Response to Tullock: Why do entrepreneurs not study the Austrian business cycle theory? Game theory approach.

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Abstract:
This paper reacts to Tullock’s suggestion that entrepreneurs should study the Austrian business cycle theory to obtain the ability to predict the consequences of the central bank policy. Game theory apparatus is used to explain why entrepreneurs have no incentive to study Austrian economics. The equilibrium outcome of non-repeated game, which is perfectly rational, is for no entrepreneur to study the Austrian theory since no one himself may change the course of cyclical fluctuations of the economy. Repeated game predicts that entrepreneurs study the Austrian theory only in a small economy and in case of sufficiently low interest rate.

Keywords:
Austrian business cycle theory, rational expectations objection, game theory, prisoner’s dilemma, trigger strategy

JEL classification:
C71, E32, E52
Introduction

The Austrian business cycle theory (Hayek 1933 and 1935, Mises 1953) is commonly criticized for its alleged incompatibility with the rational expectations hypothesis (Muth 1961, Lucas 1972). Critics of the Austrian cycle theory (e.g. Tullock 1988, Cowen 1997 or Wagner 1999) claim that if entrepreneurs’ expectations were rational, they could not be fooled systematically by the central bank lowering the market rate of interest below its natural level. Critics suggest that if entrepreneurs were rational and formed rational expectations, they would be able to predict consequences of the central bank policy and would learn systematically from their previous faults. Hence, an artificial boom-bust cycle could not be initiated in the economy with entrepreneurs who form rational expectations.¹

Additional argument against the Austrian business cycle theory is introduced by Tullock (1988, p. 73): “One would think that business people might be misled in the first couple of runs of the (...) cycle and not anticipate that the low interest rate will later be raised. (...) At the very last, one would assume that a well-informed business person interested in important matters concerned with the business would read Mises and Rothbard and, hence, anticipate the government’s action.” In other words, if entrepreneurs were familiar with the Austrian theory, they would not react in any way on expansive policy of the monetary authority and no artificial boom-bust cycle could be initiated.

There have been some attempts (e.g. Garrison 1989, Carilli and Dempster 2001 or Murphy 2005) to disprove the rational expectations objection and defend the Austrian theory against its critique. This paper aims to disprove Tullock’s suggestion by showing that entrepreneurs have no incentive to study the Austrian theory.

The paper follows the methodology of Carilli and Dempster (2001) who use the game theory apparatus to model the profit maximizing behavior of bankers and the investors during the business cycle. Since there are many entrepreneurs in the economy and no single one may change the course of economic fluctuations, interdependence of all the entrepreneurs’ decision-making must be considered; use of game theory methodology is hereby justified. Unlike Carilli and Dempster (2001), this paper

¹ The rational expectations hypothesis has gradually become one of key elements of modern macroeconomic theory. For this reason, the rational expectations objection must be taken seriously since otherwise the Austrian business cycle theory cannot be accepted by current macroeconomic mainstream.
formulates the game not only as non-repeated, but as repeated with infinite horizon as well which may lead to different conclusions compared to one-shot game. Furthermore, this paper answers different questions than Carilli and Dempster (2001).

We conclude that each entrepreneur’s dominant strategy in non-repeated game is not to study Austrian economics since no single entrepreneur may change the course of economic fluctuations. Then, socially optimal outcome is not achieved because of the prisoner’s dilemma problem. In repeated game, the possibility of socially optimal outcome achievement cannot be rejected; studying the Austrian business cycle theory may be optimal action for an entrepreneur in a small economy with sufficiently low interest rate. Thus, Tullock’s (1988) suggestion may be justifiable only in some specific cases and the Austrian business cycle theory may be defended against its critique.

The structure of the paper is as follows. Firstly, assumptions and methodology of the models are presented. The second chapter formulates non-repeated game and discusses its conclusions. The third chapter describes the game formulated as repeated with unknown termination and with players following the trigger strategy. The last chapter of this paper extends repeated game by considering postponement of the trigger strategy launch.

1. Assumptions and comments on methodology

Let us, in this paper, assume that entrepreneurs\(^2\) form rational expectations.\(^3\) Further, let us accept Tullock’s (1988) idea that if entrepreneurs knew the Austrian business cycle theory, they would possess the ability to anticipate the consequences of the central bank policy.\(^4\) If entrepreneurs used their knowledge of the Austrian theory to monitor the monetary policy, they could not be fooled by the central bank lowering the money rate of interest below its natural level and no artificial boom-bust cycle could be launched in such economy. Furthermore, let us assume that each entrepreneur prefers

\(^2\) The term “entrepreneur” is used instead of Tullock’s “business person”. This term does not refer to Kirzner’s (1997) entrepreneur; we assume all profits are known and no uncertainty and scope for entrepreneurial discovery exists.

\(^3\) There are numerous objections against the rational expectations hypothesis (e.g. Hoppe 1997, Boettke 1997, Block 1999 or Basse 2006). The assumption of rational expectations is made since aim of this paper is to show that even if entrepreneurs formed rational expectations, they would not study the Austrian theory.

\(^4\) This idea is criticized by Garrison (1986) explaining that even if entrepreneurs knew economic theory, they could not predict consequences of the central bank policy. This may be another critical argument against Tullock’s (1988) suggestion.
such outcome of smoothed course of economic development since each entrepreneur prefers smoothed course of revenues and profits over time.

Nevertheless, it is not warranted that an entrepreneur, even if he knows Austrian economics, monitors the central bank policy and aims to predict its consequences, since this activity is costly. At least opportunity costs of time spent with the monitoring and predicting must be considered and compared with the benefits from correct anticipating consequences of the monetary policy. Then, an entrepreneur has an incentive to study the Austrian theory only if he expects future use of acquired knowledge; otherwise, he has no incentive to study.\textsuperscript{5} Hence, we ask whether an entrepreneur aims to predict the consequences of the central bank policy. If so, he has an incentive to study the Austrian business cycle theory first. Let us, for simplicity, assume that studying is a costless activity.\textsuperscript{6}

Since there are many entrepreneurs in the economy, each of them possesses only very limited ability to influence the course of economic fluctuations. In such case, it is not sufficient to focus on decision-making of one separate entrepreneur. On the contrary, we need to consider interdependence of decision-making of all the entrepreneurs in the economy. Using the apparatus of the game theory is hereby justified.

For simplicity, let us make several additional assumptions. The whole economy consists of substantial number of entrepreneurs who are all small enough. Thus, no entrepreneur himself may influence the course of cyclical fluctuations of the economy. Moreover, let us assume all these small entrepreneurs are homogeneous and may be treated as one entity.

\section*{2. Non-repeated game}

Firstly, let us formulate and solve simple non-repeated simultaneous game. Two players, representative entrepreneur and all the other entrepreneurs treated as homogeneous, decide whether to use their knowledge of the Austrian business cycle theory to anticipate the consequences of the central bank policy.

\textsuperscript{5} We assume that an entrepreneur does not study the Austrian theory for any other reason than using it for predicting consequences of the central bank policy; no entrepreneurs gains utility directly from the knowledge of Austrian economics.

\textsuperscript{6} Studying economic theory is certainly not costless. If non-zero costs of studying were assumed, probability of studying would be lower compared to our conclusions.
Each player has two possible actions to be chosen (“to use” and “not to use”). Hence, the set-up leads to four possible outcomes – both representative entrepreneur and the other ones use their knowledge (square 1 in Figure 1 below), representative entrepreneur uses while the others do not (square 2), representative entrepreneur does not use while the others do (square 3) and both representative entrepreneur and the other ones do not use their knowledge (square 4).

All possible outcomes of the game bear some benefits and costs for representative entrepreneur. His pay-offs are summarized in pay-off matrix in Figure 1 below where “B” stands for his benefits and “C” denotes his costs.

<table>
<thead>
<tr>
<th></th>
<th>Other entrepreneurs</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>To use</td>
</tr>
<tr>
<td><strong>Representative entrepreneur</strong></td>
<td><strong>Square 1</strong></td>
</tr>
<tr>
<td>To use</td>
<td>B &gt; 0</td>
</tr>
<tr>
<td></td>
<td>C &gt; 0</td>
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<tr>
<td>Not to use</td>
<td><strong>Square 3</strong></td>
</tr>
<tr>
<td></td>
<td>B &gt; 0</td>
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<tr>
<td></td>
<td>C = 0</td>
</tr>
</tbody>
</table>

Figure 1 Pay-off matrix of representative entrepreneur

The costs of using the knowledge of Austrian economics are positive in squares 1 and 2 if an entrepreneur aims to anticipate the consequences of the monetary policy. These costs might be mostly opportunity costs of time and effort which could be devoted to other activities. We may, however, imagine explicit costs as well; for the purposes of our model, distinguishing between implicit and explicit costs is not necessary. In squares 3 and 4, the representative entrepreneur does not use his knowledge of the Austrian theory and, therefore, his costs are equal to zero.7

Since the representative entrepreneur prefers a smoothed course of economic development, his benefits8 are positive in cases of moderate course of cyclical

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7 One could object that an entrepreneur could hire experts with the knowledge of Austrian economics instead of predicting himself. Nonetheless, this is costly as well. It is not necessary to distinguish whether an entrepreneur learns Austrian economics and aims to understand the central bank policy or whether he hires someone to do that for him. We assume that costs of hiring forecasters should be the same as costs of forecasting himself; otherwise, profit opportunity would exist.

8 In this game, the benefits are benefits for the representative entrepreneur only, not benefits for the whole economy. Predicting the consequences of the monetary policy based on the knowledge of the Austrian theory and the following smoothing of the business cycle is the source of the positive externality; nevertheless, social benefits are not considered in the pay-off matrix since the representative entrepreneur cares only about his private benefits and does not take social benefits into account.
fluctuations of the economy and equal to zero if the business cycle occurs. Since no single entrepreneur himself may, by predicting correctly the consequences of the central bank policy, influence the course of the business cycle, these benefits depend rather on the action chosen by the other entrepreneurs. Thus, in squares 1 and 3 where the other entrepreneurs decide to use their knowledge, cyclical fluctuations should be smoothed and the representative entrepreneur’s benefits are positive, regardless whether the action he chooses. In square 2 where other entrepreneurs do not use their knowledge while the representative one does, his benefits are positive, but close to zero, since he possesses only very limited ability to change the course of the business cycle, which is smoothed only a little. Finally, in square 4, where no entrepreneur uses his knowledge of Austrian economics, cyclical fluctuations of the economy occur regularly, which bears zero benefits for the representative entrepreneur.

Let us now set up preferences of the representative entrepreneur. We assume that he aims to maximize the difference between his benefits and costs. Hence, square 3 is strictly preferred to all other squares since benefits are positive while costs are equal to zero in this square which gives the highest difference. Contrarily, squares 1, 3 and 4 are strictly preferred to square 2 since benefits are only slightly above zero while costs are positive in this square which gives the lowest difference. The question is whether the entrepreneur prefers square 1 to square 4, or *vice versa*. This cannot be determined theoretically, since the answer depends on exact values of benefits and costs in square 1. Nonetheless, the answer is not crucial for the subsequent analysis.

We may finally proceed to solve the whole game. If other entrepreneurs used their knowledge of Austrian economics, the representative entrepreneurs’ optimal action would be “not to use” since square 3 is strictly preferred to square 1. If the others did not use their knowledge, the representative entrepreneur should not use it as well, since he strictly prefers square 4 to square 2. Not to use the knowledge of the Austrian theory is, therefore, a dominant strategy for the representative entrepreneur in this game.

Since we assumed that all entrepreneurs in the economy are the same, the same decision-making problem is solved by all of them. Hence, not to use the Austrian theory to understand the consequences of the central bank policy is the dominant strategy for all entrepreneurs in the economy. Nash equilibrium of the game is in square 4; no entrepreneur has an incentive to use the knowledge of Austrian economics and aim to predict consequences of the monetary policy since no entrepreneur cannot unilaterally
increase his pay-off. Since no entrepreneur has an incentive to observe the central bank policy and to predict its consequences, knowledge of Austrian economics is useless for him. Hence, entrepreneurs have no incentive to study the Austrian business cycle theory in this one-round set-up. Tullock’s (1988) suggestion may be hereby disproved.

Nonetheless, such outcome is not socially optimal. Apparently, a socially optimal outcome might be in square 1; all entrepreneurs in the economy would use their knowledge of Austrian economics to understand the central bank policy. Thus, no cyclical fluctuations would occur in such outcome. Nevertheless, each entrepreneur has an incentive to deviate from his action by moving to square 3 which he strictly prefers to square 1. A socially optimal outcome is not achievable and sustainable because of coordination failure such as in the “prisoner’s dilemma” game. The outcome of the game is, however, perfectly rational.

3. Repeated game

The previously mentioned prisoner’s dilemma problem might be simply overcome by formulating the game as the dynamic one, consisting of more than one round (Potužák 2007). Furthermore, such set-up would be more realistic than previously described one-round game since entrepreneurs usually stay in their businesses for many years and their interactions have multiple-round nature. Thus, let us extend the model presented in the previous chapter by considering the game repeated for several times. For simplicity, the number of rounds is assumed to be infinite.10

Methodology remains the same as in the previous game; a game is played by one representative entrepreneur, whose decision-making is examined, and the other entrepreneurs, treated as one homogeneous player. Each player may choose between two possible actions, “to use” and “not to use” their knowledge of the Austrian theory. The question to be answered is whether representative entrepreneur has an incentive to use the knowledge of the Austrian business cycle theory to predict the consequences of

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9 It is not warranted that socially optimal outcome lies in square 1. We assume that square 1 is preferred to square 4 since in square 4, both benefits and costs are equal to zero, while in square 1, both benefits and costs are positive and benefits are assumed to be higher than costs. If benefits were lower than costs in square 1, this square would not represent socially optimal outcome of the game.

10 Infinite round game is an equivalent to finitely repeated game with a probabilistic continuation each round. Assuming infinite round game instead of finitely repeated game with probabilistic continuation makes computations easier. Finitely repeated game with known termination round is not considered since it may be simply transformed to non-repeated game by backward induction (Osborne 2004).
the central bank policy if the game is formulated as a repeated game with infinite horizon.

In the subsequent text, net benefit, denoted \( \pi_i \) in each of squares 1 to 4, stands for the difference between entrepreneur’s benefits and costs. Similarly to non-repeated game, an entrepreneur maximizes his net benefits; he chooses to use his knowledge only if net benefits in the case of using it exceed his net benefits in the case of not using it. Costs and benefits in later rounds of the game must be discounted to their present value.\(^{11}\)

Both players choose whether to use their knowledge of Austrian economics, which will be referred to as a cooperative action, or not to use it, which will be called non-cooperative action. We assume that both players follow the trigger strategy; an entrepreneur punishes the others through his non-cooperative action if they do not cooperate.\(^{12}\) The other entrepreneurs are expected to choose cooperative action until the representative one cooperates as well. If the representative entrepreneur stops cooperation, he is punished by the others who do not cooperate in subsequent rounds.

Cooperative action of the other entrepreneurs is supposed in the first round of the game while the representative entrepreneur may decide whether to cooperate or not. Hence, two outcomes may arise. Let us analyze all of them successively and express present value of the representative entrepreneur’s net benefits for both possible strategies.

Firstly, both the representative and the other entrepreneurs may choose a cooperative action in the first round. A socially optimal outcome is achieved and none of the players has an incentive to deviate from his action; cooperation of all entrepreneurs persists in all subsequent rounds of the game. Such situation corresponds to square 1 in Figure 1 above. For the present value of the representative entrepreneur’s net benefits in case of cooperative strategy \((NB_C)\) we obtain the following formula:

\[
NB_C = \pi_1 + \frac{\pi_1}{(1+r)} + \frac{\pi_1}{(1+r)^2} + \cdots = \pi_1 \cdot \frac{1+r}{r}.
\]  

Secondly, the representative entrepreneur may decide not to cooperate in the first round of the game while the other ones are assumed to choose cooperative action. In the first round of the game, the outcome is represented by square 3 in Figure 1.

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\(^{11}\) Present value is given by discounting future values by discount factor \(\frac{1}{(1+r)^t}\), where \(r\) denotes real rate of interest, which is, for simplicity, assumed to be constant over time.

\(^{12}\) Trigger strategy is explained in detail in Osborne (2004).
Nevertheless, since the representative entrepreneur does not cooperate, the others following the trigger strategy have an incentive not to cooperate as well in subsequent rounds of the game. Hence, the outcome in all subsequent rounds of the game will be expressed by square 4 in Figure 1 above. Present value of the representative entrepreneur’s net benefits for non-cooperative strategy \((NB_N)\) is, therefore, given by the following formula:

\[
NB_N = \pi_3 + \frac{\pi_4}{(1+r)} + \frac{\pi_4}{(1+r)^2} + \cdots = \pi_3 + \pi_4 \cdot \frac{1}{r}. \tag{2}
\]

Since both benefits and costs are equal to zero in square 4, net benefit is equal to zero as well \((\pi_4 = 0)\); hence, present value of net benefits is given just by

\[
NB_N = \pi_3. \tag{3}
\]

Using the knowledge of the Austrian business cycle theory may be rational action for the representative entrepreneur only if his net benefits of the cooperative strategy \((NB_C)\) exceed his net benefits of the non-cooperative strategy \((NB_N)\); hence, if

\[
NB_C > NB_N. \tag{4}
\]

Substituting equations (1) and (3) into the equation (4) leads to the following condition for cooperative strategy sustainability:

\[
\pi_1 \cdot \frac{1+r}{r} > \pi_3, \tag{5}
\]

which may be rewritten as

\[
r < \frac{\pi_1}{\pi_3 - \pi_1}. \tag{6}
\]

The real interest rate on the left side of equation (6) is assumed to be always positive because of positive rate of consumers’ time preference (Böhm-Bawerk 1891). The expression \(\pi_3 - \pi_1\) in denominator on the right side of this equation is positive as well since \(\pi_3 > \pi_1\).\(^{13}\) Hence, certainly no cooperation of entrepreneurs is sustainable in case of negative \(\pi_1\). The suggested inequality condition in equation (6) might be satisfied in case of positive \(\pi_1\); nonetheless, such outcome is not warranted.

Cooperative action is likely to occur only in case of sufficiently low real rate of interest; otherwise entrepreneurs do not cooperate. Whether cooperation of entrepreneurs is likely to be achieved depends mostly on parameters \(\pi_1\) and \(\pi_3\); the probability of cooperation increases with an increase in \(\pi_1\) and decreases with an increase in \(\pi_3\).

\(^{13}\) Representative entrepreneur’s benefits are almost the same in squares 1 and 3, his costs differ significantly, which explains the difference between his net profits in squares 1 and 3.
The repeated game implies that Tullock’s (1988) suggestion might be justified in some cases. If the interest rate were sufficiently low, entrepreneurs would have an incentive to use their knowledge of the Austrian theory to understand the monetary policy consequences. Then, they would need to get familiar with Austrian economics first. Hence, unlike in the non-repeated game, Tullock’s (1988) proposal may be only partly disproved if the repeated game with infinite number of rounds is considered.

4. Repeated game: An extension

When solving the infinite-round game, we assumed that entrepreneurs follow the trigger strategy, and as the representative entrepreneur chooses the uncooperative strategy, the others have an incentive not to cooperate in subsequent rounds as well. Nevertheless, such assumption seems to be feasible only in the economy with sufficiently low number of entrepreneurs having the capacity to observe the behavior of the others and hereby enforce their cooperation. In reality, this might not be the case. Entrepreneurs cannot observe one another perfectly and, therefore, their reaction to the non-cooperation strategy of the other entrepreneurs might be postponed by several rounds of the game.

Let us, therefore, extend previous model by considering the possibility of delay in trigger strategy launch. This might raise present value of net benefits in case of the non-cooperative strategy, which might decrease the probability of cooperation between entrepreneurs. Probability of studying and using the Austrian theory might be lower compared to simple repeated game solved in the previous chapter.

We expect that after the decision of the representative entrepreneur not to cooperate with the others, the trigger strategy is launched progressively, not immediately. Some entrepreneurs may react immediately, some in subsequent rounds, depending on their ability and willingness to observe the one who stopped his cooperation. Let us use the letter \( m \) \((m \geq 1)\) to denote the average number of rounds when the representative entrepreneur does not cooperate while the others do.

We may generalize the previously expressed equation (3) for present value of the representative entrepreneur’s net benefits in case of his non-cooperative strategy. Generalized equation takes the following form expressing the fact that net benefits are higher than in the case of immediate trigger strategy launch:
\[ NB_N = m \cdot \pi_3, \]  

Delay in trigger strategy launch does not change equation (1) for the present value of net benefits in case of the cooperative strategy. Then, the equation (5) expressing the condition for the cooperative strategy sustainability takes the following form:

\[ \pi_1 \cdot \frac{1+r}{r} > m \cdot \pi_3, \]  

where all variables have been described previously. The generalized condition may be rewritten as

\[ r < \frac{\pi_1}{m \cdot \pi_3 - \pi_1}. \]  

The presented generalized version of the model predicts that the cooperation of entrepreneurs is achievable only in the case of a sufficiently low interest rate, which is even lower than the interest rate expressed in previous chapter in equation (6). Thus, if the trigger strategy launch is not immediate, the probability of using the Austrian theory to predict the course of the business cycle decreases. The higher the delay in reaction (expressed by the parameter \( m \)) is, the lower is the interest rate necessary to achieve the sustainability of the cooperation of entrepreneurs. Probability of using the knowledge of Austrian economics decreases with an increase in parameter \( m \).

Apparently, \( m \) might not be an exogenous parameter. It might increase with an increase in the number of entrepreneurs in the economy since if there are many entrepreneurs, they possess only limited ability to observe one another. Thus, the probability of using the Austrian business cycle theory decreases with an increase in number of entrepreneurs in the economy. One might expect that \( m \) gradually approaches infinity if the number of entrepreneurs rises. Then, the expression on the right side of equation (9) approaches to zero if the number of entrepreneurs rises, which implies that a cooperative strategy cannot be achievable for any positive real rate of interest if there many entrepreneurs in the economy.

Using and studying the Austrian business cycle theory is likely only in the economy consisting of only few entrepreneurs who may easily observe the behavior of each other. On the contrary, modern economies consist of higher number of entrepreneurs where a lower interest rate is necessary to maintain the cooperative strategy of entrepreneurs.

This implies that even if repeated game is considered, Tullock’s (1988) critique might be disproved. Entrepreneurs might study the Austrian business cycle theory only.
in the economy with sufficiently low rate of interest and sufficiently low number of entrepreneurs.

Concluding remarks

This paper reacted to Tullock’s (1988) suggestion that entrepreneurs should study the Austrian business cycle theory to understand the consequences of the central bank policy. We aimed to reject this suggestion and hereby partly disprove the rational expectations objection against the Austrian business cycle theory.

Game theory apparatus was used to explain that entrepreneurs might have no incentive to study Austrian economics. Since entrepreneurs are too small to have the capacity to change the course of the business cycle, their dominant strategy in non-repeated game is not to study the Austrian theory. Repeated game suggests that entrepreneurs might have an incentive to study Austrian economics in some cases, but such outcome is more likely to occur in an economy with a small number of entrepreneurs with a capacity to observe one another. We have, therefore, concluded that Tullock’s proposal may be disproved.
References


