A Cost of Unified Currency*

by

Nobuhiro Kiyotaki

London School of Economics

and

John Moore

Edinburgh University and London School of Economics

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1. Introduction

Until recently, Charles and I (Kiyotaki) taught a graduate monetary economics course together. Charles usually taught first in the autumn, and then I taught in the spring. The course was a popular one. The students seemed both to enjoy and to get puzzled by the contrast between us, in content and style. When students put questions to Charles, he always had answers. When they put questions to me, I often had to ask myself, "Do I know the answer?" This short paper, joint with John Moore, is in part the result of such a question.

The question can be phrased: "In a hypothetical world where there are no country-specific macroeconomic shocks and so no need for independent stabilization policy, is having a unified currency always better than having separate national currencies?" A standard argument for separate currencies is that each country can pursue an independent monetary policy for stabilizing its national economy (assuming that monetary policy can and should stabilize an economy). A usual argument for currency unification is that it stimulates the trade of goods, services and assets. Thus it looks obvious that, if there is no need for independent stabilization, a unified currency would be better. But is it so obvious? We would like to present a counter-example.

The environment we have in mind is a world with many types of goods and many types of people. Each person is specialized in one particular type of good, but consumes another type. No two people find each other's products attractive. And, because of trading frictions, there is no central marketplace at which multilateral trades can be arranged. Instead, people randomly meet in pairs: they have to trade bilaterally. In this situation, money is essential to overcome the lack of double coincidence of wants.

People cannot barter goods for goods, but they can trade goods for money. Although people don't want money per se, they accept it because it can be used to buy what they do want.

In this world, there are two symmetric countries. Each type of good comes in three different varieties, and in each country, each type of person has the choice: either to make a "local" variety of his type of production good, a variety that is attractive to some other type of person from his own country but not to anyone from the other country; or to make a "generic" variety that is attractive to that other type irrespective of nationality, although (to someone from his own country) less attractive than the local variety.

To make our point most sharply, we ignore geography in the sense that we assume a person is equally likely to be matched with a "foreigner" as with someone from "home". A priori, one might think that, without spatial differences between the countries (reflected in a bias towards meeting someone from one's own country), a unified currency would certainly dominate two national currencies.

Indeed, the recent literature on money in an international matching framework, which allows for spatial differences between countries, reaches the conclusion that having a unified currency is preferable to having multiple currencies, insofar as inferior equilibrium allocations that are possible with multiple currencies are ruled out with a uniform currency. See, for example: Matsuyama, Kiyotaki and Matsui (1993); Trejos and Wright (1996); Zhou (1997); Ravikumar and Wallace (2002). Of course, an equilibrium in which people treat the multiple currencies on a par mimics a unified currency equilibrium. So the set of equilibrium allocations with a unified currency is nested inside the set of equilibrium allocations with multiple currencies.[1] The question is: Are there any <u>desirable</u> equilibrium

allocations which multiple currencies can achieve but which a unified currency cannot? These papers suggest that the answer is no.

However, these papers do not have people choosing the variety of good that they produce, as we have in mind: the choice of either producing a local variety or producing a generic variety. We find that once such a production choice is allowed for, a uniform currency may no longer be preferable. Specifically, we will show that for an open set of parameters:

(i) With a unified currency, only generic varieties are produced (because they can be sold more quickly).

(ii) With two national currencies, there is an equilibrium in which only local varieties are produced (by making a generic variety a producer would increase the chance of acquiring foreign money, but foreign money could only be used to buy foreign local varieties that are unattractive to him).

(iii) The two-currency equilibrium in which local varieties are produced strictly Pareto dominates the equilibrium with a unified currency.

In brief, there is a cost to having a unified currency: it can lead to too little specialization.

2. Model

Time is discrete, and continues forever. There are $k \geq 3$ distinct types good at each date, all indivisible. And there are k types of a continuum of agents with equal population size. For each type of agent, i =

1, 2, ...k, half come from one country and half come from another. For each type of good, there are three varieties: two local varieties peculiar to the two countries; and one generic variety common to both countries. Type i agents derive utility h from consuming a unit of their local variety of type i good; they derive utility ℓ, where $0 < \ell < h$, from consuming a unit of the generic variety of type i good; and they derive zero utility from consuming any other good, including the variety of type i good peculiar to the other country.

Instantaneously after consuming either a local or a generic variety of type i good, type i agents can choose to produce exactly one unit of type i+1 good -- either their local variety or the generic variety. (Type k agents produce type 1 good.) An agent can produce, store and carry one unit of his product without cost. But he cannot produce without first consuming, and he cannot store anyone else's product.

In every period, all agents meet pairwise at random, and each agent's trading history is private information. Each agent maximizes his expected discounted utility with discount factor $1/(1+r)$, where $r > 0$ is the common subjective interest rate.

In addition to goods, there is perfectly storable fiat money in fixed aggregate supply. Money is indivisible and cannot be stored more than one unit at a time. At each date a proportion m of each type of agent from each country hold one unit of money, but no goods. Everyone else holds no money, but holds one unit of their production good (the variety depends on the previous production choice).

We consider two alternative monetary regimes:

Unified Currency: a single currency is held by money holders.

National Currencies: money holders hold currency that is peculiar to their country.

We focus on steady-state Nash equilibria in which: first, each agent chooses his strategies of trade, consumption and production to maximize his expected discounted utility, taking as given the strategies of the other agents and the inventory distribution of money and products across agents; second, the strategies and the inventory distribution are stationary.

We start by considering a unified currency equilibrium in which only generic varieties are produced. At the end of each period, let V_g and V_m denote the expected discounted utilities of, respectively, a goods holder (without money), and a money holder (without goods). The Bellman equations are:

$$(1) \quad V_g = \frac{1}{1+r}\left\{\frac{m}{k}V_m + \left(1 - \frac{m}{k}\right)V_g\right\}$$

$$(2) \quad V_m = \frac{1}{1+r}\left\{\frac{1-m}{k}\left(\ell + V_g\right) + \left(1 - \frac{1-m}{k}\right)V_m\right\}$$

Equation (1) says, with probability m/k, the goods holder next period meets a money holder who consumes his product, and hence there is trade: he switches from holding goods to holding money. With probability 1 - (m/k), the goods holder does not meet a consumer of his product, or meets a consumer of his product who has no money; either way, there is no trade. Equation (2) says, with probability (1-m)/k, the money holder next period meets a person who holds his consumption good, and hence there is trade: he enjoys utility ℓ

from consumption then instantaneously produces with a view to selling in future. With probability 1- [(1-m)/k], the money holder does not meet a producer of his consumption good, or meets a producer of his consumption good who already holds money; either way there is no trade.

Rewriting these equations, we have:

$$(3) \qquad r\,V_g = \frac{m}{k}\left(V_m - V_g\right),$$

$$(4) \qquad r\,V_m = \frac{1-m}{k}\left(\ell + V_g - V_m\right).$$

Equation (3) says the return on holding goods is equal to the expected gain from trading to become a money holder. Equation (4) says the return on holding money is the expected gain from trading to consume and then instantaneously producing to become a goods holder.

Solving (3) and (4) for V_g and V_m, we obtain:

$$(5) \qquad r\,V_g = \frac{1-m}{k}\,\frac{m}{1+rk}\,\ell,$$

$$(6) \qquad r\,V_m = \frac{1-m}{k}\,\frac{m+rk}{1+rk}\,\ell,$$

$$(7) \qquad V_m - V_g = \frac{1-m}{1+rk}\,\ell.$$

From (7), we learn that $V_m > V_g$, so that a goods holder <u>is</u> willing to give up his product to acquire money. We also learn that $\ell + V_g > V_m$, so that a money holder <u>is</u> willing to give up money to acquire the generic variety of his consumption good.

To confirm that this is an equilibrium with a unified currency, we have to check that no-one strictly prefers to make the local variety rather than

the generic variety of his product. But if a producer were to make a local variety, he would only be able to sell it to people from his own country, which would halve the probability of trade without increasing the price; at the end of the production period, his expected discounted utility, V'_g say, would be the solution to

$$(8) \qquad r V'_g = \frac{m}{2k}\left(V_m - V'_g\right).$$

Comparing (3) and (8), we see that $V'_g < V_g$: no-one wants to produce a local variety in a unified currency equilibrium.

Next, we consider an equilibrium with two national currencies where only local varieties are produced. Because production is specialized to the local variety in each country, nothing is traded with foreigners. Each country's money circulates exclusively among the citizens of that country. In the absence of international trade, we call the equilibrium "autarky", and denote it by a superscript a. (It is not proper autarky, of course, since there is trade among agents from the same country.) The equations corresponding to (3) and (4) are now:

$$(9) \qquad r V^a_g = \frac{m}{2k}\left(V^a_m - V^a_g\right),$$

$$(10) \qquad r V^a_m = \frac{1-m}{2k}\left(h + V^a_g - V^a_m\right).$$

Comparing (9) and (10) with (3) and (4), the differences are: first, since only half of all matches are between agents from the same country, the frequency of trade is halved; but second, the utility of consumption increases from ℓ to h. From (9) and (10) we have

$$(11) \qquad r\,V_g^a = \frac{1-m}{2k}\,\frac{m}{1+2rk}\,h,$$

$$(12) \qquad r\,V_m^a = \frac{1-m}{2k}\,\frac{m+2rk}{1+2rk}\,h,$$

$$(13) \qquad V_m^a - V_g^a = \frac{1-m}{1+2rk}\,h.$$

From (13), we learn that $V_g^a < V_m^a < h + V_g^a$, so that people <u>are</u> willing to engage in this trading pattern.

To confirm that autarky is an equilibrium with two national currencies, we have to check that no-one strictly prefers to make the generic variety rather than the local variety of his product. By producing one unit of the generic variety, an agent could, at best, sell it for one unit of home or foreign money, depending on the nationality of the person to whom he sold it. (He might not be able to sell it all, because potential customers would prefer to wait to spend their money on local varieties from which they derive higher utility.) But in a two-currency equilibrium, he could use foreign money only to buy varieties of goods that are local to foreigners -- varieties that yield him no utility. That is, only home currency is valuable to him.[2] Moreover, he can be guaranteed of receiving home currency from his home customers if he produces their local variety. Therefore, at best, there is no benefit from switching to produce the generic variety (and there would be a loss if the generic variety weren't acceptable to his home customers).

To construct our counter-example, we need to identify when an autarky equilibrium in which only local varieties are produced (an equilibrium satisfying (11) and (12)) dominates an equilibrium in which only generic varieties are produced (an equilibrium satisfying (5) and (6)). Precisely, we pose the question in the following way. Suppose the difference between two currencies is only in their colour. Starting from the equilibrium with two

national currencies, suppose that, immediately after consumption but before production, everyone became "colour-blind" and in effect switched to the equilibrium with a unified currency. Under what circumstances would everyone be strictly worse off? This boils down to asking when would $V_g^a > V_g$ and $V_m^a > V_m$. From (5), (6), (11) and (12) we see that this happens if and only if

$$\text{(C1)} \qquad \frac{h}{\ell} > \frac{2(1+2rk)}{1+rk}.$$

Condition (C1) says that if the utility of the local variety is high enough relative to the utility of the generic variety, then everyone is better off in a world in which only local varieties are produced -- despite the fact that fewer trades occur, because a producer has to be matched with a consumer from his own country. From now on, let us assume that condition (C1) holds.

As we discussed earlier, in a world with two currencies -- here of different colour -- there is always a colour-blind equilibrium which mimics a unified currency equilibrium allocation. To clinch our argument, we need to see if there are circumstances under which the reverse is not true, in that a unified currency equilibrium cannot mimic the superior autarky allocation of a two national currency equilibrium. Is it ever the case that two national currencies are necessary to implement the Pareto dominating equilibrium allocation?

In a world with a unified currency, suppose only local varieties were produced, as in autarky. Then discounted utilities will be given by (11) and (12). To knock this out as an equilibrium, suppose that

$$\text{(14)} \qquad \ell + V_g^a > V_m^a.$$

Inequality (14) implies that if at some date an agent with money were to meet someone with a generic variety of his type of consumption good, he would be strictly better off trading then, rather than waiting for a local variety. But this implies that a producer could sell a unit of generic good for one unit of money to anyone who consumes his type of product, irrespective of their nationality. Hence it would be strictly better to produce the generic good than to produce the local good: the number of potential customers would be doubled, and there would be no drop in price. In short, if inequality (14) is satisfied, autarky cannot be implemented with a unified currency.

From (13), inequality (14) is equivalent to

$$\text{(C2)} \qquad \frac{h}{\ell} < \frac{1+2rk}{1-m}.$$

Condition (C2) says that if the utility of the local variety is not too high relative to the utility of the generic variety, then money holders will be willing to seize an opportunity to buy a generic variety rather than wait for a local variety, which in turn takes away any incentive to produce local varieties.

Notice that conditions (C1) and (C2) are compatible if and only if

$$\text{(15)} \qquad m > \frac{1-rk}{2}.$$

Inequality (15) is not hard to satisfy. For example, it is automatically true if $k > 1/r$.

We have proved the following result.

PROPOSITION. Under conditions (C1) and (C2),

(i) With a unified currency, the only stationary monetary equilibrium has generic varieties produced and traded internationally.

(ii) With two national currencies, there is a stationary monetary equilibrium in which local varieties are produced and traded locally (autarky).

(iii) The autarky equilibrium with two national currencies strictly Pareto dominates the equilibrium with a unified currency.

3. Discussion

How dependent is our counter-example on the peculiar assumptions that we have made concerning the indivisibility of goods and money, and the fact that agents cannot hold more than one unit of money at a time? In effect, we have robbed the model of price variation: all trades have to be one unit of good swapped for one unit of money. Given this, producers always have an incentive to increase the size of their market if they can. In particular, with a unified currency, producers strictly prefer to make a generic variety because it can be sold to twice as many customers, without any reduction in price.

Had price variation been possible, producers might be tempted, even with a unified currency, to make a local variety because it yields customers a higher utility and hence might be sold at a higher price.

In a Walrasian market, variations in price across products would elicit efficient production choices. However, in a Walrasian market, there would be

no need for money.

By explicitly modelling trading frictions, we admit a role for money but at the same time distort relative prices and hence production choices. Our counter-example shows that in this non-first-best world, there can be a role for several currencies, to mitigate such distortions. In general, this conclusion is robust to allowing for variation in price by, for example, considering a model with divisible goods. We conjecture that our counter-example does not ultimately hinge on our assumptions about the indivisibility of money or the upper bound on individual money holdings. Loosely speaking, with more flexibility there will be a narrower set of parameters for which a counter-example can be found; but, provided there are still trading frictions, the set will stay non-empty.

We should end with a note of caution. Our analysis shouldn't be used in a policy debate as an argument in favour of maintaining national currencies. All we have done is to find an example in which currency unification inhibits specialization: people are induced to produce generic varieties rather than local varieties. However, it must always be borne in mind that non-unification is likely to inhibit trade in all other goods. If the problem of a unified currency is too little specialization in certain goods, then this is probably best remedied by a targeted policy -- e.g. subsidizing the production of those goods -- rather than by maintaining national currencies. The choice of currency is too blunt an instrument, given that it affects every part of an economy.

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Footnotes

[1]Other papers demonstrate a positive role for multiple currencies to create small change: see, e.g., Aiyagari, Wallace and Wright (1996) and Cavalcanti (2000). But as Ravikumar and Wallace (2002) point out, this may be an artifact of assuming that money is indivisible and there is an upper bound on individual holdings. Kocherlakota and Krueger (1999) provide a different rationale for multiple currencies: to permit agents to signal private information about their preferences concerning the source, by country, of the goods to be consumed.

[2]He cannot swap foreign money for home money in a currency exchange, because in equilibrium no foreigner would accept home money: each country's citizens exclusively hold their own currency. Equally, no-one from his home country would accept foreign money.