Monetary Economics
Chapter 8: Money and credit

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2 Dichotomy between money and credit
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Introduction

Many modes of payments coexist in actual economies:

- credit arrangements, where trades are intertemporal by nature and involve a future payment;
- monetary exchanges, where trades are quid pro quo and do not involve future obligations.
One way to explain the coexistence of monetary exchange and credit arrangements is to introduce some heterogeneity among agents and/or trading matches.

In some markets agents are anonymous, and can therefore only trade with money, while in others their identities can be verified, and intertemporal contracts can be enforced, and thus agents can resort to credit arrangements.
We first consider an environment where there is a technology that enforces debt contracts in some markets but not in others.

We then assume that the gains from trade vary across matches in the decentralized market, and that the use of credit involves a costly record-keeping technology.

In the next section, we capture the notion of commitment through the reputation that buyers acquire by trading repeatedly with some sellers. We show that the availability of credit depends on the value of money and monetary policy, and the extent of the trading frictions.

Finally, we will see a model which analyzes the role that banks have as intermediaries, and the gain in utility they can provide.
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In this section, we divide the day market into two subperiods: a morning (DM1) and an afternoon (DM2).

The morning and afternoon subperiods are similar in terms of agents’ preferences and specialization:

- buyers can consume in both subperiods but cannot produce,
- sellers can produce but cannot consume

and in terms of the trading process

- buyers and sellers trade in bilateral matches.

The discount factor across periods is $\beta$. 
The buyer's instantaneous utility function is

\[ U^b(q_1, q_2, x, h) = v(q_1) + u(q_2) + x - h, \]

where \( q_1 \) is the consumption in the first subperiod, \( q_2 \) is the consumption in the second subperiod, \( x \) is the consumption of the general good in the third subperiod, and \( h \) is the utility cost of producing \( h \) units of the general good.

The utility functions \( v(q) \) and \( u(q) \) are strictly increasing and concave, with

- \( v(0) = u(0) = 0 \),
- \( v'(0) = u'(0) = +\infty \),
- \( v'(+\infty) = u'(+\infty) = 0 \).
The utility function of a seller is

\[ U^s(q_1, q_2, x, h) = -\psi(q_1) - c(q_2) + x - h, \]

where functions \( \psi(q) \) and \( c(q) \) are strictly increasing and convex, with

- \( \psi(0) = c(0) = 0 \),
- \( \psi'(0) = c'(0) = 0 \),
- \( \psi'(+\infty) = c'(+\infty) = 0 \).

We denote \( q_1^* \) the solution to \( u'(q) = \psi'(q) \) and \( q_2^* \) the solution to \( u'(q) = c'(q) \). These are the quantities that maximize the match surpluses in the first two subperiods.
Dichotomy between money and credit

<table>
<thead>
<tr>
<th>MORNING</th>
<th>AFTERNOON</th>
<th>NIGHT</th>
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<tbody>
<tr>
<td>(DM 1)</td>
<td>(DM 2)</td>
<td>(CM)</td>
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Utility of consumption: $\nu(q_1)$  $u(q_2)$  $x$
Disutility of production: $-\psi(q_1)$  $-c(q_2)$  $-h$

Record-keeping Enforcement  Anonymity  Record-keeping Enforcement

Figure 8.1: Timing of a representative period
Dichotomy between money and credit

- Both the DM1 and the DM2 are characterized by search frictions.
- A buyer meets a seller in the DM1 with probability $\sigma_1 \in [0, 1]$, and in the DM2 with probability $\sigma_2 \in [0, 1]$, where $\sigma_1$ and $\sigma_2$ are independent events.
Dichotomy between money and credit

In the DM1 all agents’ identities are known to all other agents.

We assume that any contract written in the DM1 can be (and will be) enforced at night.

As a result, buyers can get output in the DM1 by using credit—or, equivalently, by issuing an IOU—to be repaid at night.

We will assume that all the IOUs are “one period” in nature in that they are repaid in the subsequent competitive night market, CM.

Moreover, the authenticity of the IOUs issued in DM1 cannot be verified in DM2, and hence they cannot be used as medium of exchange in the afternoon.
In the DM2 all agents are anonymous.

Since buyers are anonymous in the DM2, bilateral trades cannot be publicly recorded or enforced.

As a result, sellers do not accept IOUs for output produced in the DM2 since buyers would renegade on these at night.

Because of the anonymity of agents in the DM2, money has an essential role in this environment.
Dichotomy between money and credit

- We assume that the stock of money grows at a constant rate 
  \( \gamma \equiv \frac{M_{t+1}}{M_t} \), and that this is accomplished by a lump-sum transfers to buyers in the CM.

- We focus on stationary equilibria where real balances and the quantities traded in the different subperiods are constant over time:
  \[
  \frac{\phi_{t+1}}{\phi_t} = \frac{M_t}{M_{t+1}} = \gamma^{-1}.
  \]
Consider a buyer at the beginning of the CM who holds $z = \phi_t m$ units of real balances and has issued $b$ units of IOUs in the previous DM1, where each unit is normalized to be worth one unit of general good.

The value function for this **buyer**, $W^b(z, -b)$, is given by

$$W^b(z, -b) = \max_{x, h, z'} \left\{ x - h + \beta V^b(z') \right\}$$

(8.1)

$$x + b + \gamma z' = z + h + T,$$

(8.2)

where $V^b$ is the value of a buyer at the beginning of the day market.
Substituting $x - h$ from (8.2) into (8.1), we get

$$W^b(z, -b) = z - b + T + \max_{z' \geq 0} \left\{ -\gamma z' + \beta V^b(z') \right\}. \quad (8.3)$$

As before, the value function is linear in the buyer's current portfolio, and the buyer’s choice of real balances is independent of his current portfolio. (Also, recall that sellers do not receive transfers in the CM.)
The value function of a **seller** holding $z$ units of real balances and $b$ IOUs at the beginning of the CM is given by

$$W^s(z, b) = z + b + \beta V^s,$$  

(8.4)

where $V^s$ is the value function of a seller at the beginning of the next period.
Consider now a bilateral match in the DM2 between a buyer holding $z$ units of real balances and a seller.

The buyer is anonymous and cannot use credit.

Hence, he can transfer at most $z$ units of real balances to the seller in exchange for afternoon output.

We assume that the buyer makes a take-it-or-leave-it offer.
The buyer’s offer to the seller is given by the solution to the following simple problem,

\[
\max_{q_2,d_2} \left[ u(q_2) - d_2 \right]
\]

s.t. \( - c(q_2) + d_2 \geq 0 \) and \( d_2 \leq z \),

where the first inequality represents the seller’s participation constraint and the second is a feasibility constraint.
The solution to this maximization problem is

\[ c(q_2) = \min [c(q_2^*), z], \]  
\[ d_2 = c(q_2), \]  

→ The buyer purchases the efficient level of output if he has sufficient real balances; otherwise he spends all of his balances on output.
Dichotomy between money and credit

Bilateral match in the DM1

- Since buyers’ identities are known and there is a technology that enforces contracts at night, they can purchase output with IOUs.
- If the buyer defaults on his IOU, he can be subject to an arbitrarily large fine in the CM.
- The buyer can also use his money holdings as means of payment in the morning.
- For a given level of real balances, spending money balances in the DM1 is a (weakly) dominated strategy since the buyer might need money to trade in the DM2.
Suppose then that buyers only use credit to purchase output in the DM1. The buyer makes a take-it-or-leave-it offer \((q_1, b)\) to the seller so as to maximize his surplus

\[ v(q_1) - b, \]

subject to the seller’s participation constraint

\[ -\psi(q_1) + b \geq 0. \]

Thanks to the enforcement technology in the CM, there is no feasibility constraint imposed on the transfer of IOUs since the buyer can issue as much debt as he wishes.

The solution to the buyer’s problem in the DM1 is

\[ q_1 = q_1^*, \quad b = \psi(q_1^*). \]
Dichotomy between money and credit

Given the terms of trade established in the DM1 and DM2, the value function of a buyer holding \( z \) units of real balances at the beginning of a period is

\[
V^b(z) = \sigma_1 \sigma_2 \left\{ v(q_1^*) + u[q_2(z)] + W^b [-b, z - d_2(z)] \right\} \\
+ \sigma_1 (1 - \sigma_2) \left\{ v(q_1^*) + W^b (-b, z) \right\} \\
+ (1 - \sigma_1) \sigma_2 \left\{ u[q_2(z)] + W^b [0, z - d_2(z)] \right\} \\
+ (1 - \sigma_1)(1 - \sigma_2) W^b (0, z).
\]

(8.9)
Dichotomy between money and credit

Using the linearity of $W^b$, the beginning-of-period value function can be simplified to

$$V^b(z) = \sigma_1 \{v(q_1^*) - \psi(q_1^*)\} + \sigma_2 \{u[q_2(z)] - c[q_2(z)]\} + z + W^b(0,0).$$

(8.10)

If we substitute $V^b(z)$ from (8.10) into (8.3), then the buyer’s portfolio problem in the CM can be represented by

$$\max_{z \geq 0} \left\{-iz + \sigma_2 \{u[q_2(z)] - c[q_2(z)]\}\right\},$$

(8.11)

where $i \equiv \frac{\gamma - \beta}{\beta}$. Note that the buyer’s real balances only affects his surplus in the DM2.
The first-order condition for problem (8.11) is

\[
\frac{u'(q_2)}{c'(q_2)} = 1 + \frac{i}{\sigma_2}.
\]  

(8.12)

This expression for the output traded in the DM2 is identical to the one we derived for the pure monetary economy.
The allocation is dichotomic in the sense that the output traded in the DM1, \( q_1 \), is independent of both the quantity traded in the DM2, \( q_2 \), and the value of money, \( \phi_t \).

As well, when inflation increases, \( q_1 \) is unaffected and remains at the efficient level, while \( q_2 \) decreases, see equation (8.12).

So there are no interactions between the DM1 and the DM2.
Dichotomy between money and credit

In the DM1 a fraction $\sigma_1$ of the buyers issue debt, while at the same time holding positive amounts of money. Credit is a preferred means of payment because it involves no opportunity cost.

However, credit can only be used in transactions when agents’ identities are known and debt contracts can be enforced. Buyers will hold money, even though it is more costly than credit, because it allows them to consume in the DM2 when they are anonymous.

Finally, as the cost of holding money, $i$, approaches zero, the quantity traded in the DM2 approaches its efficient level, $q_2^*$. When the cost of holding money is exactly equal to zero, there is no cost associated with holding real balances, and buyers will be indifferent between trading with money and credit in the DM1.
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2. Dichotomy between money and credit
3. **Costly record-keeping**
4. Strategic complementaries and payments
5. Short-term and long-term partnerships
6. Money, Credit and Banking
7. Conclusion
We now consider an environment where money and credit coexist, and monetary policy affects the composition of monetary and credit transactions.

The model is similar as in Chapter 5, "Divisibility of money", but we add a costly record-keeping technology.
The instantaneous utility function of a buyer is given by

\[ U^b = \varepsilon u(q) + x - h, \]

where \( \varepsilon \in \mathbb{R}_+ \) is a match-specific preference shock. The preference shock, \( \varepsilon \), is drawn from a cumulative distribution, \( F(\varepsilon) \), with support \([0, \varepsilon_{\text{max}}]\).
Matched agents in the DM have the option to record a credit transaction at a real cost of $\zeta > 0$. If a credit transaction is recorded in the DM, we assume that its repayment is enforced at night.
Costly record-keeping

The value functions for buyers and sellers at the beginning of the CM, \( W^b(z, -b) \) and \( W^s(z, b) \), are given by equations (8.3) and (8.4):

\[
W^b(z, -b) = z - b + T + \max_{z' \geq 0} \left\{ -\gamma z' + \beta V^b(z') \right\}.
\]

(8.3)

\[
W^s(z, b) = z + b + \beta V^s,
\]

(8.4)
Consider a match in the DM between a buyer with match specific preference shock $\varepsilon$ holding $z$ units of real balances, and a seller. The buyer makes a take-it-or-leave-it offer to the seller. The terms of trade, $(q, b, d)$, are given by the solution to

$$\max_{q,d,b} \left[ \varepsilon u(q) - d - b - \zeta \mathbb{I}_{b>0} \right] \quad \text{s.t.} \quad -c(q) + d + b \geq 0 \text{ and } d \leq z,$$

where $\mathbb{I}_{b>0} = 1$ if $b > 0$ and $\mathbb{I}_{b>0} = 0$, otherwise.
Costly record-keeping

If the buyer chooses to use credit as a means of payment, he must incur the fixed cost $\zeta$ due to record-keeping.

If the buyer incurs the fixed cost, then the solution is

$$q = q^*$$

with $d + b = c(q^*)$, where $q^*$ solves $\varepsilon \mu'(q^*) = c'(q^*)$. 
If the buyer does not incur the fixed cost to use credit, then

\[ q = q_\varepsilon(z) = c^{-1} \left[ \min \left( c(q_\varepsilon^*), z \right) \right] \]

and

\[ d = c(q) \]

If he has enough real balances, the buyer purchases the efficient level of output for his particular preference shock; otherwise he spends all of his real balances.
Costly record-keeping

The buyer’s surplus from a trade match in the DM is

\[ S^b(z, \varepsilon) = \max \left\{ \varepsilon u(q^*_\varepsilon) - c(q^*_\varepsilon) - \zeta, \varepsilon u[q_\varepsilon(z)] - c[q_\varepsilon(z)] \right\}. \] (8.13)

Note that \( S^b(z, \varepsilon) \) is increasing in \( \varepsilon \), i.e., both terms in the maximization problem increase with \( \varepsilon \). We represent each of these terms as a function of \( \varepsilon \) in Figure 8.2. The slope of the first term is \( u(q^*_\varepsilon) \), and the slope of the second is \( u[q_\varepsilon(z)] \).
Let $\bar{\varepsilon}$ denote the value of $\varepsilon$ such that $c(q^{*}_{\varepsilon}) = z$, i.e., $\bar{\varepsilon}$ is a threshold below which the buyer has enough real balances to purchase the efficient level of DM output.

For all $\varepsilon < \bar{\varepsilon}$, $u[q_{\varepsilon}(z)] = u(q^{*}_{\varepsilon})$, which implies that the slopes of the two terms in the maximization problem (8.13) are equal.

For all $\varepsilon > \bar{\varepsilon}$, $u[q_{\varepsilon}(z)] < u(q^{*}_{\varepsilon})$, and the slope of the second term in the maximization problem (8.13) is independent of $\varepsilon$ and lower than the slope of the first term.

When $\varepsilon = 0$, the first term is equal to $-\zeta$, while the second is equal to zero.
For $\varepsilon > \bar{\varepsilon}$ sufficiently large,

$$\{\varepsilon u(q^*) - c(q^*) - \zeta\} - \{\varepsilon u(q_{\varepsilon}(z)) - c(q_{\varepsilon}(z))\} > 0.$$ 

Consequently, there exists a threshold $\varepsilon_c > \bar{\varepsilon}$ above which the buyer uses credit as means of payment and below which he uses money.
This threshold is given by,

\[ \varepsilon_c u(q^{*}_{\varepsilon_c}) - c(q^{*}_{\varepsilon_c}) - \zeta = \varepsilon_c u \left[ c^{-1}(z) \right] - z. \tag{8.14} \]

Graphically, the first term in the maximization problem (8.13) intersects the second term from below at \( \varepsilon = \varepsilon_c \), see Figure 8.2.
Costly record-keeping

Figure 8.2: Credit vs monetary trades
It should be emphasized that the value of the threshold, \( \varepsilon_c \), is for a given level of real balances, \( z \). Hence, from (8.14), \( \varepsilon_c \) increases with \( z \), i.e.,

\[
\frac{d\varepsilon_c}{dz} = \frac{\varepsilon_c u'(c^{-1}(z))}{c'(c^{-1}(z))} - 1
\]

\[
> 0, \quad \text{since } q^{*}_{\varepsilon_c} > c^{-1}(z) \text{ for } \varepsilon_c > \bar{\varepsilon}.
\]
Graphically, as $z$ increases $\bar{\epsilon}$ increases and for all $\epsilon > \bar{\epsilon}$ the second term of the maximization problem (8.13) moves upward. Buyers increase their surplus by holding more real balances in all trades where they don’t trade the efficient quantity. Consequently, as buyers hold more real balances the fraction of trades conducted with credit decreases: money and credit are complements.
Costly record-keeping

Using the linearity of $W^b$, the value of being a buyer at the beginning of the period, $V^b(z)$, is

$$V^b(z) = \sigma \int_0^{\epsilon_{\text{max}}} S^b(z, \epsilon) dF(\epsilon) + W^b(z).$$  \hspace{1cm} (8.15)

Substituting $V^b(z)$ from (8.15) into (8.3), and simplifying, we get

$$\max_{z \geq 0} \left[ -iz + \sigma \int_0^{\epsilon_{\text{max}}} S^b(z, \epsilon) dF(\epsilon) \right].$$  \hspace{1cm} (8.16)
The objective function in (8.16) is continuous and the solution to (8.16) must lie in the interval \([0, c(q^*_{\varepsilon_{\text{max}}})]\) for all \(i > 0\).

An equilibrium corresponds to a pair \((\varepsilon_c, z)\) that solves (8.14) and (8.16) and can be determined recursively: A value for \(z\) is determined independently by (8.16), and given this value for \(z\), (8.14) determines a unique \(\varepsilon_c\).
We now investigate the effects that monetary policy has on the use of fiat money and credit as means of payment. The first-order (necessary but not sufficient) condition associated with (8.16) is

\[ i = \sigma \int_{\bar{\varepsilon}(z)}^{\varepsilon_c(z)} \left\{ \frac{\varepsilon u' [c^{-1}(z)]}{c'[c^{-1}(z)]} - 1 \right\} dF(\varepsilon). \tag{8.17} \]

From (8.17), real balances have a liquidity return when the realization of the preference shock is not too low—so that the buyer’s budget constraint in the match is binding—and when the preference shock is not too high—so that it is not profitable for buyers to use credit—i.e., when \( \bar{\varepsilon}(z) < \varepsilon < \varepsilon_c(z) \).
Suppose that inflation and, hence, the cost of holding money, $i$, increases:

- the right side of (8.17) must also increase,
- it reduces buyers’ real balances and increases the use of costly credit,

As the cost of holding real balances approaches zero, from (8.16):

- real balances approach $c(q_{\varepsilon_{\text{max}}^{*}})$,
- buyers find it profitable to trade with money only.
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In order to be able to accept credit, sellers must invest ex-ante—i.e., before trades take place—in a record-keeping technology that allows the transactions to be recorded and enforced.

Buyers will form rational expectations about sellers’ investment decisions and choose which means of payment(s) to carry into meetings.

These decisions made by buyers and sellers create strategic complementarities for payment choices and network-like externalities.
Strategic complementarities and payments

The model with network externalities is similar to that of the previous section, but modified in the following ways:

- All matches are identical, i.e., $\varepsilon = 1$.
- It is the seller who invests in the record-keeping technology and this investment is undertaken at the beginning of the DM before matches are formed.
- The cost to invest in this technology is $\zeta > 0$.
- The pricing mechanism must be changed from the previous section to one that permits sellers to extract a fraction of the match surplus; otherwise sellers could not recover their ex ante investment costs and would have no incentive to invest in the record-keeping technology.

Again, the buyer receives a constant share $\theta \in [0, 1)$ of the match surplus, while the seller gets the remaining $1 - \theta > 0$ share.
Consider first a match between a buyer holding $z$ units of real balances and a seller who has invested in the technology. The terms of trade are given by the solution to the following problem:

$$\max_{q,d,b} \left[ u(q) - d - b \right]$$  \hspace{1cm} (8.18)

subject to:

$$- c(q) + d + b \geq \frac{1 - \theta}{\theta} \left[ u(q) - d - b \right]$$  \hspace{1cm} (8.19)

$$d \leq z$$  \hspace{1cm} (8.20)
Since $b$ is unconstrained—buyers can borrow as much as they want in the DM—the constraint $d \leq z$ never constrains the purchase of $q$.

Because of this, the output produced in the DM will be at the efficient level, $q = q^*$, and $d + b = (1 - \theta) u(q^*) + \theta c(q^*)$, i.e., the seller gets the fraction $1 - \theta$ of match surplus.
Consider next the case where the seller has not invested in the record-keeping technology. The terms of trade are still determined by the problem (8.18)-(8.20), but with the added constraint that $b = 0$. If $z \geq (1 - \theta) u(q^*) + \theta c(q^*)$, then the buyer will have sufficient money balances to purchase the efficient level of output and $q = q^*$; otherwise, the level of DM output, $q(z)$, will satisfy

$$z = z(q) \equiv (1 - \theta) u(q) + \theta c(q),$$

(8.21)

where $q(z) < q^*$. 

Strategic complementarities and payments

Seller’s decision

Considering that all buyers hold the same real balances, \( z \), it is optimal for a seller to invest in the technology if

\[
\sigma(1 - \theta) [u(q(z)) - c(q(z))] \leq \sigma(1 - \theta) [u(q^*) - c(q^*)] - \zeta. \tag{8.22}
\]

From (8.22), the flow cost to invest in the record-keeping technology must be less than the increase in the seller’s expected surplus associated with accepting credit instead of money.
Strategic complementarities and payments

Seller’s decision

The left side of (8.22) is increasing in $z$:

- it equals 0 if $z = 0$
- it equals $\sigma(1 - \theta) [u(q^*) - c(q^*)]$ if $z \geq (1 - \theta) u(q^*) + \theta c(q^*)$.

Consequently, if $\zeta < \sigma(1 - \theta) [u(q^*) - c(q^*)]$, then there exists a threshold $z_c > 0$ for the buyer’s real balances, below which sellers invest in the record-keeping technology.
Strategic complementarities and payments
Seller’s decision

This threshold is given by the solution to

$$u[q(z_c)] - c[q(z_c)] = u(q^*) - c(q^*) - \frac{\zeta}{\sigma(1 - \theta)}.$$  (8.23)

Let $\Lambda$ be the measure of sellers who invest in the record-keeping technology. Then,

$$\Lambda = \begin{cases} 1 & \text{if } z \in [0, 1] \\ 0 & > z = z_c. \end{cases}$$  (8.24)

The seller’s reaction function is depicted in Figure 8.3. As buyers hold more money, sellers have less incentives to invest in the costly record-keeping technology.
Given the seller’s decision to invest in the record-keeping technology, (8.24), the buyer’s decision problem is given by

$$\max_{z \geq 0} \{-iz + \sigma(1 - \Lambda)\theta \{u[q(z)] - c[q(z)]\} + \sigma\Lambda\theta \{u(q^*) - c(q^*)\}\}.$$

(8.25)
Strategic complementarities and payments

Buyer’s decision

The first-order condition for problem (8.25) is

\[
\frac{\sigma(1 - \Lambda)\theta - i(1 - \theta)}{(1 - \theta)u'(q) + \theta c'(q)} u'(q) - \frac{[i + \sigma(1 - \Lambda)]\theta c'(q)}{(1 - \theta)u'(q) + \theta c'(q)} \leq 0, \tag{8.26}
\]

and holds with an equality if \(z > 0\). If \(z > 0\), and the numerator of (8.26) will equal to zero, and

\[
\frac{u'(q)}{c'(q)} = \frac{[i + \sigma(1 - \Lambda)]\theta}{[i + \sigma(1 - \Lambda)]\theta - i}. \tag{8.27}
\]
Strategic complementarities and payments

Buyer’s decision

The right side of (8.27) is increasing with $\Lambda$, which implies that an increase in $\Lambda$ will decrease $q$, and, hence, $z$. Therefore, the buyer’s choice of real balances is decreasing in $\Lambda$.

Intuitively, if it is more likely to find a seller who accepts credit, then money is needed in a smaller fraction of matches, and since it is costly to hold money buyers will find it optimal to hold fewer real balances.

Moreover, there is a critical value for $\Lambda$ above which buyers hold no real balances, and this happens when the denominator of equation (8.27) is equal to zero, or when $\Lambda_c = \frac{\sigma \theta - (1-\theta)i}{\sigma \theta}$, where $\Lambda_c > 0$ if $i < \frac{\sigma \theta}{1-\theta}$. 
Figure 8.3: Buyers’ and sellers’ reaction functions
A stationary symmetric equilibrium is a pair \((z, \Lambda)\) that solves (8.24) and (8.25).

There exists a pure monetary equilibrium with \(\Lambda = 0\) and \(z > 0\); a pure credit equilibrium, with \(\Lambda = 1\) and \(z = 0\); and a “mixed” monetary equilibrium, where buyers use both credit and money, accumulating \(z_c > 0\) real balances, and a fraction \(1 - \Lambda \in (0, 1)\) sellers accept only money, while other sellers, \(\Lambda \in (0, 1)\) of them, are willing to accept both money and credit.

The multiplicity of equilibria arises from the strategic complementarities between the buyers’ decisions to hold real balances and the sellers’ decisions to invest in the record-keeping technology.
When there are multiple equilibria, which one is preferred from the society’s viewpoint? Social welfare is given by

$$\mathcal{W} = \sigma \Lambda \{u(q^*) - c(q^*)\} + \sigma (1 - \Lambda) \{u[q(z)] - c[q(z)]\} - \Lambda \zeta.$$ 

Consider a case where $z_0$ is greater but close to $z_c$:

- There is a pure monetary equilibrium with $z = z_0$, $\Lambda = 0$, and social welfare is $\mathcal{W}_0 = \sigma \{u[q(z_0)] - c[q(z_0)]\} - \zeta$.

- There is also a pure credit equilibrium with $\Lambda = 1$ and social welfare is $\mathcal{W}_1 = \sigma \{u(q^*) - c(q^*)\} - \zeta$. 
Strategic complementarities and payments

Social welfare

Given the definition of $z_c$ in (8.23),

$$
\zeta \approx \sigma(1 - \theta) \left\{ [u(q^*) - c(q^*)] - [u(q(z_0)) - c(q(z_0))] \right\}
$$

$$
< \sigma \left\{ [u(q^*) - c(q^*)] - [u(q(z_0)) - c(q(z_0))] \right\},
$$

where we get the strict inequality because $\theta > 0$.

In this case, the difference in the surpluses associated with credit and monetary transactions strictly exceeds the cost of investment in the record-keeping technology.

Hence, $\mathcal{W}_1 \succ \mathcal{W}_0$, the pure monetary equilibrium is dominated, from a social welfare perspective, by the pure credit equilibrium.
However, the socially inefficient monetary equilibrium can prevail because of a hold-up externality. If a seller decides to adopt the technology to accept credit, he incurs the full cost of the technology adoption, but he only receives a fraction $1 - \theta < 1$ of the increase in the match surplus.

Hence, sellers fail to internalize the effect of the credit technology on buyers’ surpluses, which can lead to excess inertia* in the decision to adopt the record-keeping technology.

*Excess inertia occurs when a particular compatibility switch would increase social welfare, but each player is not willing to initiate it, unsure if others will follow.
When $i$ is close to zero, $z_0$ will be close to $\theta c(q^*) + (1 - \theta)u(q^*)$ and $q(z_0) \approx q^*$. Hence, $\mathcal{W}_0 \approx \sigma \{u(q^*) - c(q^*)\}$. Provided that $\zeta > 0$ the pure monetary equilibrium dominates the pure credit equilibrium from a social welfare perspective.

The resources allocated to the record-keeping technology are “wasted” in the sense that a monetary equilibrium avoids costs associated with record-keeping and provides an allocation that is almost as good as the credit allocation.

Still, if $\zeta < \sigma(1 - \theta) [u(q^*) - c(q^*)]$, agents can end up coordinating on the inferior (credit) equilibrium because of the strategic complementarities between the buyers’ and sellers’ choices.
Structure of this chapter

1. Introduction
2. Dichotomy between money and credit
3. Costly record-keeping
4. Strategic complementaries and payments
5. Short-term and long-term partnerships
6. Money, Credit and Banking
7. Conclusion
In the next section, we capture the notion of commitment through the reputation that buyers acquire by trading repeatedly with some sellers.

We show that the availability of credit depends on the value of money and monetary policy, and the extent of the trading frictions.
We assume that there is no enforcement technology and buyers cannot commit to repay their debt.

- Debt contracts must be **self-enforcing**.
- If there can be repeated interactions with a seller, a buyer will want to generate a reputation for paying his debts, and the **buyer’s desire** for this reputation results in contracts being self enforced.
We allow for the possibility of both short-term and long-term partnerships.

- A short-term match corresponds to a situation where the buyer and the seller know they will not meet again in the future.
- In a long-term match the buyer and the seller have a chance to stay together for more than one period.
Short-term and long-term partnerships

- At the beginning of a period, unmatched agents can enter into a long-term trade match with probability $\sigma_\ell$ or a short-term trade match with probability $\sigma_s$, with $0 < \sigma_\ell + \sigma_s < 1$.

- A short-term match is destroyed with probability one at the end of the day or DM, while a long-term match will be exogenously destroyed with probability $\lambda < 1$ at the beginning of the CM.
In addition, either party to a long-term match that is not exogenously destroyed can always choose to terminate the relationship at the beginning of the DM.

Since the measures of buyers and sellers are equal, there are also equal measures of unattached buyers and unattached sellers.
Short-term and long-term partnerships

A fraction $\sigma_l (\sigma_s)$ of unmatched agents find a long-term (short-term) match.

Matched sellers produce $q_l (q_s)$ in long-term (short-term) matches.

Matched buyers in long-term matches produce $y_l$.

A fraction $\lambda$ of long-term matches are destroyed.

Agents can readjust their money holdings.

Figure 8.4: Timing of a representative period.
The night period begins with buyers who are in a long-term partnership producing the general good for sellers if trade was mediated by credit in the previous DM.

A fraction $\lambda$ of buyers in the long-term partnership then realize a shock which dissolves the relationship they have with their currently matched seller.
Short-term and long-term partnerships

- This is followed by the opening of the CM, where the general good and money are traded.

- In terms of pricing mechanisms, we assume that buyers make take-it-or-leave-it offers to sellers in the DM, and that the night market is competitive, where one unit of money trades for $\phi_t$ units of the general good.
Short-term and long-term partnerships

We will restrict our attention to a particular class of equilibria that exhibit two features.

- First, money is valued, but is only used in short-term trade matches.
- Second, the buyer’s incentive-compatibility constraint in long-term matches—that the buyer is willing to produce the general good for the seller to extinguish his debt obligation—is not binding.
Short-term and long-term partnerships

- This latter assumption implies that a buyer in a long-term partnership will be able to purchase the efficient quantity of the DM search good, $q^*$, with credit alone.

- So these equilibria will be such that money and credit coexist but are used in different types of meetings, as in the previous sections, but we do not need to impose enforcement or commitment.
The value of being an unmatched buyer in the CM, $W_u^b(z)$, is given by

$$W_u^b(z) = z + T + \max_{z' \geq 0} \{-\gamma z' + \beta V_u^b(z')\}, \quad (8.28)$$

where $V_u^b(z')$ is the value of being an unmatched buyer holding $z'$ units of real balances at the beginning of a period.
The value function of an **unmatched buyer** in the **DM** who holds $z$ units of real balances, $V_u^b(z)$, is given by

$$V_u^b(z) = \sigma_{\ell} V_{\ell}^b(z) + \sigma_s V_s^b(z) + (1 - \sigma_{\ell} - \sigma_s) W_u^b(z).$$  

(8.29)
The expected lifetime utility of an unmatched seller in the CM is

$$W_u^s(z) = z + \beta V_u^s,$$  \hspace{1cm} (8.30)

where we take into account that sellers have no incentives to hold real balances in the DM.
Short-term and long-term partnerships

In the DM, the value of an **unmatched seller** is

\[ V_{u}^{s} = \sigma_{l} V_{l}^{s} + \sigma_{s} V_{s}^{s} + (1 - \sigma_{l} - \sigma_{s}) W_{u}^{s}(0), \tag{8.31} \]

where \( V_{l}^{s} (V_{s}^{s}) \) is the value of a seller in a long-term (short-term) match in the DM.
The **buyer** in a **short-term** trade match makes a take-it-or-leave-it offer, \((q_s, d_s)\), to the seller, where \(q_s\) is the amount of the search good that the seller produces and \(d_s\) is the amount of real balances transferred from the buyer to the seller.

The value function of a buyer holding \(z\) units of real balances in a short-term trade match, \(V^b_s(z)\), is given by

\[
V^b_s(z) = u[q_s(z)] + W^b_\mu[z - d_s(z)] = u[q_s(z)] - d_s(z) + z + W^b_\mu(0),
\]

(8.32)
Similarly, the value function of a **seller** (with no real balances) in a **short-term** trade match is

$$V^s_s = -c[q_s(z)] + d_s(z) + W^s_u(0), \quad (8.33)$$

where $z$ represents the buyer’s real balances.
The take-it-or-leave-it offer by the buyer maximizes the buyer’s surplus

$$u(q_s) - d_s$$

subject to the seller’s participation constraint

$$-c(q_s) + d_s \geq 0$$

and the feasibility constraint

$$d_s \leq z.$$ 

It is characterized by either $q_s(z) = q^*$ and $d_s(z) = c(q^*)$ if $z \geq c(q^*)$, or $q_s = c^{-1}(z)$ if $z < c(q^*)$. 
Hence, (8.32) becomes

\[ V^b_s(z) = u[q_s(z)] - c[q_s(z)] + z + W^b_u(0), \quad (8.34) \]

and, from (8.33), \( V^s_s = W^s_u(0) \).
The value function for a buyer in a long-term relationship holding $z$ units of real balances at the beginning of the period is

$$V_b^\ell (z) = u \left[ q_\ell (z) \right] + W_b^\ell \left[ z - d_\ell (z), -y_\ell (z) \right], \quad (8.35)$$

where $W_b^\ell (z - d_\ell, -y_\ell)$ is the value of the matched buyer at night holding $z - d_\ell$ units of real balances, with a promise to produce $y_\ell$ units of the general good for his trade-match partner.
Short-term and long-term partnerships

Even though we allow the terms of trade \((q_\ell, d_\ell, y_\ell)\) to depend on the buyer’s real balances, \(z\), in the following we will consider equilibria where buyers don’t use money in long-term partnerships, \(d_\ell = 0\) and \((q_\ell, y_\ell)\) is independent of \(z\).
The value function of a buyer in a long-term partnership at the beginning of the night satisfies

$$W^b_\ell(z, -y_\ell) = z - y_\ell + T + \lambda \max_{z' \geq 0} \{-\gamma z' + \beta V^b_u(z')\}$$

$$+ (1 - \lambda) \max_{z'' \geq 0} \{-\gamma z'' + \beta V^b_\ell(z'')\}. \quad (8.36)$$
Short-term and long-term partnerships

The value function for a seller in a long-term relationship at the beginning of the period is

\[ V^s_\ell = -c[q_\ell(z)] + W^s_\ell[d_\ell(z), y_\ell(z)]. \]  
(8.37)

The value function of the seller at night is

\[ W^s_\ell(z, y_\ell) = z + y_\ell + (1 - \lambda)\beta V^s_\ell + \lambda\beta V^s_u. \]  
(8.38)
Short-term and long-term partnerships

- We now turn to the formation of the terms of trade in long-term partnerships.

- We will assume that the buyer makes a take-it-or-leave-if offer, \((q_\ell, y_\ell, d_\ell)\).

- The offer must satisfy the incentive-compatibility constraint according to which the buyer is willing to repay his debt at night.
The buyer chooses \((q_\ell, y_\ell, d_\ell)\) in order to maximize \(V_b^\ell(z)\) subject to the seller’s participation constraint

\[-c(q_\ell) + W_s^\ell(d_\ell, y_\ell) \geq W_s^\ell(0, 0),\]

and the incentive compatibility constraint

\(W_b^\ell(z - d_\ell, -y_\ell) \geq W_b^\ell(z - d_\ell).\)

The incentive-compatibility constraint states that the buyer is better-off paying his debt than walking away from his partnership.
The buyer’s problem can be expressed as

$$\max_{q,y,d} [u(q) - y - d] \text{ s.t. } -c(q) + y + d \geq 0, \quad d \leq z,$$

$$y \leq W^b_\ell(0,0) - W^b_u(0).$$
We will focus on equilibria where the incentive-compatibility constraint (8.40) does not bind for all values of $z$. As a result, $q\ell = q^*$ and $y\ell + d\ell = c(q^*)$.

So the terms of trade in long-term partnerships are independent of the buyer’s real balances. With no loss, we can assume that buyers pay with credit only, $d\ell = 0$.

It is also immediate from (8.35) and (8.36) that a buyer in a long-term partnership at night will not accumulate real balances (in (8.36) $z'' = 0$).
Let us consider the choice of real balances by unmatched buyers. From (8.28)-(8.36), the optimal choice of real balances at night, $z$, for a buyer who is not in a long-term relationship satisfies

$$\max_{z \geq 0} \{-iz + \sigma_s \{ u[q_s(z)] - c[q_s(z)] \} \}. \quad (8.41)$$

This leads to the familiar first-order condition,

$$\frac{u'(q_s)}{c'(q_s)} = 1 + \frac{i}{\sigma_s}. \quad (8.42)$$
The last thing we need to check is that the incentive-compatibility condition, (8.40), is not binding.

Using that \( y_\ell = c(q^*) \), (8.40) becomes

\[
c(q^*) \leq W^b_\ell(0, 0) - W^b_u(0).
\]

(8.43)

With the help of equations (8.29)-(8.36), and after some rearranging, inequality (8.43) can be rewritten as

\[
c(q^*) \leq (1 - \lambda) \beta \left\{ (1 - \sigma_\ell) u(q^*) + ic(q_s) - \sigma_s \left[ u(q_s) - c(q_s) \right] \right\},
\]

(8.44)

where \( q_s \) satisfies (8.42).
If inequality (8.44) holds, then there exists an equilibrium where buyers and sellers in long-term relationships consume and produce $q_\ell = q^*$ units of the search good during the day and $y_\ell = c(q^*)$ units of the general good at night, using credit arrangements to implement these trades.

Buyers and sellers in short-term partnerships trade $q_s$ units of the search good for $y_s = c(q_s)$ units of real balances during the day.
Perhaps not surprisingly, if $\sigma_s = 0$, then from (8.42), $q_s = 0$ and the incentive condition (8.44) is identical to the one obtained in a model where money was absent and trade in long-term relationships was supported by reputation.
If the frequency of short-term matches, $\sigma_s$, increases, then, from (8.42), agents will increase their real balance holdings; as a result the incentive-constraint (8.44) becomes more difficult to satisfy.

Hence, the availability of monetary exchange in the presence of a long-term partnership increases the attractiveness of defaulting on promised performance.

However, if inflation increases, then, from the envelope theorem, the term $-ic(q_s) + \sigma_s [u(q_s) - c(q_s)]$ decreases, which relaxes the incentive-constraint (8.44).

Hence, a higher inflation rate reduces the buyer’s incentive to default on this long-term partnership obligations.
Short-term and long-term partnerships

Summary

The use of credit is not incentive-feasible in short-lived matches, since the buyer will always default on repaying his obligation.

In contrast, the buyer’s behavior in a long-lived match is disciplined by reputation considerations that will trigger the dissolution of a valuable relationship following a default.
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2. Dichotomy between money and credit
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7. Conclusion
The following Section has been adapted from the paper:

"Money, Credit and Banking" by Aleksander Berentsen, Gabriele Camera and Christopher Waller. CESifo Working Paper No. 1617, December 2005.
The economy now has three markets: A banking market, a decentralized market, and a centralized market. Agents lend or borrow in the banking market, and receive interest or pay back loans in the centralized market:

Figure 8.5: The BCW model
• All markets are competitive.
• Agents are anonymous in the DM market.
• Record keeping of financial transactions by banks only.
• The nominal price of goods in the DM is $p$.
• $i$ is the nominal interest rate in the Bank market.
• $\phi$ is the price of money in the CM.
• The government makes lump-sum transfer $T$ to agents in CM.
At the beginning of the period, agents learn their type:

- buyer with probability $1 - n$,
- seller with probability $n$.

In equilibrium, buyers borrow money and seller deposit money.

We solve the model backwards.
The value function at the beginning of the CM is

\[
V_3(m, l) = \max_{h, x, m'} u(x) - h + \beta V_1(m')
\]

s.t. \[x + \phi m' = h + \phi m - \phi l(1 + i) + T\]

\(l\): loan (\(l \leq 0\))

\(\phi\): \(\frac{1}{p}\)
The quantity $l$ can either be positive (to take a loan), or negative (to give somebody a loan; i.e., a deposit in a bank).

From the constraint:

$$h = x + \phi m' - \phi m + \phi l(1+i) - T$$

$$= x + \phi [m' - m + l(1+i)] - T$$
We can therefore rewrite (8.45):

\[ V_3(m, l) = \max_{x,m'} u(x) - x - \phi [m' - m + l(1 + i)] - T + \beta V_1(m') \]

FOC:

\[ x : \quad u'(x) = 1 \]

\[ m' : \quad \phi = \beta V'_1(m') \]
The envelope conditions are:

\[ m : \quad V_3^m(m, l) = \phi \quad \text{(8.46)} \]
\[ l : \quad V_3^l(m, l) = -\phi(1 + i) \quad \text{(8.47)} \]

Equation (8.46) is the marginal value of money. The negative sign in (8.47) reflects the disutility that an agent faces when he repays his debt.
The value functions at the beginning of the DM are

\[ V_{2b}(m, l) = \max_{q_b} u(q_b) + V_3(m - pq_b, l) \quad \text{s.t.} \quad pq_b \leq m \quad (\phi \lambda_q) \]

\[ V_{2s}(m, l) = \max_{q_s} -c(q_s) + V_3(m + pq_s, l) \]

where \( \phi \lambda_q \) is the Lagrange multiplier for the buyer’s constraint.

A seller has no constraint, because he can produce as much as he wants to.
The first-order conditions are:

- For a buyer:
  \[ u'(q_b) - p \cdot V_3^m - \phi p \lambda_q = u'(q_b) - \phi p - \phi p \lambda_q = 0 \] (8.48)

- For a seller:
  \[ -c'(q_s) + p \cdot V_3^m = -c'(q_s) + \phi p = 0 \] (8.49)

Combining (8.48) and (8.49) yields

\[ \frac{u'(q_b)}{c'(q_s)} = 1 + \lambda_q \] (8.50)
The envelope conditions are:

- For a buyer:

\[ m : \quad V_{2b}^m = \phi + \phi \lambda_q \]
\[ l : \quad V_{2b}^l = V_3^l = -\phi (1 + i) \]

- For a seller:

\[ m : \quad V_{2s}^m = V_3^m = \phi \]
\[ l : \quad V_{2s}^l = V_3^l = -\phi (1 + i) \]
The value function at the beginning of the Banking market is:

\[ V_1(m) = (1 - n) \max_{l_b} V_{2b}(m + l_b, l_b) \]
\[ + n \max_{l_s} V_{2s}(m + l_s, l_s) \]

subject to:

\[ l_b \leq \bar{l} \quad (\phi \lambda_b) \]
\[ m + l_s \geq 0 \quad (\phi \lambda_s) \]

where \( \bar{l} \) is an exogenous borrowing constraint.
The first-order conditions are:

\[ V_{2b}^m + V_{2b}^l - \phi \lambda_b = 0 \iff \phi \lambda_q - \phi i - \phi \lambda_b = 0 \] (8.51)

\[ V_{2s}^m + V_{2s}^l + \phi \lambda_s = 0 \iff \phi \lambda_s = \phi i \] (8.52)

The envelope condition is:

\[ V_1^m = (1 - n) V_{2b}^m + n (V_{2s}^m + \phi \lambda_s) \] (8.53)
As soon as they know what type of agent they are, the buyer will want more cash and will be ready to pay for it (interest rate).

The banking market reallocates the cash of sellers (the surplus) to people who want more money (the buyers).
Rewriting (8.53) using the results obtained for $V_2^b$, $V_2^s$ and $V_3$ yields:

\[
V_1^m = (1 - n) V_{2b}^m + n (V_{2s}^m + \phi \lambda_s) \\
= (1 - n) (\phi + \phi \lambda_q) + n (\phi + \phi \lambda_q) \\
= (1 - n) \frac{u' (q_b)}{p} + n (\phi + i \phi) \\
= (1 - n) \frac{u' (q_b)}{c' (q_s)} \phi + n \phi (1 + i) \\
\phi \frac{-1}{\beta} = (1 - n) \frac{u' (q_b)}{c' (q_s)} \phi + n \phi (1 + i)
\]
In a stationary equilibrium, \( \phi M = \phi_{-1} M_{-1} \iff \frac{\phi_{-1}}{\phi} = \frac{M}{M_{-1}} = \gamma \), and so:

\[
\frac{\gamma}{\beta} = (1 - n) \frac{u'(q_b)}{c'(q_s)} + n(1 + i)
\]  

(8.54)
We need one more equation that determines $i$. From Equation (8.48):

\[
    u'(q_b) = \phi p + p\phi \lambda_q \\
    = c'(q_s) + p\phi (i + \lambda_b) \\
    = c'(q_s) (1 + i + \lambda_b)
\]

(8.55)

From Equation (8.55), we can analyze two cases; i.e., when $\lambda_b$ is binding, and when it is not.
When $\bar{I}$ is not binding, it means that $\bar{I}$ is not relevant because people pay back and they never reach the exogenous borrowing constraint. Thus,

$$\frac{u'(q_b)}{c'(q_s)} = 1 + i$$

From (8.54), it follows that

$$\frac{\gamma}{\beta} = \frac{u'(q_b)}{c'(q_s)} = 1 + i$$  \hspace{1cm} (8.56)
Thus with financial intermediation, and from the market clearing condition \((1 - n) \cdot q_b = n \cdot q_s\), \(q_b\) solves

\[
\frac{\gamma}{\beta} = \frac{u'(q_b)}{c' \left[ \frac{(1-n)q_b}{n} \right]}.
\]

Without banking, we get

\[
\frac{\gamma}{\beta} = (1 - n) \frac{u'(q_b)}{c' \left[ \frac{(1-n)q_b}{n} \right]} + n.
\]

Consumption, and hence welfare, is strictly larger with financial intermediation than without it.
It is easy to see that financial intermediation provides a higher utility:

\[
\begin{bmatrix}
\frac{u'(q_b)}{c'(q_s)} \text{ intermediation} \\
\frac{u'(q_b)}{c'(q_s)} \text{ without intermediation}
\end{bmatrix}
\]

thus:

\[u(q_b)_{\text{intermediation}} > u(q_b)_{\text{without intermediation}}\]
Notice that the Fisher equation holds. From (8.56):

\[ \gamma = 1 + \pi \]
\[ \beta = \frac{1}{1 + r} \]

and thus

\[ (1 + \pi)(1 + r) = (1 + i) \iff \pi + r = i \] (8.57)
When the borrowing constraint $\bar{l}$ is binding, we have

$$\frac{u'(q_b)}{c'(q_s)} = 1 + i + \lambda_l$$

and thus

$$\frac{u'(q_b)}{c'(q_s)} > 1 + i$$

The Fisher equation does not hold. Moreover, the exogenous borrowing constraint reduces consumption relative to the amount that could be attained without it.
To analyze welfare, let us sum up the above results, we have:

\[
\frac{\gamma - \beta}{\beta} = (1 - n) \left[ \frac{u'(q_b)}{c'(q_s)} - 1 \right] + n\iota
\]

with financial intermediation

or:

\[
\frac{\gamma - \beta}{\beta} = (1 - n) \left[ \frac{u'(q_b)}{c'(q_s)} - 1 \right]
\]

without financial intermediation
From these two equations, it is clear that the benefit of the banking system is that it allows agents to earn interest on "idle" money.

This increases the demand for money and hence it’s value, which allows agents to consume more.
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In this chapter we considered environments where monetary trades coexist with credit arrangements.

We first examined a model where in some matches, agents’ transactions are monitored and debt contracts are enforceable while in other matches, agents are anonymous and debt contracts are not incentive-feasible.

In this benchmark economy, there is a dichotomy between the monetary and credit sectors and monetary policy does not affect the use of credit.

To break this dichotomy, we extended the model by allowing the gains from trade to vary across matches, and by making the access to a record-keeping technology costly. We showed that credit is used for large transactions and, as inflation increases, the fraction of credit transactions increases.
Conclusion

- Moreover, if the use of credit requires an ex-ante costly investment by sellers, multiple equilibria can emerge with different payment arrangements.
- Then, we endogenized the commitment that allows agents to repay their debt in an environment where agents can develop both long-term and short-term partnerships. In such an environment, self-enforced debt contracts coexist with fiat money.
- Finally, we developed a model which shows the role of banks as intermediaries and the gain in utility they allow.