

# Quantitative Aggregate Effects of Asymmetric Information

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In this note I propose a calibration of the model in Kurlat (forthcoming) to try to assess the potential magnitude of the effect of asymmetric information on the economy's response to shocks. One clarification is in order. The model does not attempt to be a representation of everything that takes place in business cycles. Labour supply is fixed and there are no frictions in product markets so the determination of output is trivial. The focus of the model is on how asymmetric information affects the way shocks are transmitted to investment and therefore that is the effect that the calibration seeks to quantify. I view this as a first step in constructing a full-blown business-cycle model that incorporates asymmetric information about asset qualities.

## Calibration

I define the time period to be one year and set the discount factor to  $\beta = 0.95$  and the depreciation rate to 0.1, which requires setting  $\gamma = \frac{0.9}{1-\lambda}$ . The production function is Cobb-Douglas with a capital share of 0.4. Other than that, the two parameters to set are the fraction of projects that become lemons each period,  $\lambda$ , and the distribution of investment-productivities across entrepreneurs,  $F(A)$ .

Doms and Dunne (1998) report the distribution of growth rates of capital, defined as  $g_{K_t} = \frac{I_t - \delta K_{t-1}}{0.5(K_{t-1} + K_t)}$  across US manufacturing firms, which is highly skewed. In the model, I can compute  $g_K$  as a function of  $A$  for each entrepreneur and I choose  $F(A)$  so that the skewness coefficient of the distribution of  $g_K$  approximately matches its empirical counterpart, which is around 3.4. I choose a simple functional form such that the density is a step function with two levels and

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an upper bound normalized to 1, setting

$$f(A) = \begin{cases} 13.9 & \text{if } A \in [0, 0.0647] \\ 0.1069 & \text{if } A \in (0.0647, 1] \end{cases}$$

The right calibration of  $\lambda$  is less straightforward. One source of guidance comes from the fact that the probability that a firm becomes a lemon is the only source of idiosyncratic risk in the model, so the dispersion of idiosyncratic asset returns can be used to choose values for  $\lambda$ . I look at two different ways of doing this.

The first approach uses data from returns on IPOs. Assume that an investor in an IPO corresponds to a Buyer in the model. This requires assuming that investors in IPOs do not know the quality of the firm they are investing in while the original shareholders do, and the difference in information disappears in the course of one year, all of which are admittedly strong assumptions. In the model, if the Buyer has bought a lemon (which happens with probability  $\lambda^M$ ), his gross return will be 0; instead if he has bought a nonlemon, his gross return will be  $\gamma \left(1 + (1 - \lambda) \frac{r}{p}\right)$ .<sup>1</sup> Therefore the idiosyncratic component of the standard deviation of returns for IPO investors should be

$$\sigma_{IPO} = [\lambda^M (1 - \lambda^M)]^{0.5} \gamma \left(1 + (1 - \lambda) \frac{r}{p}\right)$$

Carter et al. (1998) report a value of 1.59 for a three-year horizon, which translates to  $\sigma_{IPO} = 0.78$  at a one-year horizon (assuming iid lognormal daily returns).

A second approach is to use idiosyncratic stock returns for the stockmarket as a whole rather than just IPOs. However, it is harder to argue that in the stock market as a whole sellers are truly better informed than buyers. One (imperfect) way to relate the model to the stockmarket is to compute what would happen in the model if equally uninformed entrepreneurs were able to trade projects with each other (something that in the model they are not able to do). The returns for Buyers from those trades can then be compared to stock market returns. In these symmetrically uninformed trades, the fraction of lemons that a Buyer would obtain would be  $\lambda$  rather than  $\lambda^M$ , so the standard deviation of returns would be

$$\sigma_{SM} = [\lambda (1 - \lambda)]^{0.5} \gamma \left(1 + (1 - \lambda) \frac{r}{p}\right)$$

Campbell et al. (2001) report a value of  $\sigma_{SM} = 0.25$ .

I set  $\lambda = 0.1$ , which produces  $\sigma_{IPO} = 0.57$  and  $\sigma_{SM} = 0.36$ , not quite the same as the

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<sup>1</sup>This assumes that the risk that the nonlemon he has bought becomes a lemon *next* period is counted as part of next period's risk and not this period's. It turns out that doing it one way or the other makes little difference quantitatively.

empirical values but roughly on the right order of magnitude. Since the model is very stylized, the calibration should be taken with some scepticism; I also check how the model would behave with  $\lambda = 0.05$  and  $\lambda = 0.15$ .

## Results

Using the parameter values described above, I compute the steady state of the model (which can easily be shown to exist) and then simulate three possible shocks: a negative productivity shock that reduces  $Z$  by 3% (approximately the order of magnitude that would produce a typical recession), a negative investment shock that reduces  $A$  by 3% for every entrepreneur and a negative information shock that increases  $\lambda$  from 0.1 to 0.11.

Figure 1 shows investment to capital ratios across entrepreneurs in the steady state. In the steady state,  $A^M = 0.16$  so entrepreneurs with lower  $A$  become Buyers and do not invest.  $p = 2.02$  so  $\frac{\gamma}{p} = 0.49$  and entrepreneurs with higher  $A$  become Sellers: they sell all their old projects in order to invest. Entrepreneurs with intermediate  $A$  become Keepers. Given  $F(A)$ , 91% of entrepreneurs are Buyers, 4% are Keepers and 5% are sellers, which results in the skewed distribution of investment that matches the US data. Despite a relatively low number of lemons overall, projects that are sold are highly adversely selected, so  $\lambda^M = 0.67$ .

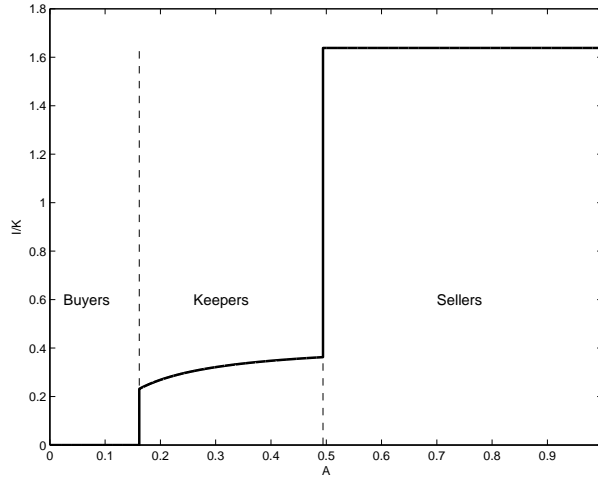


Figure 1: Investment levels across entrepreneurs

Figure 2 shows the same investment to capital ratios after the economy has suffered a negative information shock that raises  $\lambda$  from 0.1 to 0.11. Since the information shock lowers  $A^M$ , entrepreneurs with  $A \in [0.15, 0.16]$  become Keepers and invest positive amounts rather than rely on the market. The price of projects drops 7.5% in response to the shock, which lowers the investment of Keepers since they get fewer goods for the lemons they sell. This effect is relatively small: on average Keepers reduce investment about 3%. Entrepreneurs with

$A \in [0.49, 0.53]$  switch from being Sellers to being Keepers in response to the drop in price and consequently they lower their investment levels significantly, about 78%. Entrepreneurs with  $A > 0.53$  remain Sellers but lower their investment about 6% due to the lower price they obtain for the projects they sell. Overall, in this calibration, a negative information shock that lowers asset prices by 7.5% lowers investment by 10.5%.

The effect on the average rate of transformation is a mixture of composition effects. The increase in investment from Buyers who become Keepers lowers the average  $A$ , and so does the decrease in investment by high- $A$  Sellers. The decrease in investment by Sellers who become Keepers could in principle go either way: in this calibration these former Sellers have below-average  $A$  so the decrease in their investment actually increases the average  $A$ , so that the net effect of the information shock on average  $A$  is almost zero.

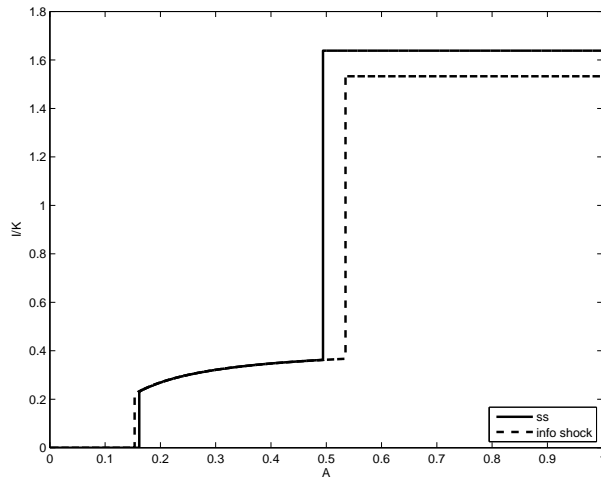


Figure 2: Investment levels across entrepreneurs after an information shock

As discussed in Kurlat (forthcoming), the effects of productivity and investment shocks can be decomposed into the effects that the shocks would have even in an economy with symmetric information and the added effect of asymmetric information via changes in implicit tax rates. Qualitatively, the effect of increasing implicit taxes on the pattern of investment is just like the effect of an information shock.

The quantitative importance of asymmetric information in transmitting productivity shocks is shown on Table 1. This gives magnitudes to the effects on real and financial variables described in Kurlat (forthcoming) Proposition 7.1. A 3% negative productivity shock results in a 4.4% fall in investment in an economy with symmetric information and a 6.3% fall in investment when there is asymmetric information, so the effect of the shock is amplified by a factor of 1.43. The effect on capital accumulation (which combines the effect of investment, the weighted-average  $A$  and depreciation) is amplified by a factor of 1.46 and the effect on asset prices by a factor of 1.67. The return for Buyer, which would increase due to reduced asset

demand in a world with symmetric information, increases less, by a factor of 0.52 due to the worsened selection.

	% change in response to productivity shock		Amplification ratio
	with symmetric info.	with asymmetric info.	
$I$	-4.4	-6.3	1.43
$\frac{K'}{K}$	-0.38	-0.55	1.46
$p$	-2.2	-3.7	1.67
$A^M$	+2.3	+1.2	0.52

Table 1: Effects of a negative productivity shock

The quantitative importance of asymmetric information in transmitting investment shocks is shown on Table 2. This gives magnitudes to the effects on real and financial variables described in Kurlat (forthcoming) Proposition 7.2. The effects of the shock are amplified by a factor of 2.36 for investment, by 1.46 for capital accumulation and by 2.36 for the returns for Buyers, as worsened selection combined with a reduction in asset supply.

Asymmetric information also makes the effect of the investment shock on the price of projects switch sign. With symmetric information, the negative shock leads to an increase in project prices as the replacement cost increases. With asymmetric information, the worsened-selection effect dominates and the price of projects actually falls. This reversal calls into question the sometimes-used strategy of empirically identifying investment shocks as those that (when positive) make the relative price of capital fall. In the presence of asymmetric information, negative investment shocks can lead to falls in the price of capital.<sup>2</sup>

	% change in response to investment shock		Amplification ratio
	with symmetric info.	with asymmetric info.	
$I$	-1.4	-3.4	2.36
$\frac{K'}{K}$	-0.38	-0.55	1.46
$p$	+0.78	-0.77	N/A
$A^M$	-0.78	-1.8	2.36

Table 2: Effects of a negative investment shock

Table 3 provides a quantitative counterpart to Proposition 6 in Kurlat (forthcoming). It shows the magnitude of each shock that would be sufficient to lead to a market shutdown. The magnitudes of the shocks are quite large, implying that each shock single-handedly is unlikely to lead to a complete market shutdown. However, a combination of, say, a 3% negative

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<sup>2</sup>Justiniano et al. (2008) also question this identification strategy by making a distinction between the transformation of consumption goods into investment goods and the transformation of investment goods into productive capital. See also Greenwood et al. (2000), Fisher (2006) and Schmitt-Grohe and Uribe (2008) for variants of this approach.

productivity shock together with a 3% negative investment shock and one-percentage-point negative information shock would reduce the volume of projects sold by 21%.

Shock		
Productivity	Investment	Information
-35%	-35%	+6.4 % points

Table 3: Size of each shock that is sufficient to lead to a market shutdown.

Table 4 shows how the effect of an information shock and the amplification of productivity and investment shocks would change under different values for  $\lambda$ .<sup>3</sup> The model is quite sensitive to the value of this parameter so, given the uncertainty about how it should be calibrated, the numbers should be taken as no more than an indication of the potential order of magnitude of effects. Nevertheless, the effect of asymmetric information is reasonably large in all cases.

	$\lambda = 0.05$	$\lambda = 0.15$
Amplification of productivity shock	1.18	1.98
Amplification of investment shock	1.66	3.71
Effect of an information shock	-9%	-14%

Table 4: Effects of shocks on investment under alternative values of  $\lambda$ .

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<sup>3</sup> $\gamma$  is adjusted in each case to keep the rate of depreciation constant.

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