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Discussion

Discussion of Alvarez and Dixit: A real options perspective on the euro

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1. Comments on Alvarez and Dixit

As I told Mark and Hal, I am delighted to talk about this paper. It is on an interesting topic — the possible breakup of the Euro Area — and the authors are two of my favorite economists. I will describe what they do, then talk about how it informs our view of what is going on in Europe right now.

1.1. Perpetual options

Since the Alvarez–Dixit model has a similar mathematical structure, I thought I would start by reviewing perpetual options: options that, unlike most financial market examples, have no expiration date. Valuation takes a beautiful recursive form, as we decide each period whether to exercise the option, which we can do only once, or wait another period. I find the logic incredibly clear in discrete time, so I will either clarify or run roughshod over the paper's continuous-time math, depending on your point of view.

Consider asset pricing in a stationary Markov setting with a state variable x. The ex-dividend value of a claim to the stream of future dividends d might be expressed as

$$V(x_t) = E_t\{m(x_t, x_{t+1})[d(x_{t+1}) + V(x_{t+1})]\}, \tag{1}$$

where m is the pricing kernel. The value of a perpetual option to buy this asset at strike price k is then

$$J(x_t) = \max\{E_t[m(x_t, x_{t+1})J(x_{t+1})], V(x_t) - k\}. \tag{2}$$

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The right branch of this Bellman equation is the value of exercising the option now, the difference between the market price and the strike. The left branch is the value of waiting till next period, discounted back to the present.

The solution has a number of typical features, some of which require additional structure:

- *Threshold property*: The solution has the form: exercise if $V(x_t) \ge V^*$ for some threshold value V^*, wait otherwise.
- *Convexity*: Options have convex payoffs. The one-period payoff $\max\{0, V-k\}$ is convex in V. If we rewrite the problem so that V is the state variable, this leads to a convex value function J.
- *Option value*: One consequence of convexity is that there is value in waiting: generally $V^* \gg k$, which means we wait for V to rise well above the strike before exercising the option.
- *Volatility*: Another consequence of convexity is that the value of the option increases with uncertainty. A mean-preserving spread, for example, raises $J(V)$ and V^*. Why? Because there is a greater chance we will get lucky. There is also a greater chance we will get unlucky, but the option chops off the left tail.

I give an example in the appendix (Gerber and Shiu, 1994). All of these features show up, in one form or other, in the Alvarez–Dixit model.

1.2. The Alvarez–Dixit model

Their model captures some of the salient features of the common currency of the Euro Area. One feature is the benefit of a common currency. That shows up here as a constant positive payoff every period the system is in place. Another feature is the cost of imposing the same monetary policy on every country. That shows up here as squared deviations from purchasing power parity. I think we want to interpret these deviations flexibly, so I will refer to them simply as deviations.

Here are the ingredients. Each country i has a state variable X_{it}, an AR(1) with normal innovations. With policy Z_{it}, the deviation is $x_{it} = X_{it} - Z_{it}$. The welfare of country i is

$$u_i = \begin{cases} -x_{it}^2 & \text{with independentpolicy} \\ \alpha - x_{it}^2 & \text{with common policy,} \end{cases}$$

where $\alpha > 0$ is the benefit of a common currency. Aggregate welfare is the sum. With common policy, that is

$$U = \sum u_i = n\alpha - \sum x_{it}^2.$$

With independent policies, each country sets $Z_{it} = X_{it}$ so that the deviation x_{it} is zero. Welfare is zero, both individually and in the aggregate. With common policy, the optimal policy sets the average deviation equal to zero with $Z_t = n^{-1}\sum_j X_{jt}$. The question is whether welfare is greater with common policy, which contributes $n\alpha$ to aggregate welfare but generates deviations that reduce welfare.

They introduce a breakup option that mirrors the perpetual option problem. If they (meaning the Euro Area as a whole) pay a breakup fee of nk, they can dissolve the common currency system and revert to individual country policies, in which welfare is zero. (They label the fee Φ, but k seems to me a better fit for an option.) Here is how that works. There is one really clever trick here, which is to express aggregate welfare in terms of a single state variable,

$$Y_t = \sum x_{it}^2.$$

The same trick is used in Fernando's earlier work on price setting with Francesco Lippi (Alvarez and Lippi, 2013). The Bellman equation for the breakup option is then

$$J(Y_t) = \max\{n\alpha - Y_t + e^{-r} E_t[J(Y_{t+1})], 0 - nk\}$$

The right branch is the breakup option: pay the fee nk and revert to the welfare of zero you get from following individual country policies. The left branch is the value of staying in the common currency system for another period. Each country then gets the benefit α minus the cost of deviations, now summarized by Y_t. Future value is discounted by e^{-r}.

The solution, which they find numerically, has familiar features: the threshold property, option value, etc. They are described in numerical examples, designed to be plausible. One difference from the traditional option problem is that the impact of volatility is ambiguous. Why? I think the answer is that increasing volatility of the X's increases the mean as well as the volatility of Y.

1.3. What does this tell us about the Euro Area?

Let us step back and think about what is going on in the doomsday machine that is Europe today. What do we learn from this model? How do we interpret it? What have we missed?

How should we think about deviations? The authors suggest that deviations are departures from purchasing power parity. Using numbers from flexible exchange rate regimes, they choose parameters that generate a standard deviation of annual exchange rate changes of about 8%, which is roughly what you would see for the US dollar against the euro, the yen, or the pound.