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A note on Chui, Gai and Haldane's "Sovereign liquidity crisis: Analytics and implications for public policy"

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Abstract

This note corrects the welfare calculations in Chui, Gai and Haldane's paper on sovereign liquidity crisis [Chui, M., Gai, P., Haldane, A.G., 2002. Sovereign liquidity crisis: Analytics and implications for public policy. Journal of Banking and Finance 26, 519–544]. We show that the exact formula not only dramatically reduces the computed welfare consequences from 66% of ex-ante expected output to roughly 13%, but also changes the direction of some reported comparative static results. In addition, we clarify the difference between fundamentals-driven and belief-driven welfare costs and extend some of the sensitivity calculations.

JEL classification: F34; G28

Keywords: Sovereign debt; Liquidity crisis

1. Introduction

In their contribution about sovereign liquidity crises Chui et al. (2002) develop an analytical framework with which they assess the recent proposals for strengthening the international financial architecture.

The social planner in their small open economy is confronted with three stages in time ($t = 0, 1, 2$). During stage 0 he receives two endowments, which can be thought of as domestic capital E and (non-productive) liquid reserves A which yield a return r_A in $t = 2$. In order to augment domestic capital, the planner can borrow an amount L abroad at interest rate $r_L > r_A$ which has to be paid back at $t = 2$. Production of output needs time to mature and is realized at $t = 2$.

At the interim stage ($t = 1$) foreign investors have to decide whether to roll over their loan until maturity in stage 2 or to withdraw their money and invest it (net of transaction cost) in the risk-free international asset. In the following, λ defines the proportion of creditors who decide to flee at $t = 1$. The premature departure of foreign creditors causes disruption in the production process. Consequently, since the value of production which is finally realized at stage 2 depends on the state of fundamentals $\theta \sim N(\mu_\theta, \sigma_\theta^2)$ and the marginal disruption of output by fleeing creditors $k > 0$, the fundamental solvency constraint of the planner at stage $t = 2$ is

$$\theta(E + L) - k\lambda L + (1 + r_A)(A - \lambda L) \geqslant (1 - \lambda)L(1 + r_L). \tag{1}$$

The left-hand side shows the planner's resources, consisting of output and (remaining) liquid reserves and the right hand side defines the remaining repayment obligations. From the solvency constraint (1) a critical proportion of fleeing creditors $\lambda^*(\theta)$ can be derived for any state of fundamentals. If the observed fraction of fleeing creditors λ is greater than the critical mass $\lambda^*(\theta)$, the government will declare default. Setting $\lambda = 1$ ($\lambda = 0$), we can also define a "strong" ("weak") state of fundamentals $\bar{\theta}(\underline{\theta})$, where the planner would be able (unable) to repay his debt even if

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all other creditors decide to flee (stay). If $\theta < \underline{\theta}$, the economy is considered fundamentally insolvent, if $\theta > \bar{\theta}$, the economy is considered strongly solvent.

If fundamentals lie in the region $\theta \in [\underline{\theta}, \bar{\theta}]$, a coordination problem among creditors with a common knowledge arises which results in a potentially infinite number of equilibria. In order to solve for a unique equilibrium the authors follow Morris and Shin (1998) and assume that each creditor i privately observes at the interim stage $t = 1$ a noisy signal $x_i = \theta + \epsilon_i$ with $\epsilon_i \sim N(0, \sigma_\epsilon^2)$ of the state of fundamentals at $t = 2$. Since the creditor i also obtains information (through θ) on creditor j's signal, it is possible to solve for a unique equilibrium of this co-ordination game between creditors, where the planner will always default whenever the state of fundamentals is below some critical value $\hat{\theta}$. It is possible to show that $\hat{\theta} \in [\underline{\theta}, \bar{\theta}]$ if the disparities in the information set (i.e. σ_ϵ^2) of creditors are sufficiently small.

2. Welfare computations and policy implications

In order to compute the belief-based welfare cost of co-ordination failure in the debtor country, Chui et al. (2002) compute the disruption cost from fleeing creditors in situations where the country defaults although the state of fundamentals is not too "weak":

$$W^b = kL \int_{\underline{\theta}}^{\hat{\theta}} \lambda^*(\theta)\phi(\theta)\,\mathrm{d}\theta \tag{2}$$

where $\phi(\theta)$ is the density function of the normally distributed random variable θ. Evaluating the integral relative to ex-ante expected output gives[1]

$$\begin{aligned}\frac{W^b}{\mu_\theta(E+L)} = \frac{k}{(k+r_A-r_L)\mu_\theta}\Bigg\{&\left[\mu_\theta + (1+r_A)\frac{A}{E+L} - (1+r_L)\frac{L}{E+L}\right] \\ &\times \left[\Phi\left(\frac{\hat{\theta}-\mu_\theta}{\sigma_\theta}\right) - \Phi\left(\frac{\underline{\theta}-\mu_\theta}{\sigma_\theta}\right)\right] \\ &- \frac{\sigma_\theta}{\sqrt{2\pi}}\left[\exp\left(-\frac{(\hat{\theta}-\mu_\theta)^2}{2\sigma_\theta^2}\right) - \exp\left(-\frac{(\underline{\theta}-\mu_\theta)^2}{2\sigma_\theta^2}\right)\right]\Bigg\}.\end{aligned} \tag{3}$$

This formula differs substantially from the welfare cost formula (19) reported in Chui et al. (2002). Applying Eq. (3) also changes the numerical results of the original paper dramatically. Using the baseline simulation parameters of Table 1 in the original article, total welfare costs as a percentage of ex-ante expected output are reduced from 66% to 13.5%. For very small values of k (i.e. $k = 0.06$), welfare costs are now 0.1% of expected output (instead of 10% in the original paper) and for higher values of k (i.e. $k = 0.6$) welfare losses increase to 28% of output.

As Chui et al. (2002), we also find that a tighter monetary policy ameliorates co-ordination inefficiencies. However, in contrast to the original article, we find a perfect linear coherence and a significantly stronger relative impact on welfare costs. Now they decline from roughly 18% to almost 11% of ex-ante expected output within the same interest rate interval, see the left-hand side of Fig. 1.

The right hand side of Fig. 1 shows the effects of a simultaneous change in r_A and r_L, e.g. a change in the world interest rate. A zero change means we are in the basic setting. To the left we have a lowering, to the right we have an increase of the world interest rates. In contrast to the original article, we find that both the critical $\hat{\theta}$ and $\underline{\theta}$ are slightly increasing. The latter follows directly from the definition of $\underline{\theta}$. The "weak" state of fundamentals increases since the higher returns from liquid assets are offset by the higher credit costs. The rise in $\underline{\theta}$ is slightly stronger than the rise in $\hat{\theta}$ which leads to a small, but continuous fall in the belief-based welfare costs. In contrast, Chui et al. (2002) report a non-linear rise in welfare costs although the area $[\underline{\theta}, \hat{\theta}]$ becomes smaller. All in all, a common shock such as a rise in the world interest rate does not seem to have a significant influence on welfare in this model.

Next we analyze the possible effects of prudent debt and liquidity management. The reserve and the gearing ratio are important elements which characterize the fundamental state of a debtor economy. Fig. 2 shows our results for alternative reserve ratios. It is interesting, that the authors have chosen a reserve ratio of 33% as the baseline case, which yields the highest belief-based welfare losses. If the reserve ratio rises further, welfare costs fall as in the original article, since the probability of both fundamentals and belief-driven crisis is reduced. If the reserve ratio falls below 32%, belief-based welfare costs decrease while at the same time fundamentals-based welfare cost increase. When the reserves of a country decrease, fundamental-based welfare costs grow due to a rising $\underline{\theta}$ while at the same time belief-based welfare costs decline. If a country owns no reserves at all, the crises probability converges to $\Phi\left(\frac{(1+r_L)L}{E+L}\right)$. As shown in Fig. 2 this implies a fundamental-based welfare loss of about 70% of expected output. The latter is computed as follows:

$$\frac{W^f}{\mu_\theta(E+L)} = \frac{kL\Phi(\underline{\theta})}{\mu_\theta(E+L)},$$

where we have taken into account $\lambda = 1$ for $\theta < \underline{\theta}$.

The other element of a prudent debt management considered here is a variation of foreign borrowing L. As Fig. 3 shows, the effects are qualitatively similar as the effects of an increase in the reserve ratio. For gearing ratios lower than 54% belief-based welfare costs decrease continuously. For example, a policy which aims at a reduction in the short-term incumbrance from 50% to 40% of total productive assets almost eliminates belief-based welfare costs as in the original article. Again, for gearing ratios higher than 54% we find that bad fundamentals scale the area of possible expectations-driven crises down, which reduces the likelihood and, therefore, the expected costs of such crises. Of course, fundamentals-based welfare costs increase

[1] For computation see appendix.