *For any $\lambda \geq 0$ and any seller preferences, a guarantee with full coverage and actuarially fair fees yields (weakly) higher welfare than any conditional subsidy.*

The reason is that the guarantee removes the source of the friction, whereas the subsidy only compensates sellers for it.

Proof of Corollary OA.1. By Corollary 3 in the main text, the guarantee attains $W^*(0)$ for any seller preferences. Under perfect enforcement, the sellers with the lowest costs contract, up to the efficient level, and no risk premium is borne on contracts. This maximizes welfare subject to at most θ contracts being signed and spot investors bearing r. A conditional subsidy does not relax either constraint, leaves a non-negative risk premium on every contract, and costs $\lambda T \geq 0$ per contract. Hence, $W^{PS}(\gamma, T) \leq W^*(0)$. □

OA.4 Additional Extensions

In this section, we develop additional extensions.

OA.4.1 Renegotiation Cost

This section extends the model in the main text by introducing a cost of renegotiation. We use the notation of the main text throughout.

In our baseline model, we assumed that buyers could renegotiate the contract at no cost. We now relax this assumption by introducing a renegotiation cost, $z > 0$. We implicitly assume that contract default entails a cost at least as high as z, as otherwise renegotiation would never take place. Because this cost helps align the incentives of buyers and sellers, the incidence of counterparty risk is reduced.[11]

We need to consider two cases. First, if $z \geq f$, buyers never find it optimal to renegotiate, as the cost of doing so exceeds any potential price savings. Hence, buyers' and sellers' profits coincide with the case of perfect contract enforcement.

[11] Similar results would emerge if, instead, we allowed buyers to derive a direct benefit from long-term contracts arising, for instance, because the seller produces clean energy that helps buyers meet regulatory requirements or attain Corporate Social Responsibility targets.

Second, if $z < f$, buyers only renegotiate the contract if $p < f - z$, in which case they incur the additional cost z. Their profits become

$$\Pi_B(f, \gamma) = v - \gamma \int_0^{f-z} (p + z)\, \phi(p)\, dp - f\,[1 - \gamma\Phi(f - z)]\,.$$

As buyers' profits decrease in z, the maximum contract price they are willing to pay also decreases in z, and equals $E(p)$ when $z = E(p)$.

For sellers, profits become

$$\Pi_S(f, c) = \gamma \int_0^{f-z} p\, \phi(p)\, dp + f\,[1 - \gamma\Phi(f - z)] - R(f - z, \gamma) - c.$$

Since sellers' contract profits are increasing in z, the contract-supply curve shifts downward as z rises.

Combining these demand and supply effects, the increase in the renegotiation cost z drives the equilibrium outcome closer to the perfect-enforcement benchmark. In particular, depending on the value of γ, equilibrium prices go down and investment (weakly) goes up. The intuition is that higher renegotiation costs better align the incentives of buyers and sellers, thereby mitigating the inefficiencies associated with imperfect contract enforcement. In the limit, as z approaches $E(p)$ and renegotiation becomes prohibitively costly, contracts are effectively perfectly enforceable.

OA.4.2 Dynamic Interactions and Time-Varying Prices

Our analysis is based on a static model, despite the long-term nature of the contracts. The implicit assumption is that the relevant uncertainty concerns the future price level, rather than short-run price fluctuations, so that a single price realization fully determines the incentives to renegotiate or to remain in the contract. The conclusions of the baseline framework extend naturally to environments in which price realizations are highly correlated over the lifetime of the contract.

In this section, we show that when prices are only weakly correlated over time, the buyer is more likely to honor the contract in the first period due to its option value in the future. Interestingly, default can occur with positive probability in the first period, as it may be preferable for the buyer to default rather than to renegotiate the contract.

To illustrate these ideas, we extend our one-period model to two periods. To keep the model comparable to the static benchmark, we make two assumptions. First, we assume that after the contract is signed, with probability γ the buyer can renegotiate

in both periods and with probability $1-\gamma$ this renegotiation is never possible. Second, we normalize first- and second-period profits according to the weights $1-\delta$ and δ, with $\delta \in [0, 1/2]$.[12] Since contracts span both periods, when price realizations are perfectly correlated over time, the outcome coincides with the static setting, and investment is unaffected.

Consider now the case where price realizations are *i.i.d.* across the two periods, following the same distribution $\Phi(p)$. When renegotiation is possible, in each period, after observing the price realization, the buyer decides whether to make a take-it-or-leave-it offer to lower the contract price under the threat of default, and the seller then decides whether to accept it. If the parties renegotiate at $t = 1$, the new contract price also applies at $t = 2$ and may be renegotiated again in the second period. If default occurs at $t = 1$, all future transactions remain unhedged, and both buyer and seller rely on the spot market.

The game is solved by backward induction. If default occurs in the first period, the contract is terminated, and both the seller and the buyer are exposed to spot prices. Otherwise, the second-period problem reduces to the static model.

At $t = 1$, the buyer may attempt to renegotiate the contract price to some $f_1 < f$. When the spot price p falls below f, the seller is willing to accept renegotiation as long as the new price f_1 is at least equal to a threshold $\underline{f}_1$, defined by the seller's indifference between continuing under the contract and switching to the spot market in both periods,

$$(1-\delta)\underline{f}_1 + \delta\left[\int_0^{\underline{f}_1} p\phi(p)dp + \underline{f}_1\left(1-\Phi\left(\underline{f}_1\right)\right)\right] = (1-\delta)p + \delta E(p). \tag{OA.5}$$

However, this same condition also pins down the buyer's indifference between renegotiating and defaulting (and then buying at the spot price). As a result, there is no scope for mutually acceptable renegotiation: any f_1 the seller would accept leaves the buyer better off defaulting, while any f_1 that makes the buyer prefer renegotiation is rejected by the seller. This is not surprising since, at this stage, the continuation game is effectively zero-sum, as the investment decision is already sunk.

The previous result, however, does not imply that the buyer will always honor the contract in the first period. On the contrary, when p is sufficiently low, the buyer may prefer to default by making an offer $f_1 < \underline{f}_1$, anticipating that the seller will reject it and

[12] Restricting attention to $\delta \leq 1/2$ ensures that first-period profits receive at least as much weight as second-period profits.

default will ensue. In that case, trade in both periods takes place at spot prices, and the buyer's net present value of profits is

$$(1-\delta)(v-p)+\delta\big(v-E(p)\big),$$

instead of the payoff from staying in the contract,

$$(1-\delta)(v-f)+\delta\Pi_B(f,1).$$

Comparing these expressions implies that the buyer defaults at $t=1$ if and only if p falls below $\hat{p}$, defined as

$$\hat{p}\equiv f-\frac{\delta}{1-\delta}\int_f^1(p-f)\phi(p)dp\leq f. \tag{OA.6}$$

Intuitively, the buyer trades off the first-period gain from default, $f-\hat{p}$, against the expected loss from forgoing hedging in the second period. When the second period receives sufficiently little weight (i.e., when δ is small), default occurs with positive probability in equilibrium (i.e., $\hat{p}>0$).

Hence, an important difference relative to the baseline case (or to the case in which prices are perfectly correlated over time) is that default can arise in equilibrium as a strictly preferred option for the buyer, relative to renegotiation. The reason is that renegotiation offers no upside to the seller: it lowers the price in the first period, $f_1<f$, and it also lowers the effective ceiling on the contract price in the second period, when renegotiation may occur again. Default, by contrast, does not require the seller's consent and can therefore be used by the buyer to extract additional rents.

Overall, relative to the case of perfect price correlation over time, for a given f the contract is more likely to be honored—with probability $(1-\gamma\Phi(\hat{p}))$ rather than $(1-\gamma\Phi(f))$—because it provides an option value to the buyer. Yet there remains a positive probability that the contract is renegotiated in the second period or not honored in the first period. Thus, as in the baseline model, contracts do not provide sellers with a perfect hedge: limited enforceability raises risk premia relative to full enforceability, which in turn depresses investment below the efficient level.

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