Back to Cantillon: On the Relevance of the Monetary Economics of Richard Cantillon

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Dedication

To my teachers.

Acknowledgements

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Abstract

BACK TO CANTILLON: ON THE RELEVANCE OF THE MONETARY
ECONOMICS OF RICHARD CANTILLON

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Richard Cantillon was an eighteenth-century economist who raised the idea of

monetary non-neutrality that we today also know as "Cantillon Effects". Cantillon

and his followers emphasize that changes in the quantity of money progress over

the economy in a step-by-step fashion and lead to wealth redistributions and to

real effects on production processes. Cantillon's idea of monetary non-neutrality

is the underlying theme of the three chapters of the dissertation. In the first

chapter, I argue that the idea of "Cantillon Effects" has been downplayed in the

modern macroeconomics. I conclude that it should not have been so because

the idea stands the test of consistency of the equilibrium analysis as well as that

of historical relevance. The following two chapters are additional illustrations of

the usefulness of the idea of "Cantillon Effects". In the second chapter, I

reconsider the Austrian business cycle theory, where "Cantillon Effects" are an

important component. I show that the theory holds also for the assumption when

people hold unbiased expectations. In the third chapter, I apply the Austrian

business cycle theory into international context and show that the application is

consistent with the basic stylized facts.

Introduction

While being one of the most important predecessors of Adam Smith, Richard Cantillon is an unknown name to many living economists and so is his work. One might argue that this does not have to be something worrisome. George Stigler (1969) might after all be correct and all the useful ideas that the history of economics can offer are already incorporated within the modern economic thought. The ignorance about Cantillon then poses no setback for the development of the discipline and it is rational for a professional economist to be ignorant in this respect.

However what if Stigler is wrong and it is rather Kenneth Boulding (1971) who got it right? In other words, what if history of economics can systematically offer important insights that have not been incorporated into modern economics? It is my contention that some of the Cantillon's ideas on monetary economics – particularly his analysis of non-neutrality of changes in the money supply – have been downplayed and that important insights have been lost.

Cantillon's insights on non-neutrality of money relate to the chapters 6 and 7 of the second volume of his book (2010 [1755]: 147-157). He explains there his views on consequences of changes in the money supply, today also known as "Cantillon Effects", in three steps. First, he identifies that there are different

potential channels through which new money enters the economy. Second, he views changes in the money supply as progressing thorough the economy in a step-by-step-pattern. Third, given the previous two steps, he concludes that a change in the money supply changes relative prices.

Cantillon considers the first point to be very important as he indicates by his repeated concern about the sources of the changes in the quantity of money that he discusses. He mentions the owners of the gold or silver mines, balance of foreign trade, and other possible sources. The point to be taken is simple – an increase in the money supply does not just happen, it comes about through actions and money balances of particular individuals.

The emphasis that he puts on the sources of the injection of the new money allows Cantillon to talk about the second point – the step-by-step process of diffusion of the additional money supply. It is the early recipients of money who receive the new money first while others get their hands on the new money only later.

The previous two points then lead to the third point, where Cantillon shows causal relationship between changes in the money supply and changes in relative prices:

The change in relative prices, introduced by the increased quantity of money in the state, will depend on how this money is directed at consumption and circulation. No matter who obtains the new

money, it will naturally increase consumption. However, this

consumption will be greater or less, according to circumstances. It

will more or less be directed to certain kinds of commodities or

merchandise, according to the judgment of those who acquire the

money. Market prices will increase more for certain goods than for

others, however abundant the money may be. (Cantillon 2010

[1755]: 156)

Cantillon's idea of monetary non-neutrality is the underlying theme of the

three chapters that follow. In the first chapter, I argue that the idea has been

downplayed in the modern macroeconomics. While "Cantillon Effects" can be

also expressed in terms of the equilibrium analysis, this option has been set

aside. I illustrate this by the Nobel Lecture of Robert Lucas and his discussion of

David Hume's analysis of monetary change, which is identical to the analysis of

Cantillon. I conclude that the idea of "Cantillon Effects" should not have been set

aside because it stands the test of consistency of the equilibrium analysis as well

as that of historical relevance. The two chapters that follow are further

illustrations of the usefulness of the idea of "Cantillon Effects".

In the second chapter, I reconsider the Austrian business cycle theory,

where "Cantillon Effects" are an important component. Critics often point out that

the theory relies on the assumption of people committing systematic errors

during monetary expansions. How else could one relate economic recessions to

a cluster of errors as the Austrian business cycle theory does? Contrary to the criticisms the theory holds also in settings where people commit unbiased errors. If heterogenous people form unbiased expectations about the length of monetary expansion, there are both overestimating and underestimating people. The pattern of errors produced by the overestimations is, however, different when compared to the pattern of the underestimations. The overall pattern of errors then conforms to the Austrian business cycle theory.

In the third chapter, I expand the Austrian business cycle framework into the international context. I argue that domestic monetary policy imposes real effects at home as well as abroad and aligns international co-movement of business cycles across different currency areas. I show that domestic monetary expansion changes through "Cantillon Effects" the relative prices between domestic and foreign goods and also between goods of earlier stages of production and goods of later stages of production. The change in the relative prices leads to coordination failures as people invest into specific factors of production that become unprofitable once the monetary expansion ends. The framework explains the surge of coordination failures that we see during the bust phase of the business cycle. The framework is also consistent with the stylized facts of co-movement in economic aggregates across countries.

Chapter 1: Notions of Non-neutrality: Lucas on Hume and Money

1.1 Introduction

Besides being a medium of exchange, money is also a medium of change.
But changes in the quantity of money impose real effects on economies in a
number of ways. It is perhaps for this reason that the meaning of the term "non-
neutrality of money" is not as precise as one would hope for (*cf.* Humphrey 1991,
Subrick 2010) and one has to use proper qualifications to avoid ambiguities. I
will focus on one specific meaning of money non-neutrality that can be traced
back to David Hume (1987abc [1752])[1]. Hume considered changes in the money
supply as processes that happen through money balances and expenditures of
particular people. Being injected through particular people, it takes time before
the new money reaches everyone in the economy and the final equilibrium is re-
established. During the period of transition towards the final equilibrium, a

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1   The same theory of non-neutrality that I discuss here can be also traced back to Richard
    Cantillon (2010 [1755]). Although Cantillon's work was published in 1755, which is three years
    after the Hume's 1752 publication, Cantillon probably completed the manuscript around 1730
    (Thornton 2007: 454). There is no direct evidence proving an intellectual influence of Cantillon
    on Hume (Henderson 2010: 163-166, Monroe 2001 [1923]: 211 n658, Murphy 1985: 203,
    Perlman 1987: 283-284 n5, Viner 1937: 74 n2, Wennerlind 2005: 227 n3). Still, a number of
    authors make unbacked suggestions in this respect (Blaug 1991: ix, Hayek 1967 [1935]: 9,
    1985 [1931]: 238, Rothbard 2006 [1995]: 360, Spengler 1954a: 283) and Thornton (2007)
    provides some indirect evidence. The fact that Hume and Cantillon share the same theory of
    non-neutrality of money might be also explained by an independent factor that had influence
    on both of them. Marget (1966a [1938-1942]: 501-502, 1966b [1938-1942]: 309) makes this
    very claim when he argues that the theory was not a product of an isolated individual but that
    it was rather part of intellectual debates of the time.

change in the money supply, or a monetary process, affects relative prices and leads to redistributions.

The academic interest in Hume's theory over the last eighty years seems to follow a U-shaped pattern. After being in the center of discussions in the time between the world wars (*cf.* Hayek 1967 [1935], Keynes 2011 [1930], Robbins 1971 [1934]), the theory became rather uninteresting in the post-second world war period. A good illustration of the fading interest during this period is the change in views held by Milton Friedman. Friedman initially uses Hume's theory to explain the existence of the time lags between monetary policy and changes in output (Friedman 1961: 461-463). Later, when discussing the effects of the helicopter drop of additional money supply (Friedman 1969: 4-7), he still recognizes the theory and although he is not critical, he abstains from any further elaborations. In later works, Friedman becomes openly critical. He criticizes Hume's theory due to the lack of systematic supporting evidence[2] – a point to which I will return (Friedman 1972: 15, Friedman 1987: 10)[3].

Hume's theory of non-neutrality managed to attract some supporters after Friedman's 1961 piece. Cagan (1966: 229-230, 1969) and Allais (1974: 311-315)

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2 A similar claim about the lack of empirical evidence is made by Chari (1999: 6).
3 One might also consider Alchian (2006 [1968]: 386-387, 389) and Alchian and Kessel (2006 [1956]: 410, 412) as critical voices against the Hume's theory of non-neutrality of money as I presented it above. Especially Alchian and Kessel (2006 [1956]) can be interpreted as arguing that redistributive effects of increases in the money supply are not at all related to the fact that someone holds the new money first. This would be, however, a rather uncharitable interpretation, especially when the two papers are taken together. The purpose of the papers is to distinguish between the redistributive effects inflation, defined as a general rise in the price level, when compared to other redistributive effects that might accompany inflation. Because inflation, as it is defined, is not necessarily related to changes in the money supply, the redistributive processes coming form changes in the money supply do not have to accompany inflation.

use it to explain the liquidity effect. Hayek (1969: 277-282) argues on its basis that changes in the money supply lead to changes in relative prices and have an effect on production. Morgenstern calls for an attention towards the theory in general (1972: 1184-1185). Wagner (1977) discusses its implications in the context of self-interested policy makers who are trying to affect relative prices through monetary policy and unintentionally create business-cycle. And Bordo (1983) and Perlman (1987) revisit Hume's non-neutrality in the context of exercises in the history of economic thought[4] [5].

It seems that the last decade has witnessed a resurgence of support for Hume's theory, although the authors do not necessarily recognize it to be so. Anthonisen (2010) interprets Friedman (1961) in the fashion of the Hume's non-neutrality of money and creates a corresponding model with geographic diffusion of money. New money injections thereby change relative prices and production. Sanches and Williamson (2011) also discuss Hume's idea of how new money enters the economy through specific markets and has non-neutral effects. Their model is inhabited by heterogenous individuals with information asymmetries who face both centralized segmented markets and spatially segmented markets. Shi (2004) considers point-injections of additional medium of exchange into economy with a centralized bond market and a decentralized market for goods. And Williamson (2008, 2009) looks at the non-neutralities when money is

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[4] Morgenstern (1972), Allais (1974), and Bordo (1983) revisit the Humean notion of non-neutrality while discussing the work of Richard Cantillon (see n1).

[5] In my account of the supporters, I focus on the main outlets in the profession as these outlets tend to indicate the prevailing research interests of the time.

injected into the economy that is characterized by segmented asset markets and segmented goods markets[6]. In spite of the recent increase in interest, Hume's theory still remains only a side-issue in academic discussions on non-neutrality of money. It is my contention that such marginalized position of the theory is not justified.

1.2 Lucas and Hume

The Nobel Lecture of Robert E. Lucas, Jr. (Lucas 1996) offers an analytic foil for reintroducing Hume's theory of money non-neutrality into the foreground of our discussions. Lucas (1996) recognizes Hume as an intellectual predecessor of his own views on money non-neutrality. A recognition of similarity, however, does not mean identical views and Lucas (1996) realizes a cognitive dissonance between himself and Hume. It is the analysis of the dissonance that, I believe, proves helpful in finding common ground between the theory that Hume holds about the non-neutrality of money and the current mode of thinking about the real effects of changes in the money supply.

My primary goal is thus not to compare Lucas and Hume on money for the sake of comparing Lucas and Hume. It is the scalability of such a comparison that is more interesting. Lucas (1996) is, in a sense, a representative of the way of thinking that is characteristic for both New Classical and New Keynesian

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6   The number of related works is even higher when one includes exercises in history of economic thought published in the journals that do not specialize in the field. See Berdell (2010: 216-217), Schabas and Wennerlind (2011: 218-220), and Wennerlind (2005). Berdell discusses Hume's theory while revisiting Cantillon.

models when addressing the question of money neutrality[7]. The common thread in the models is the initial assumption of essentially frictionless money that is injected into a world of various frictions. No matter what the assumed frictions are, the focus of the analysis is directed towards characteristics of particular markets and individuals rather than towards money. Hume and his theory of non-neutral money proceeds differently. For Hume, it is the money, or the monetary process, that itself contains "frictions". No additional assumptions about the frictions of the outside world are necessary.

Making a distinction between the world of frictions represented by Lucas (1996) on the one hand and the monetary process containing frictions described by Hume on the other hand, is therefore not a mere quibble. Hume builds a theory that is consistent with empirical findings and that also has theoretical importance. I discuss these two claims in a more detail later on, referring to the empirical literature on relative price variability and using the version of the islands model developed by Lucas to illustrate the theoretical usefulness of Hume's theory.

The story of Hume and Lucas also speaks to the importance of the history of economic thought as a tool for doing economic research. Consider here the tension between Stigler (1969) and Boulding (1971)[8]. Stigler argues that although economics has useful past, the costs of doing research related to the history of economic thought seem to surpass the benefits. The low benefits of

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7   For surveys, see Hoover (1988) on New Classical Economics and Gordon (1990) on the New Keynesians.
8   See Boettke (2000) discussing Stigler (1969) and Boulding (1971).

revisiting past authors come from the fact that their useful ideas are already

incorporated within the modern economic thought. Accepting the view that

history of economic thought is too costly as a research tool, Stigler concludes his

piece saying "it remains the unfulfilled task of the historians of economics to

show that their subject is worth its cost" (Stigler 1969: 230). In the reply,

Boulding argues that history of economic thought can systematically offer

important insights that have not been incorporated into modern economics.

Older works can be understood as a part of the extended present and analyzed

in the light of present discussions. This is, Boulding says, particularly important

nowadays when the focus of the profession is directed towards quantitative

research and when an increasing amount of resources employed in quantitative

research leads to significant diminishing returns of this research. The present

essay offers a datapoint in support of Boulding's argument against Stigler's

challenge.

1.3 What Hume said and how to think about it

Hume discusses consequences of changes in the money supply in his "Of

Money" (1987a [1752]), "Of Interest" (1987b [1752]), and "Of the Balance of

Trade" (1987c [1752]). Hume considers the differences in the levels of money

supply in closed economy as irrelevant[9] but he argues that changes in the money

supply matter[10] (Humphrey 1991: 5). I have already briefly presented Hume's

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9   Hume (1987a [1752]: 281-286, 288-290, 294; 1987b [1752]: 295-299, 301-303; 1987c [1752]:
    311, 316-317).
10 Hume (1987a [1752]: 286, 286-288, 294; 1987b [1752]: 296, 305-306; 1987c [1752]: 317 n13).

theory of non-neutrality which is an outcome of Hume's broader discussion of changes in the money supply. The theory says that additional money supply diffuses around the economy through particular points of initial injection. The process takes time and involves changes in relative prices.

The theory can be broken into three constituent parts. First, new money enters economy through expenditures of specific individuals. Second, it takes time before new money gets into the cash balances of all individuals and the economy reaches equilibrium. And third, a change in the money supply leads to temporary changes in relative prices. I elaborate each of the three parts separately to clarify the theory and the assumptions involved.

1.3.1 Points of injection

The following statement illustrates the first part of the theory:

> When any quantity of money is imported into a nation, it is not at
> first dispersed into many hands; but is confined to the coffers of a
> few persons, who immediately seek to employ it to advantage.
> (Hume 1986a [1752]: 286)

New money is always imported through money balances of a few specific people. While there might be a number of reasons behind the importation of money into a country which is on a commodity standard, Hume gives examples of international

trade (1986a [1752]: 286-287) and conquest of foreign lands with mines (1986b [1752]: 305-306).

Besides his discussion of international trade, Hume does not directly address other situations when the new money enters monetary system, like when it comes from debasement or from expansion of paper money. One can, however, make a case that Hume generally thought that changes in the money supply originate with some specific individuals.

While Hume, for example, does not discuss the injections of new money coming from debasement, he observes that the effects of debasement on prices spread over time (1986a [1752]: 287). Based on the discussion of the effects, one can argue that newly debased money is in Hume's eyes injected into the economy through expenditures of some particular individuals, most likely the king.

Hume also indirectly touches the case of paper money (1986c [1752]: 317 n13). He says that the consequences of an increase in the quantity of paper money can have the same beneficial impact on output that he described for the situation when new money enters country through importation of specie. Since such beneficial impact also includes the assumption of point-injection of the new money, one can infer that when there is an increase in the money supply through paper money, Hume thinks that it happens by injecting the money through money-balances of particular people.

Irrespective of how broadly Hume intended to apply his statement about

injection of new money through specific individuals, the statement applies to

other types of changes in the money supply under commodity money regimes

and fiat regimes. There is always someone who receives the new money first

and someone who receives it later[11]. If the money is imported, it is the importer

who has it first; if it comes from mining, it is the owner of the mine; if it is printed

by a printing press, it is the person who uses the money first, and so on.

1.3.2 Spending and frictions

The previous subsection is a statement of the assumption that new money

enters at some specific point. Next, the theory needs to consider the spending

patterns of the holders of the new money. Let me assume with Hume that people

are heterogenous, or that recipients of the new money do not spend it in exact

proportion to the existing composition of aggregate expenditures on goods. This

assumption means that as the new money progresses through the economy, the

relative revenues and expenditures of people change. The changes in relative

nominal incomes resulting from the injection of the new money then allows me to

distinguish between people on the basis of the order in which they receive the

new money. If someone receives the new money first, there has to be someone

who receives it second, third, and so forth. Hume recognizes the step-by-step

dispersion of the new money when he says:

[S]ome time is required before the [new] money circulates through

11 One can think of exceptions but these are rare and not relevant for my analysis.

the whole state, and makes its effect be felt on all ranks of people[.] (Hume 1986a [1752]: 286)[12]

Hume later gives an example of the process in which new money spreads through the economy after it is imported by merchants from the Spanish city Cadiz:

Here are a set of manufacturers or merchants, we shall suppose, who have received returns of gold and silver for goods which they sent to CADIZ. They are thereby enabled to employ more workmen than formerly, who never dream of demanding higher wages, but are glad of employment from such good paymasters. … [Each workman] carries his money to market[.] ... The farmer and gardener [who supply workmen]… can afford to take better and more cloths from their tradesmen[.] … It is easy to trace the money in its progress through the whole commonwealth[.] (Hume 1986a [1752]: 286-287)

The reader who is familiar with the passage might notice the omission of most of the parts referring to changes in the output and relative prices. I do not focus in the present paper on the changes in the output and I discuss the changes in

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12 Hume makes a similar statement in a more specific context when he talks about money that is imported into a country through conquest (Hume 1986b [1752]: 305).

prices in the following subsection. The abridged quote stresses Hume's idea that

new money spreads over the economy in a step-by-step fashion. The initial

holders of the new money are in this case manufacturers and merchants. The

initial holders hire additional workmen who in turn increase expenditures for the

products of farmers and gardeners. Farmers and gardeners increase their own

expenditures buying products from their tradesmen, and so forth.

It might be sometimes useful to abstract from the fact that changes in the

money supply happen in a step-by-step fashion. Alchian (2006 [1968]), who

distinguishes between wealth redistributions caused by changes in the general

price level from all the other redistributive effects that might circumstantially

accompany the change in the price level, is a good example of usefulness of

such an abstraction. At the same time, one should not forget that each

abstraction is a tool that serves its limited purposes. We should not blind

ourselves to the possible importance of the fact that changes in the money

supply almost necessarily have to happen in the step-by-step fashion as

described by Hume.

The step-by-step process follows from the simple fact that the same piece

of money cannot be simultaneously spent in two different transactions. Two

transactions using the same piece of money can therefore happen only

sequentially and not simultaneously.

But recognizing the fact of sequential nature of transactions is not enough

for making Hume's story of step-by-step injection of new money consequential for

relative prices. If the initial recipients of the new money spent the new money exactly in proportion to the current aggregate expenditures on the existing goods, the step-by-step process would have hardly any real consequence. To abstract from the inconsequential set of possibilities I assume that the initial recipients do not spend the new money exactly in proportion to the current aggregate expenditures, or in other words I assume that individuals are heterogenous.

1.3.3 Relative prices

The assumption that new money enters the economy through particular money balances, combined with the assumption that people are heterogenous, so that those who receive the new money have spending patterns that differ from the relative aggregate expenditures on different goods, leads to the Hume's conclusion that a change in the quantity of money leads, at least temporarily, towards changes in relative prices of goods. In Hume's own words

> [T]hough the high price of commodities … [is] a necessary
> consequence of the encrease of gold and silver, yet it follows not
> immediately upon that encrease; but some time is required before
> the money circulates through the whole state, and makes its effect
> be felt on all ranks of people. At first, no alteration is perceived; by
> degrees the price rises, first of one commodity, then of another; till
> the whole at last reaches a just proportion with the new quantity of

specie which is in the kingdom. (Hume 1986a [1752]: 286)[13]

The question to be answered is whether Hume's theory, which relates changes in the quantity of money to changes in relative prices, requires additional assumptions next to the two that are already stated. For example, one might think of introducing imperfect market-clearing, imperfect information, or imperfect expectations. While introduction of such phenomena might serve as a good complement to the story, it is unnecessary.

To confirm the previous claim, I make the following thought experiment. Assume an environment with (1) perfect information about current events, (2) no information asymmetries, (3) no transactions costs, and (4) people and firms who have no significant market powers. The environment implied by (1) through (4) takes care of all the external frictions which means that people have immediate optimal responses with respect to any new information or event.

In addition, assume that (5) during the whole run of the model, there is only one unexpected monetary shock, where money supply enters economy through particular people. Assumption (5) allows to abstract from influences of all other thinkable shocks.

Last, assume that (6) once the shock happens, everyone has perfect foresight of the consequences of the shock. The last assumption allows to abstract from the effects of imperfect foresight that might sometimes accompany monetary shocks.

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13 *Cf.* Hume (1986a [1972]: 288; 1986b [1972]: 296, 305-306).

I now trace the effects of the unexpected shock to the money supply in the framework of the assumptions (1)-(6). In the same instant as the new money is accepted by the initial receivers, all people in the economy are aware of the monetary shock. In addition, everyone has the same perfect foresight of all future consequences of the shock which means that all future prices and revenues are a public information. To describe the effects of the monetary shock on relative prices, I start by focusing on the newly injected money, introducing three consecutive groups of recipients – *merchants*, *workers*, and *farmers*. Assume that the new money is worth $1 and it is received by *merchants* at time *0*. *Merchants* spend all the new money at time *1* for goods owned by *workers*. *Workers*, in turn, spend all the new money at time *2* for goods of *farmers*. The example rises a question with respect to the situation of *workers* and *farmers*. It is one of the assumptions that *workers* and *farmers* hold perfect foresight of the results of current monetary shock on their future income. Does the perfect foresight also allow them to neutralize the effects of the monetary shock on relative prices?

The answer to the question is negative. Assume that the nominal interest rate for the period between *0* and *1* is r_1 and that the nominal interest rate for the period between *0* and *2* is r_2. Time preference and progressing inflation imply that $1 < r_1 < r_2$. The difference in the nominal interest rates means that *merchants*, *workers*, and *farmers* apply different discount rates in time *0* when they determine the present value of increase in cash balances resulting from the

monetary shock. While the present value in time 0 is $1 for *merchants*, it is only

$1/r_1$ for *workers*, and $1/r_2$ for *farmers*, where $1 > 1/r_1 > 1/r_2$. The difference in the

present values means that in spite of perfect foresight, the three groups of people

can respond to the monetary shock in time 0 only in a disproportionate fashion.

The monetary shock increased the ability of *merchants* to outbid *workers* and

farmers. For the same reasons, the ability of *workers* to outdo *farmers* in the

bidding process has also increased. The change in the abilities of different

individuals to bid for different goods also means that the relative prices will differ

in comparison to what would have happened without the monetary shock. With

the conclusion that the shock is accompanied with a change in relative prices, I

have explained why it is that change in the money supply is not fully neutralized

even when people perfectly predict its consequences once it happens. To be

sure, the perfect foresight allows people to make use of their advantage before

the new money physically enters their cash balances. In this sense, perfect

foresight affects the process of changes in relative prices that accompanies the

step-by-step process of change in the money supply. But it does not change the

very fact that monetary shocks have an effect on relative prices and are therefore

non-neutral. This holds long as new money is injected into the economy through

some particular person who does not spend the new money in line with the

already existing equilibrium, which are the assumptions that I made in the

beginning of this subsection.

1.4 Lucas on Hume and money

Hume's theory of money non-neutrality is very powerful because the essence of the theory depends on two assumptions to which one can hardly object: that money is injected into the economy through money balances of particular individuals, and that people are heterogenous, so the initial recipients of the new money do not spend it on existing goods in proportions that would neutralize the real effects of monetary expansion. The assumptions bring the necessary conclusion that a change in the money supply has a temporary effect on the distribution of resources, relative prices, and correspondingly on what people produce.

Yet, as I have noted in the Introduction, Lucas (1996) displays some cognitive dissonance when he goes through the conclusions of Hume's theory (Hume 1986ab [1752])[14]. This dissonance has been already briefly discussed by Blaug (2001: 154-155) and noted by Laidler (2010: 48 n13). Blaug (2001: 155)

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14 It is an interesting question by itself to think about the possible motivations that lead Lucas to discuss Hume at such a length. I have found two plausible clues that might be complementary in providing the answer. First clue was pointed to me by Maria Paganelli who stressed the link between Lucas and Milton Friedman, who cites Hume (*cf.* Friedman 1987: 3). The second clue is "A sticky-price manifesto" of Ball and Mankiw (1994) to which Lucas wrote a comment (Lucas 1994). Ball and Mankiw make a distinction between traditionalists and heretics in macroeconomics (1994: 127-128), where traditionalists believe in the importance of price-stickiness and heretics do not. While Ball and Mankiw decide to include among the traditionalists Friedman and Hume (1994: 127), they put Lucas into the category of heretics (1994: 135). Lucas (1994: 154) labels Ball and Mankiw's (1994) distinction between traditionalists and heretics as "ideological" and he finds application of this type of ideology within economics profession to be "risky" (1994: 154-155). Being an ideologue, according to Lucas, one has an incentive to caricature one's opponents and to abstain from acknowledging contributions from the other side of the barricade just for the sake of staying ideologically pure. Perhaps it was for this reason that Lucas chose Hume as a foil for his lecture. If he accepted the view of Ball and Mankiw (1994) that Hume is in some sense a predecessor of the tradition of the idea of sticky prices in economics, Lucas might have decided to make an example of the views that he expressed in Lucas (1994). In his 1996 lecture, Lucas therefore considers Hume as a peer with interesting insights, some of which are useful and some of which are, at least for Lucas, not so useful.

criticizes Lucas (1996) for trying to reconstruct Hume's account of short-run non-neutrality of money through the general equilibrium model.   According to Blaug, Hume never intended to do so and it is no wonder that Lucas (1996) finds problems with Hume's discussion of non-neutrality of money.

One can certainly make an argument, as Blaug (2001) does, that the source of the problem of Lucas (1996) with Hume is a clash of methodologies that cannot be reconciled in a single unified framework. It might be argued persuasively that while Hume explains non-neutrality of money through a perspective of disequilibrium reasoning, Lucas is struggling to reconcile Hume's explanation with the general equilibrium framework. After all, the assessment that Lucas (1996) gives himself is similar to Blaug's (2001), although with a different aftertaste. According to Lucas, Hume and economists who follow Hume have to "resort to disequilibrium dynamics" (Lucas 1996: 669), or different methodology. The methodology used by Hume is, however, presumably inferior because Hume and his followers use such methodology "only because the analytical equipment available to them offers no alternative" (Lucas 1996: 669). Lucas gives a more comprehensive statement later on when he says:

> The intelligence of these attempts to deal theoretically with the real
> effects of changes in money is still impressive to the modern
> reader, but serves only to underscore the futility of attempting to
> talk through hard dynamic problems without any of the equipment

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of modern mathematical economics. (Lucas 1996: 669).

Although one might accept the argument advocated by Blaug (2001) and Lucas (1996) about the methodological difference, I think that there is a more fruitful way of reconsidering the clash between Lucas and Hume. In my reconsideration, I will focus only on the question of redistributions and relative price effects that result from change in the money supply, or on what I have called Hume's theory. It is true that both Hume (Hume 1986ab [1752]) and Lucas (1996) explore the link between the theory and changes in aggregate output in some specific direction but this is a separate problem that I do not intend to discuss here.

The starting point of my reconsideration is the following passage where Lucas tries to square Hume's "disequilibrium dynamics" with the framework of general equilibrium.

> If everyone understands that prices will ultimately increase in proportion to the increase in money, what force stops this from happening right away? Are people committed, perhaps even contractually, to continue to offer goods at the old prices for a time? If so, Hume does not mention it. Are sellers ignorant of the fact that money has increased and a general inflation is inevitable? But Hume claims that the real consequences of money changes are

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"easy to trace" and "easily foreseen." If so, why do these consequences occur at all? (Lucas 1996: 663-664)

The passage above is noteworthy for at least two reasons. First, Lucas judges the outcomes described by Hume's theory through the lens of an equilibrium framework where the point of injection of new money does not matter. As it becomes clear later, only if the point of injection does not matter and all frictions are assumed away, does it make sense to ask "why do consequences of monetary expansion occur at all?", as Lucas does. And second, it is interesting to see what kind of frictions is Lucas looking for in order to understand and justify Hume's story. Lucas hypothesizes about contracts that extend over more periods of time, ignorance, or imperfect expectations. All of these are frictions that would create the non-neutrality of otherwise neutral money. But the frictions are not related to the diffusion of the money, rather with people who populate the world where the new money is injected.

The essence of Hume's theory that relates changes in the money supply with changes in relative prices and redistributions does not rely on *ad hoc* assumptions about the world. Quite to the contrary, one has to recognize only four points that are quite reasonable, where the first two are assumptions and the remaining two can be derived from the standard assumptions of economic analysis. First, money enters economy through money balances of particular people. Second, the initial holders of money do not spend the new money

exactly in the same proportions of the prevailing pattern of aggregate expenditures. Third, new money does not miraculously spread into the money balances of all individuals in the same instant as it is injected into the economy. And fourth, present revenues and future revenues of the same nominal values have different present discounted values. The four points can answer the concern raised by Lucas in the passage cited above. Increase in the money supply leads to real effects even if people are not bound by inflexible contracts, ignorance, or imperfect expectations.

Why is it then, as Lucas wonders, that some sellers abstain from an increase in prices to the equilibrium levels at the very same moment with the monetary shock? Sellers are profit maximizers and they have to respond to the demand of their customers. Some customers have their money balances increased right when the new money is injected, money balances of others remain for some time unchanged. Sellers whose primary customers is the latter group of people might find that the optimal solution is to not to immediately raise their prices to the long-run equilibrium level. One can point out that sellers with temporarily disadvantaged customers can still make an arbitrage between the low prices prevalent at the moment and the higher future prices. Even if the costs of storing goods over time are zero, some sellers still have an incentive, at least to some extent, from such increase of present prices. The discount factor of the future revenues of the sellers, which includes time preference and inflation premium, might be too high to justify the intertemporal exchange[15].

15 The same reasoning applies to buyers.

The essence of what I call here Hume's theory of non-neutrality of money, which relates changes in the money supply with redistributions and changes in relative prices, is therefore not in conflict with equilibrium style of reasoning. Hume's theory can be conveyed, as I have done above, in a framework with maximizing individuals who use money in an otherwise frictionless world. The distinction between Hume and Lucas therefore does not have to be put as the one between equilibrium and disequilibrium or between rigorous analysis and "patched-in" dynamics as Lucas puts the issue at a point (Lucas 1996: 669). The underlying analytical tool is in both cases a similar framework of general equilibrium, the real difference comes with the recognition of what constitutes non-neutrality of money. While Hume recognizes this feature primarily in the diffusion process of money, Lucas has a tendency to point to the non-neutral features of the world which is characterized by otherwise neutral money.

1.5 Rigor and relevance

I have argued that Hume's theory of money non-neutrality can be understood as an equilibrium theory. But the fact that a theory comports to a certain standard of rigor does not mean that the theory also stands to the standard of relevance. I now bring arguments supporting the claim that Hume's theory of non-neutrality of money can stand the test of theoretical as well as historical relevance.

1.5.1 Theoretical relevance

Turning first to the relevance on the theoretical level, it is Lucas himself who, probably without knowing it, provides a good illustration of the usefulness of Hume's theory. In his paper 'Understanding business cycles' (Lucas 1977), Lucas discusses a version of his islands model, where every price change can be either a permanent real change, or a transitory real change, or a nominal change. Because people face the signal extraction problem and cannot distinguish between nominal price changes and the other types of price changes, an unexpected monetary expansion can lead to cyclical changes in aggregate output. Lucas perceives a particular weakness in his model, namely, the justification of the assumption that individuals cannot recognize a nominal price change especially when monetary aggregates are readily available (1977: 24). The sketch of an answer that Lucas provides to the weakness is very interesting in the light of Hume's theory that I discussed in the sections above.

Lucas knows that if there was a straightforward relationship between money and other variables, the problem of identification of nominal price changes would become "trivial". But the world is more complex and "... the link between money and … [prices and output] and other variables is agreed to be subject … to 'long and variable lags.'" (Lucas 1977: 24). Perhaps the most interesting part is what Lucas suggests as the answer to the question of the source of the variable lags, a "question [on which] little is known" (Lucas 1977: 24).

It seems likely that the answer lies in the observation that a

monetary expansion can occur in a variety of ways, depending on

the way the money is "injected" into the system, with different price

response implications depending on which way is selected. (Lucas

1977: 24)

Lucas (1977) recognizes that the point of injection of new money matters.

Alternative injections of money supply spread throughout the economy in

different ways and have different effects on relative prices. The different effects

of alternative injections of new money supply can then, at least to some extent

explain, the variable lags in which variables respond to changes in the money

supply.

There is a close correspondence between the way that Lucas (1977)

answers the signal extraction problem related to monetary shocks and Hume's

theory discussed above. Hume also recognizes that new money is injected into

the economy through money balances of particular people. But he does more

than that, and in this sense expands the story that one can read in Lucas (1977:

24). Hume's theory explains why the injection is followed by a series of relative

price changes. Assuming heterogenous people, injections through different

people have to lead to different ways in which new money diffuses through the

economy. Reconsidering Hume's theory in a stochastic environment, it is no

surprise that people have problems to identify which price changes have nominal

causes. And having accounted for the source of confusion that people have to bear during a shock to the money supply, the business cycle model proposed by Lucas (1977) becomes more plausible.

1.5.2 Historical relevance

Hume's theory is consistent with the existing empirical literature on relative price variability. If money supply increases through balances of particular individuals, it is likely that only a subset of goods is initially purchased by the additional monetary units. Correspondingly, it is the prices of the initially purchased goods that are affected by the increase in the money supply relatively sooner. Such an increase in prices of selected goods should be then related to an increased relative price variability. That this is the case has been documented by Bordo (1980), and Fischer et al. (1981).

Further, the recognition that increase in the money supply leads to an overall increase in the price level can be used in restatement of the previously discussed relationship. If an increase in the money supply leads to an increase in the relative price variability, it should also be the case that an increase in the price level leads to an increase in the relative price variability. That this conclusion is also a fact therefore serves as another confirmation of the consistency of Hume's theory with the data[16].

Last, Hume's theory is also consistent with another statistical property of

16 The important contributions include Fischer et al. (1981), Parks (1978), Vining and Elwertowski (1976), Debelle and Lamont (1997), and Lastrapes (2006). For a recent overview, see Lastrapes (2006).

relative prices that is observed during an inflationary period, namely, with the rightward skewness of the distribution of shocks to individual prices (Vining and Elwertowski 1976, Ball and Mankiw 1995). If the new money is injected through specific cash balances, the owners of the new money likely spend it on a limited number of goods. If the Hume's theory holds, it should be then a small number of prices that statistically push the inflation rate upwards. The observation that inflation is driven by a relatively small number of therefore prices makes Hume's theory again consistent with the data.

After making a case for the relevance of Hume's theory, I would like to bring attention to some current questions where the theory might prove to be important. If monetary policy affects relative prices, to what extent are the respective bubbles in particular industries, e.g., a housing bubble or a dot-com bubble, result of monetary policy decisions? Or, if the point of infusion of the new money into the economy matters, to what extent does this observation explain the unprecedented actions of Fed over the recent crisis when it decided to purchase mortgage-backed securities instead of the Treasury bills? Hume's theory seems to be more than well suited for answering these and similar questions.

1.6 Conclusion

Modern economics has overly discounted the importance of one aspect of non-neutrality of money represented here by David Hume. The aspect is not the

non-neutrality of a frictionless money circulating in a world of frictions as represented by Robert Lucas. The aspect represented by Hume is rather the non-neutrality that results from money being the commonly accepted medium of exchange.

The neglect of Hume's insights in modern monetary theory, I believe, is an understandable consequence of the nature of economic science. Most of the insights in economics are not based on experiments, but are established by deductive reasoning (Hayek 1944: 136-137). With every new generation of economists, the knowledge of previous generations is sustained only when it is successfully replicated. And the very need for this replication opens a chance of losing particular insights. Economic theorems are therefore never established "once and for all", and methodological trends make it difficult to rediscover in some eras (Hayek 1944: 137).

It is an empirical question how often it happens that an important theorem is lost in transfer across generations of economists. The example of Hume's theory is only one datapoint for such an empirical investigation and cannot be generalized. Yet, while I do not provide a definitive answer to the Stigler's challenge that he raised against usefulness of history of economic thought, my result still seems to be encouraging for those who believe that history of economic thought is one of the tools of doing economics.

Chapter 2: The Austrian Hydraulics: A Restatement

[Economic system] is a system of thoughts before it is a system of actions.

– Shackle (1988 [1981]: 172)

2.1 Introduction: hydraulics and kaleidics

Macroeconomic theorems that are built as equilibrium constructs often resemble hydraulic mechanics. In the same way as hydraulic mechanics allows one to control objects through mechanical properties of liquids, macroeconomic laws are presented as tools for controlling social aggregates. As long as one uses hydraulic mechanics and macroeconomics to understand relationships between certain variables, the two have a lot in common and the analogy between them can go as long as one stays descriptive. The matter becomes more complicated when it comes to the real ability to control the variables in question. Here the road shared by hydraulic mechanics and macroeconomics comes to a fork and each of the two takes different direction. While the mechanics is primarily about control, the ability to control assumed by hydraulic macroeconomics is usually just a matter of thought experiment. To avoid this pretense of the ability to control, I confine my discussion of "economic hydraulics" to the descriptive meaning of the term.

Although there might be different emphasis on hydraulic issues, particularly due to the recognition of the importance of the emergent phenomena (*cf.* Menger 2009 [1883]), economists working in the Austrian tradition do not deny the importance of the hydraulic style of reasoning. An example in place is the Austrian business cycle theory, also called "the Austrian hydraulics"[17]. The term is appropriate as the canonic expositions of the theory make it quite clear (Hayek 1967 [1935], Mises 1971 [1912][18]). The expositions describe the relationship between monetary policy and different economic aggregates as that of a cue playing different balls on a billiard table. An increase in the money supply drives real interest rates down and leads entrepreneurs to invest into overly long production processes. The new investment is, however, unsustainable because it is incompatible with the willingness of people to save. The discrepancy between savings and investment is eventually revealed and cluster of entrepreneurs suffers losses on their unfinished investment. Capital goods representing the unfinished investment have to be scrapped or reallocated.

Since hydraulic economics – or the equilibrium style of theorizing – is *a* method of doing economics, one can hardly object against theory, like the Austrian business cycle theory, just for the sake of hydraulics. However, once hydraulic theory becomes questionable on the grounds of its logical consistency

17 I heard the term for the first time from Richard E. Wagner during his graduate
   macroeconomics class in 2008. He referenced Daniel J. D'Amico as the originator of the term.
18 Besides the discussions on pages 24-30 and 76-83, Garrison (2001) also falls into this
   category.

or on the grounds of certain assumptions, there are three options to choose from. First, one can fix the problem within the hydraulic style of theorizing. Second, one can, at least to some extent, abandon the hydraulic style of theorizing while keeping the basic message of the theory. Or third, one can decide to scrap the theory because of the implausibility of the message.

As I explain below, the Austrian business cycle theory faces important problems related to its assumptions about expectations. It would be, however, a mistake to use the problems as a justification for quick dismissal of the theory. If for anything else, its intuitive appeal as well as the supporting empirical evidence (*cf.* Callahan and Garrison 2003, Curott and Watts 2011, Hughes 1997, Powell 2002, Robbins 1971 [1934], and Rothbard 2000 [1963]) should in this respect lead to great caution. Taking the cautious position as the starting point, one is left with the two remaining options that can possibly lead to a satisfactory reconstruction of the theory. One can either restore the theory within the existing hydraulic style of theorizing or he can change the style of theorizing.

A comprehensive solution of the problem of expectations in the Austrian business cycle theory would require to abandon the existing hydraulic framework. For now, I do not take this ultimate step and, as the title suggests, I confine myself to the problems of hydraulics. In spite of this confinement, I still find it important to briefly compare the present endeavor with the possible more comprehensive solution.

The Austrian business cycle theory is partly an attempt to explain

erroneous investment into industries producing higher order goods. The errors

have one specific characteristic – they are revealed at certain point in time in a

cluster. The existence of the cluster of errors is therefore, in some sense, the

starting point of the analysis – the problem to be explained. The nature of the

problem opens up possible complementary approaches for discussion of clusters

of errors. The first, hydraulic, approach searches for the types of errors that are

consistent with the dynamics of the Austrian business cycle theory. The

approach enables the of the theoretical possibilities rather than that of the actual

states of the world. Such discussion allows one to assess whether the range of

assumptions for which the theory holds is sufficiently general and "reasonable" or

rather strict and "implausible".

The second, kaleidic, approach to the discussion of errors complements

the first one with explanatory and empirical content. It relates different

circumstances to various distributions of errors across people. With help of the

first approach, the distributions of errors might be recognized as those that lead

to the dynamics described by the Austrian business cycle theory or those that do

not.

As I note above, I focus on the matters of hydraulics by developing a

general framework which explores consequences of monetary expansion under

different types of assumptions about errors and expectations. I focus my efforts

towards a specific application of this general framework where people hold

expectations about future that do not lead to systematically biased errors. I start

with the recognition that with such unbiased expectations, some people underestimate the length of an on-going monetary expansion and some people overestimate it, on average all being correct. The underestimating people tend to invest into shorter productions and overestimating people tend to invest in longer productions. The people from the two groups, however, learn about their errors differently. The underestimating people tend to find about their errors at different points in time and the errors sometimes cannot be observed others. In contrast, the overestimating people all learn about their errors at the same point in time – once the monetary expansion stops. It is then the errors of the overestimating people that are visible as a cluster, which is the pattern of the traditional Austrian business cycle theory. I thereby show that the dynamics of the Austrian business cycle theory is consistent with a broader set of assumptions, including that of individuals with unbiased expectations, than it is usually recognized.

2.2 The points of departure

Error is nothing but a manifestation of previous decisions based on incorrect expectations. Since the Austrian business cycle theory is often portrayed as theory of clusters of errors (*cf.* Hayek 1975 [1939]: 141, Hülsmann 1998, Robbins 1971 [1934]: 31, Rothbard 2000 [1963]: 8), one would think that the expositions of the Austrian business cycle theory make their assumptions about expectations very clear. Such thought would be, however, mistaken as a surprisingly large number of contributors to the Austrian business cycle theory

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does not discuss the question of expectations at all, including a number of major contributions (*cf.* Hayek 2008 [1933][19], Machlup 1940, Mises 1971 [1912]: 339-364, Robbins 1971 [1934]: 30-54[20], Rothbard 2000 [1963]: 3-36, 2009 [1962]: 989-1024)[21] [22]. Even the existing discussions of the problem of expectations are rather scattered.

I have divided the arguments addressing the problem of expectations in the Austrian business cycle literature into, what I call, the three lines of defense. The arguments of the first line of defense assume that entrepreneurs suffer during monetary expansion from a systematic bias, where the resulting errors are concentrated in the higher order goods industries. The arguments of the second line of defense explain why people commit errors during the monetary expansion but the arguments fail to explain the cluster of observed errors in the industries producing higher-order goods. The argument of the third line of defense brings a mixture of the problems of the first two lines of defense.

I first turn to the works of the first line of defense, where Hayek's 1933

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19 Hayek (2008 [1933]: 33) briefly recognizes that the Austrian business cycle dynamics happens under circumstances when changes in the money supply lead entrepreneurs towards incorrect expectations about future prices. After this brief recognition Hayek changes the topic and does not revisit the problem of expectations in this work.

20 On page 39, Robbins (1971 [1934]) discusses the problem of unfulfilled expectations but does not state the assumptions explicitly.

21 The silence about the problem of expectations in the literature possibly led Morgenstern towards his dissatisfaction with the treatment of expectations in the business-cycle literature of the time (1937: 104-105).

22 Butos (1997: 76-81) tries to explain the insufficient discussion of expectations in the works of Mises and Rothbard. Mises, and arguably also Rothbard, understands expectations as thoughts that are contingent on particular circumstances of time and place. Because economic laws hold irrespective of particular data, expectations of given time and place cannot be explained by general economic laws. Salerno (2010 [1995]: 214-219) seems to agree with this interpretation Mises'es view on expectations. Salerno also recognizes that the theory of, or the specific set of assumptions about, expectations brought by Mises, is outside of the pure logic of choice, or praxeology.

Copenhagen lecture (Hayek 1975 [1939]: especially 141-142) is a good starting

point (*cf.* also Hayek 2008 [1937]: 524, 529). Hayek argues that the Austrian

business cycle dynamics depends on the assumption that entrepreneurs use

present prices to form expectations about future prices. When monetary

expansion decreases short-term real interest rates, entrepreneurs fall prey to the

belief that the period of low real interest rates is going to last for a relatively long

period of time. Longer production processes become in their eyes more

profitable and they invest accordingly (*cf.* O'Driscoll 1977: 102-103, White 1999:

114)[23]. Entrepreneurs recognize their mistaken beliefs only when the monetary

expansion comes to its end.

Hayek thus assumes that monetary expansion somehow leads people into

overestimating of the period of low real interest rates. Without the assumption, or

without a substitute leading to similar outcomes, the Austrian business cycle

dynamics does not hold. But what could possibly justify the view that

entrepreneurs are systematically and repeatedly fooled when predicting

durations of monetary expansions? This question has been raised by multiple

authors, including Caplan (1997), Cowen (1997), Lachmann (1943), Tullock

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23 Or as Hayek puts it:

> In general it is probably true to say that most investments are made in the
> expectation that the supply of capital will for some time continue at the present
> level. Or, in other words, entrepreneurs regard the present supply of capital and
> the present rate of interest as a symptom that approximately the same situation
> will continue to exist for some time. And it is only some such assumption that will
> justify the use of any additional capital to begin new roundabout methods of
> production which, if they are to be completed, will require continued investment
> over a further period of time. (1975 [1939]: 142)

(1987), and Wagner (1999)[24].

The remaining contributions to the first line of defense try to justify the assumption that people *do* suffer from a systematic bias and therefore *do* have a tendency to overestimate the period of low interest rates during monetary expansions. Mises (1943) supports the assumption with a multiple of reasons[25], all of which boil down to the claim that entrepreneurs lack sufficient economic education[26]. Barnett and Block (2006: 35-36, 46, 71-72)[27], and Simpson (2008: 122-124) raise similar argument when they claim that entrepreneurs tend to ignore existing monetary expansion and that they also tend to ignore the effects of monetary expansion. In his take on the issue, Lachmann (1945, 1978 [1956]: 29-34) suggests that every person has a mental range of feasible prices. If the

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24 Monetary business cycle models of New Classical Economics (*cf.* Lucas 1977, 1996) face a similar problem when they talk about the signal extraction problem. The New Classical models have to justify why people have a systematic problem to distinguish between changes in relative prices and changes in the general price level. Rather than having the problem to identify what is happening in different sectors of the economy at a given point in time, the Austrian business cycle theory assumes that people have insufficient amount of information when they compare present prices with prices of the future. The New Classical story then presents puzzle of systematic miscoordination in space and the Austrian theory presents puzzle of intertemporal miscoordination (*cf.* O'Driscoll 1979: 163).

25 These reasons include observation of an increasing demand for one's goods, falling prey to the gospels of "would-be-experts" who claim that "mankind has finally entered the stage of everlasting prosperity" (Mises 1943: 251), or a problem to distinguish between nominal and real interest rates. The last reason might come from the fact that in an inflationary period, monetary expansion keeps low real interest rates while the nominal interest rate remains high due to the inflation premium also called the Fisher effect. Entrepreneurs who look only at the nominal interest rates might think that the interest rates have not been artificially lowered by the monetary policy and that a fear of bust is unjustified.

26 "Nothing but a perfect familiarity with economic theory and a careful scrutiny of current monetary and credit phenomena can save a man from being deceived and lured into malinvestment." (Mises 1943: 252). *Cf.* Butos (1997: 76-77), Cachanosky (2012: 4), and Salerno (2010 [1995]: 228-230).

27 A number of works cited in this section, like Barnett and Block (2006), use a range of arguments to defend the Austrian business cycle theory against the concerns related to the assumption about expectations. I have decided to discuss the contributions on argument-by-argument basis rather than on work-by-work basis in the cases when it makes the discussion more systematic.

present price is within the range, entrepreneurs are likely to expect the price to

persist in the future. Although Lachmann does not apply his model of formation

of expectations to the Austrian business cycle theory, the model explains why

entrepreneurs could tend to expect persistence of low real interest rate during

monetary expansion. Barnett and Block (2005: 433), Block (2001: 66-67),

Cachanosky (2012), and Garrison (1986: 446) go further and show that not all

entrepreneurs have to be biased. The Austrian theory holds even when only a

segment of entrepreneurs overestimates the length of the monetary expansion

while the remaining segment has correct expectations. The entrepreneurs who

are not fooled can then still participate on unsustainable processes by becoming

suppliers of the projects envisioned by the mistaken entrepreneurs[28].

The explanations included in the first line of defense imply a cluster of

errors in longer production processes but all of them face the same problem as

Hayek's argument in the Copenhagen lecture. They assume underlying

unexplained errors that lead entrepreneurs, or a segment of entrepreneurs,

towards systematically biased expectations about future real interest rates. The

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28 This argument has a caveat, however. The extent of participation of entrepreneurs who have
   correct expectations is limited by the amount of projects that are planned by the entrepreneurs
   who have mistaken expectations. Cachanosky (2012) can be understood as a response to
   this potential limitation. He argues that a minority of mistaken entrepreneurs can create a
   strong aggregate tendency towards investment into overly long production processes. Such
   tendency is possible when there is a group of similarly mistaken bankers who accommodate
   the demands of the mistaken entrepreneurs for additional credit. The mistaken entrepreneurs
   then use the credit to outbid other entrepreneurs when competing for the factors of production.
   Unsustainable projects thereby crowd out the sustainable ones. Cachanosky's (2012)
   argument, however, rests on the unexplained assumption of systematic error on the level of
   the banking system. Mistaken banks have to be able to create sufficient amount of credit to
   fund the mistaken entrepreneurs. Cachanosky (2012) does not explain where the ability of the
   mistaken banks to create sufficient amount of credit comes from, given the limitations that
   every bank in this respect faces.

fact that erroneous investment into overly long production process is particularly costly (Cowen 1997: 81, 82-83), however, undermines the plausibility of such systematic bias. But if it is implausible to assume that entrepreneurs suffer from a tendency to overestimate the length of monetary expansion, how generalizable is the dynamics described by the Austrian business cycle theory?[29]

Contributions included in the second line of defense recognize the objection against the unexplained errors that entrepreneurs make in the arguments of the first line of defense. The contributors raise a number of arguments explaining why entrepreneurs are bound to commit errors during monetary expansions. I present the arguments in two groups according to their level of generality.

The general arguments within the second line of defense include Barnett and Block (2005: 432) and Block (2001: 67-68), who realize that people have heterogenous expectations and some of them are therefore bound to commit errors, Barnett and Block (2006: 62), who note that people are endowed with free will which makes perfect forecast impossible, and O'Driscoll and Rizzo (1996 [1985]: 207-208), who recognize that people are endowed with imperfect knowledge.

The general arguments can be understood as the basis for the set of five

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29 The conclusion that Austrian business cycle theory has only limited application in this respect can be identified in Hülsmann (1998). According to Hülsmann, government has incentives to conceal monetary expansions. If government succeeds, it can decrease unemployment and prevent public outrage related to inflationary redistributions (Hülsmann 1998:15). People, however, do not necessarily have to be fooled and monetary expansion does not have to lead to the dynamics described by the Austrian business cycle theory.

more specific arguments that explain why people commit errors when they form

expectations about monetary expansions. First, actions of policy makers are not

fully predictable (Barnett and Block 2005: 432, O'Driscoll and Rizzo 1996 [1985]:

218, Simpson 2008: 120-121)[30]. Second, outcomes of economic policies, even if

the policies themselves are known, are not fully predictable (Barnett and Block

2005: 432). Third, there is no consensus on the correct economic model (Barnett

and Block 2005: 432, Block 2001: 65, Garrison 1986: 444, O'Driscoll and Rizzo

1996 [1985]: 218-219, Simpson 2008: 119). Fourth, even if people had the

correct model, they would not know the correct values of the variables of the

model (Garrison 1986: 444, O'Driscoll and Rizzo 1996 [1985]: 222-223, 227,

Simpson 2008: 120-121). Fifth, monetary expansion is related to the problem of

monetary misperceptions because people might have problems to distinguish

between permanent real and temporary monetary sources of changes in

demands for their products (Barnett and Block 2006: 39, Block 2001: 68,

Garrison 1986: 446-447, 2001: 26-29, 77-79, 82-83)[31].

      I do not intend to evaluate the relative strengths of the individual

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30 The discussion of Callahan and Horwitz (2010: 220-222) is an extension of this argument.
Callahan and Horwitz argue that an increase in discretionary monetary policy increases
uncertainty at financial markets and people are therefore more likely to commit errors. This
conclusion is based on the analysis of Big Players in Koppl (2002). Big Player is an institution
like central bank – it can exercise a higher level of discretion than other market participants.
An increased presence of a Big Player at a market leads to an increased uncertainty at this
market and therefore to a higher likelihood of errors.

31 Evans and Baxendale (2008) argue that banks tend to allocate the additional funds coming
from monetary expansion towards more risky projects. The projects are performed by less
experienced entrepreneurs and more to fallible, possibly because of the winner's curse (Evans
and Baxendale 2008: 87). The scenario described by Evans and Baxendale is possible,
however, it remains implausible without further argument relating monetary expansion and the
incentives that banks have to invest more into risky projects. Since winner's curse holds
irrespective of monetary expansions, it cannot by itself explain the sudden increase in the
proportion of risky projects undertaken during monetary expansions (Cowen 1997: 82).

arguments included in the second line of defense because they all share the same weakness. While the arguments might explain why people commit errors when forming expectations about monetary policy and its consequences, the resulting errors do not tend to concentrate towards investment into long production processes. The absence of the bias in the arguments of the second line of defense then calls for further discussion that would explain how the unbiased errors translate into clusters of errors in long production processes. Such discussion, however, does not come and the respective authors therefore fail to restore the dynamics of the Austrian business cycle theory on a footing of sounder assumptions about expectations.

Carilli and Dempster (2001), who represent the third line of defense, argue that monetary expansion allows entrepreneurs to start more projects. They assume that once entrepreneurs begin to act on the new opportunity, the proportion of unsustainable projects in the economy increases. Since people and banks, again by assumption, cannot ex ante distinguish between sustainable and unsustainable projects, there is an incentive to use the new money from the monetary expansion and to start new projects. After all, while each additional project increases the risk of failure of all projects in the economy, the project itself bears only fraction of the related expected cost. The principle of concentrated benefits and dispersed costs then dictates people to accept the additional funds coming from monetary expansion in spite of the resulting increased risk for the economy as a whole. With the higher risk, monetary expansion eventually ends

up with an increased number of errors in the economy.

Carilli and Dempster (2001) face a combination of the problems mentioned before. In a similar way as it is with the first line of defense, Carilli and Dempster (2001) do not explain how monetary expansion causes an increased risk of the failure of projects. Since there is no self-evident and unambiguous way in which monetary expansion makes people more prone to commit errors, the lack of the explanation of the higher riskiness of projects accompanying monetary expansion decreases the persuasiveness of Carilli and Dempster (2001). Carilli and Dempster (2001) also do not discuss the type of errors that people tend to commit during monetary expansions and thereby the types of projects that are more likely to fail as a result. This omission relates Carilli and Dempster (2001) to the problems faced by the second line of defense. It prevents them from making a link between monetary expansion, the errors that people commit, and the existence of a cluster of errors related to investment into overly long production processes. Their theory therefore does not describe the dynamics of the Austrian business cycle theory.

The framework below addresses the problems of the three lines of defense discussed in this section. I show that the conclusions coming from the overly specific assumptions of the first line of defense can be replicated also for the assumption when people hold unbiased expectations. This illustration also addresses the arguments of the second line of defense, which explains the existence of unbiased errors without building a link between them and the

Austrian business cycle dynamics. I also show that the Austrian business cycle

dynamics does not rely on an increased number of errors created during

monetary expansion as the arguments in the second and third line of defense

might imply although such kaleidic features are consistent with my framework.

2.3 Expectations and errors

While the fact that people commit errors can be justified by a number of

theories, fallible person is an assumption of the present framework and not a fact

to be explained. Taking fallibility as the starting assumption allows the discussion

of particular types of errors that are consistent with the Austrian business cycle

theory. I build such framework in the three following sub-sections.

2.3.1 Individual and his imperfect expectations

Our expectations of future events, like the delay of a train or the

temperature in New York City tomorrow, are imperfect. I begin the discussion of

such imperfect expectations on the level of an individual whom I call *Person 1*. I

choose the following notation for *Person 1* who is forming his expectation about a

specific manifestation of variable *x*

$$^m xe_1 = {}^m x + {}^m \varepsilon x_1$$

where *m* identifies the manifestation of the variable *x*, $^m xe_1$ is the expected value

of ^mx by *Person 1*, and $^m\varepsilon x_1$ is the error that *Person 1* commits when forming expectation $^mxe_1$.

I assume that the expectation belongs to a class of expectations. A membership in a class means that $^mxe_1$ can be related to other expectations xe_1 of *Person 1* with which $^mxe_1$ shares all characteristics besides the position in time. One can then construct a set of expectations Xe_1 for *Person 1*

$$Xe_1 = \{^1xe_1, \ldots {}^zxe_1\}$$

where *1 … z, z $\in$ R*, identifies expectations xe_1 of different manifestations of variable *x*. Having the set of expectations, it is possible to construct the set of errors Ex_1 that corresponds to the set of expectations

$$Ex_1 = \{^1\varepsilon x_1, \ldots {}^z\varepsilon x_1\}$$

The set of errors Ex_1 has corresponding discrete probability distribution characterized by a probability mass function of errors, $\hat{E}x_1$. The function assigns probability to each value of error εx. Assuming for the sake of the graphical exposition that εx converges to a continuous variable, probability mass function $\hat{E}x_1$ can look like the one at *Figure 2.1*.
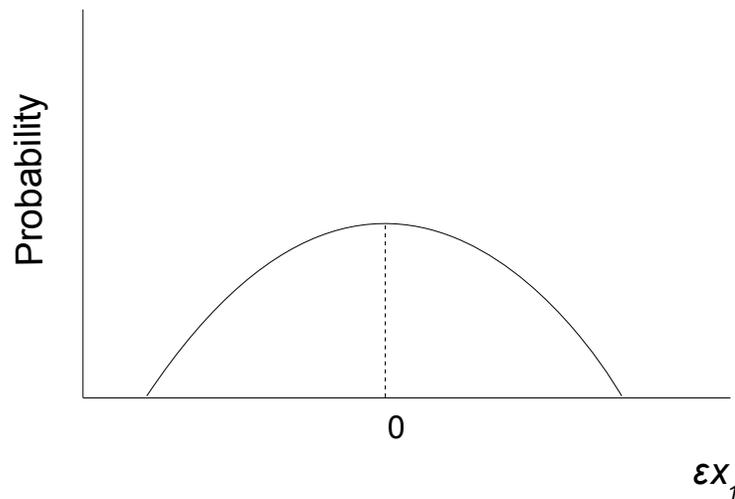
Figure 2.1 Probability mass function $\hat{E}x_1$

2.3.2 Aggregate patterns of errors

I will now shift the focus from a single *Person 1* to a group of heterogenous people (*cf.* Wagner 1999: 71-72). In terms of the previous examples, more than one person now forms expectations about the delay of a specific train or tomorrow's temperature in New York City. More formally, thinking in terms of a group of people means that n people are forming expectations about specific manifestation of the same variable, the same ^{m}x. Each specific manifestation, each ^{m}x, can be then linked with the corresponding set of expectations ^{m}Xe that n people form about ^{m}x or

$$^{m}Xe = \{^{m}xe_1, \ldots \, ^{m}xe_n\},$$

where $^{m}xe_1, \ldots \, ^{m}xe_n$ are expectations of people 1 … n such that $^{m}xe_1 = {}^{m}x + {}^{m}\varepsilon x_1,$

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... $^m xe_n = {}^m x + {}^m \varepsilon x_n$. Since people are heterogenous, the values of objects of $^m Xe$ might differ from each other.

Each object of $^m Xe$ has corresponding error committed by person when he or she forms expectation about $^m x$. Set $^m Xe$ therefore has a corresponding set of errors $^m Ex$, where

$$^m Ex = \{{}^m \varepsilon x_1 \in Ex_1, \ldots {}^m \varepsilon x_n \in Ex_n\}$$

Set of errors $^m Ex$ can be assigned discrete probability distribution characterized by probability mass function, $^m \hat{E} x$. The function assigns to every value of $^m \varepsilon x$ the probability that a randomly chosen person commits error of the given value.

The probability mass function $^m \hat{E} x$, or the aggregate pattern of errors, does not have any predetermined characteristics. If it, however, characterizes symmetric, single-peaked discrete probability distribution with zero mean, the group of people that it represents forms unbiased expectations about $^m x$. Assuming that $^m \varepsilon x$ converges to a continuous variable, the probability mass function is similar to $^m \hat{E} x$ at Figure 2.2.

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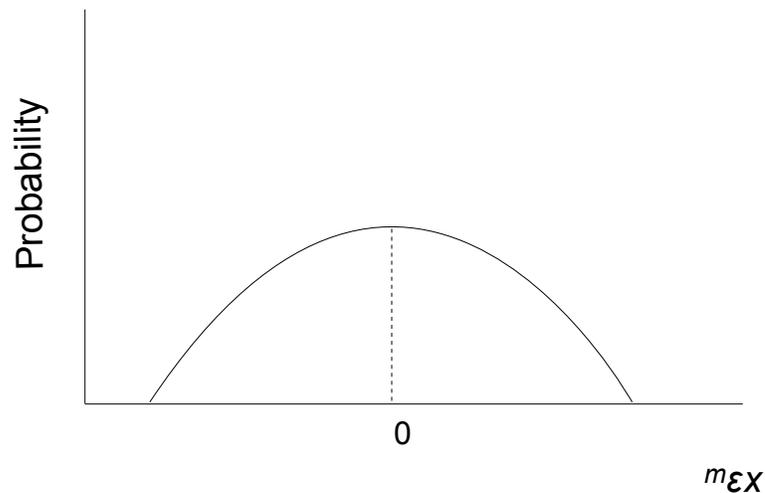
Figure 2.2 Probability mass function of the prediction errors of a group of people

2.3.3 Heterogenous people and rational expectations

The framework that I build in the following sections does not depend on a specific mechanism linking individual expectations and probability mass function representing errors of a group of people. It is one of the starting assumptions of the framework that individual people themselves as well as people as a group hold unbiased expectations. The discussion over the possible link, however, still remains worthy because it allows me to evaluate the relationship of my framework with the rational expectations hypothesis.

The search for an overlap between rational expectations hypothesis and my framework is bounded by three constraints. First, the rational expectations hypothesis assumes that all people work with the same correct model of the economy (Sargent 2008). Second, the correct model under the rational expectations hypothesis implies that people hold unbiased expectations (*cf.* Muth

1961, Sargent 2008, Sheffrin 1996: 4-9). And third, my own framework requires

people to hold heterogenous expectations.
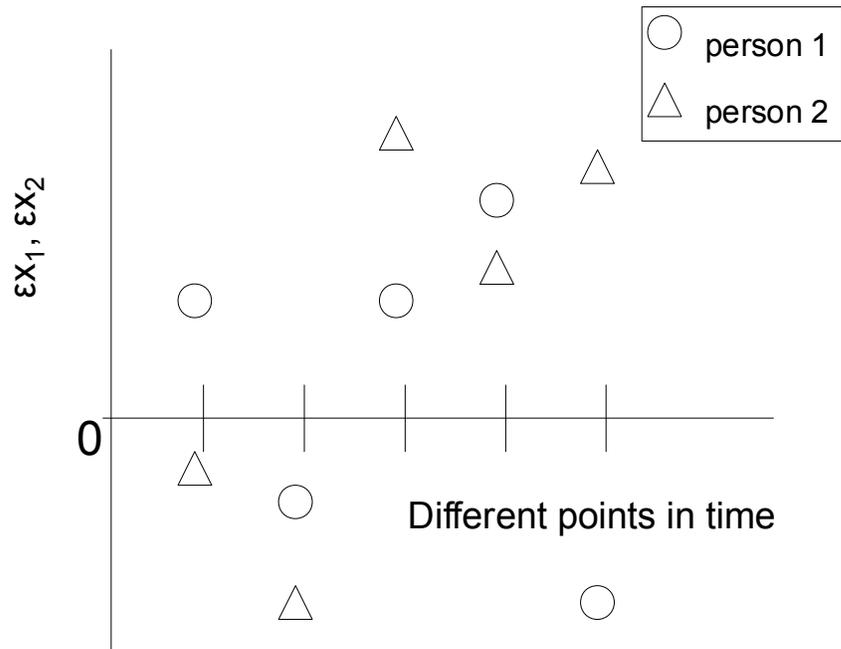
Figure 2.3 Time series of errors of two randomly chosen people

The framework is consistent with the rational expectations hypothesis

when I shift the level at which people share the same model of the economy.

Instead of sharing one single model, people share a set of an infinite number of

models where each model equally well describes the economy, i.e., each model

leads to expectation errors described by the same probability mass function. If a

group of n people forms expectations about ^mx, each person then commits error

that is drawn from the same discrete probability distribution so that $\hat{E}x_1=\hat{E}x_2= …$

$\hat{E}x_n$. Different people can be, however, at the same time using different models

to form their expectations because every person randomly chooses one of the correct models of the economy. Expectations that different people form about ^mx can be heterogenous and two people forming expectations about a specific manifestation of a given variable might then commit different errors as I illustrate at Figure 2.3.

Since people choose their models in a random process, the discrete probability distribution describing the errors of people who form expectations about ^mx is the same as the discrete probability distribution that individual faces when he predicts x, or $^m\hat{E}x=\hat{E}x_1= \ldots \hat{E}x_n$. The present version of the rational expectations hypothesis thereby implies that event ^mx is related to expectations which are unbiased on the level of a group of people as well as for each individual person.

2.4 The Austrian business cycle theory

Having clarified my framework for expectations, I can use it for re-evaluation of the Austrian business cycle theory. I begin this re-evaluation with a list of six assumptions which are all necessary components of the traditional version of the theory. It is not my intention to discuss these assumptions.

First, monetary expansion takes place through the market for loanable funds and it decreases real interest rates (Cowen 2000: 93-94, O'Driscoll 1979: 164-165, O'Driscoll and Rizzo 1996 [1985]: 221, for a dissenting view see Hülsmann 1998: 4-8), particularly the short term real interest rates.

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Second, monetary expansions and their effects on real interest rates cannot be perpetuated for an infinite period of time, they have to come to an end.

Third, the future real short-term interest rates are important for present evaluation of the relative profitability of alternative future projects[32].

Fourth, capital goods are heterogenous and investment in capital which is already undertaken cannot be fully reversed.

Fifth, production of consumption goods takes time and production of different goods can take different lengths of time.

Sixth, when people start previously unexpected transformation of a number of shorter processes into a number of different and longer processes, the transformation does not result in a significant number of unemployed resources. This is possible because the shorter processes do not have to be completely abandoned. The shorter processes can still produce consumption goods while the factors of production employed in them are not being replaced. The effect of the previously unexpected transformation towards longer processes is asymmetric when it is compared to the effect of previously unexpected shortening of production processes. Shortening of production processes leads to the situation when a number of production factors becomes unemployed. Long

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32 The importance of real short-term interest rates is derived from the following thought. It is irrelevant whether the entrepreneurs engaged in overly long production processes believe themselves that the period of low real interest rates will last for a relatively long time and finance their long-term projects with short-term loans or whether they find someone who himself expects a relatively long-term period and is willing to provide a long-term loan at a low real interest rate. In both cases, once the monetary authority decides to stop the monetary expansion before it is expected, the higher real short-term interest rates decrease the profitability of the long-term production processes. In the first case, the price of rolling over the short-term financing goes up. In the second case, the person has an option to scrap the production process and to lend or invest the proceeds at the currently higher interest rate.

processes need additional investment to produce consumption goods but the investment is too costly to incur. Some of the factors that are already invested in the unfinished long processes therefore become obsolete and unemployed (Hayek 1967 [1935]: 93 n1, for a critical view see Hummel 1979: 42-45).

Taking the list as it is, I now want to bring the attention again to the assumptions about expectations. Austrian business cycle theory in its traditional versions assumes that unexpected monetary expansion leads people to overestimate the period of low real short-term interest rates and thereby to invest into longer production processes[33] [34]. The period when new longer productions begin is perceived as the boom period of the cycle: shorter production processes that are being abandoned still produce consumption goods, while the factors that would have been used for their replacement are used in the new longer productions. The expectations about the future low interest rates, however, get disappointed once the monetary expansion ends. The disappointment translates into the bust phase of the cycle, where the overly long production processes have to be liquidated and some of the production factors employed in these processes remain unemployed[35].

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33 For example, if the real interest rates are expected to be low during the period of the next five years, investors tend to invest into overly long production processes within the five-year period.

34 The tendency to invest into long production processes during the period with low expected real interest rates is given by the inverse relationship between real interest rates and profitability of long production processes. Real interest rate, which also determines the discounting rate, has higher impact on the present value of the revenues that are more distant in time. It is for this reason that low interest rate increases profitability of longer production processes more than the profitability of the shorter ones, *cf.* O'Driscoll and Rizzo 1996 [1985]: 205-206.

35 The overestimation of the period of low interest rates might take many different forms that are always costly for the person who commits the error. First, a person might start projects that require refinancing. In this case, he underestimates the future interest rate at which he has to

Unlike the six assumptions on the list above, the assumptions about expectations are for the purposes of the present discussion not given. The question is how to think about the overestimating investors described above. On the most general level, the dynamics described by the Austrian business cycle theory holds only when a sufficient number of people have expectations with three features and when these features are not cancelled out by actions of other people. First, the group of people has serially correlated expectations about the future real short-term interest rates. Second, the group of people overestimates the length of the period during which the serial correlation takes place. Third, the group of people realizes the mistake at the same point in time.

The feature of serial correlation is necessary because only an expectation that real short-term interest rates move in a specific direction and stay there for a certain period of time gives people the incentive to increase the length of production processes. People also have to be misconceived about the length of the period during which the interest rates are going to be low so that the errors are concentrated in longer production processes. And only a synchronized sobering from erroneous investment decisions leads to the outcome when a number of processes go bust at the same point in time, causing an observable "cluster of errors".

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refinance the project. Second, a person might overestimate the future demand for the intermediate goods that he produces. If the savings are lower than expected, the higher interest rate leads to lower present discounted value of the intermediate good when he is willing to sell the good. And third, a person might underestimate the opportunity costs of using the given borrowed funds in his own production. It might mean that at some point, he simply discontinues the production and lends the money that he intended the employ in his own production.

In the subsections that follow, I use my framework for expectations to explore the question about the types of expectations that are consistent with the Austrian business cycle dynamics as captured by the three features discussed above. First, I present the traditional Austrian business cycle theory in the light of the framework for expectations. Then, I show that the traditional dynamics holds even when one relaxes some of the original assumptions about expectations that preclude the existence of people with unbiased expectations.

2.4.1 The traditional Austrian business cycle theory

As I have repeatedly noted, the traditional Austrian business cycle theory assumes that people use real interest rates today to form expectations about future real interest rates. Assume *Person 1*, who is at the point in time *0* and who has expectations about future real short-term interest rates. His expectations are the following

$$^1rre_1 = {}^1rr + {}^1\varepsilon rr_1, \quad {}^1rre_1 = {}^1f_1\left({}^1\mathbf{o}_1, {}^0rr\right),$$

$$\ldots$$

$$^zrre_1 = {}^zrr + {}^z\varepsilon rr_1, \quad {}^zrre_1 = {}^zf_1\left({}^z\mathbf{o}_1, {}^0rr\right)$$

where ^mrr, $m \in \{1, 2 \ldots z\}$, is the real short-term interest rate charged for loans taken for the period between *m* and *m+1*, $^mrre_1$ is ^mrr that *Person 1* expects, and $^m\varepsilon rr_1$ is the error of his expectation. Function $^mf_1(\cdot)$ embodies Hayek's (1975

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[1939]) view on formation of expectations during monetary expansion. Vector $^{m}o_1$ is the first argument of the function and it captures "other variables" which are inconsequential for the present analysis. It is ^{0}rr, or the present real short-term interest rate, which is important. Lower real short-term interest rate ^{0}rr today means that *Person 1* expects lower interest rates of the same type, ^{1}rr … ^{z}rr, in the future. Assuming that the partial derivatives exist, one can also say that

$$\frac{\partial(^{1}f_{1})}{\partial(^{0}rr)} > 0 \quad , \quad \dots \quad \frac{\partial(^{z}f_{1})}{\partial(^{0}rr)} > 0 \quad .$$

The effect of current interest rate ^{0}rr on the expected values of future interest rates leads during monetary expansion to the already discussed bias. Assume a monetary expansion that starts at the point in time *0* and ends at some future point in time *t*. Since the monetary expansion leads to liquidity effect, *Person 1* observes lower real interest rate ^{0}rr and he expects a decrease of real interest rates in the future. The time period for which *Person 1* expects the decrease, however, tends to be longer than the period of the monetary expansion that causes the lower rates, or *t<z*. *Person 1* therefore underestimates future real short-term interest rates ^{t}rr, ^{t+1}rr, … ^{z}rr and, assuming the respective continuities, his situation is the following

$$\frac{\partial(^{t}\epsilon\, rr_{1})}{\partial(^{0}rr)} < 0 \quad , \quad \dots \quad \frac{\partial(^{z}\epsilon\, rr_{1})}{\partial(^{0}rr)} < 0 \quad .$$

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The discrete probability distribution of errors committed by *Person 1* when forming expectations about the real short-term interest rates $^t rr,$ $^{t+1} rr,$ ... $^z rr$ is then skewed to the left, as *Figure 2.4* illustrates.
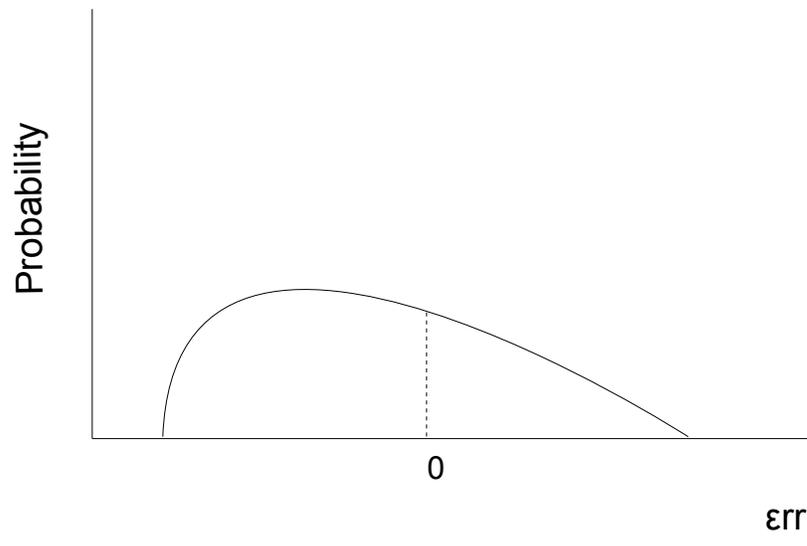
Figure 2.4 Probability mass function of the prediction errors εrr_1 of *Person 1*

I now assume, as the traditional Austrian business cycle theory does, that all people form their expectations in the same way as *Person 1*. I call $^m RRe$ the set of expectations formed by people *1 ... n* about the real short-term interest rate charged at the point in time *m*, $m \in \{1, 2 ... z\}$, for the loans that people take between *m* and *m+1*. The short term interest rates that people expect at the point in time *0* are

$$^1RRe = \{^1rre_1, \; \dots \; ^1rre_n\},$$

$$\dots$$

$$^zRRe = \{^zrre_1, \; \dots \; ^zrre_n\}.$$

The corresponding sets of errors ^mErr of the expectations are then

$$^1Err = \{^1\varepsilon rr_1, \; \dots \; ^1\varepsilon rr_n\},$$

$$\dots$$

$$^zErr = \{^z\varepsilon rr_1, \; \dots \; ^z\varepsilon rr_n\}.$$

Because people form their expectations in an identical manner, monetary expansion leads everyone towards underestimation of future real interest rates for the period $t \dots z$. The corresponding discrete probability distributions of errors that group of people commits while predicting each of these real interest rates are skewed to the left, in the same way as I illustrate at *Figure 2.5*.

The assumption that people generally use current real short-term interest rate while forming their expectations about future real interest rates leads to the three features of the Austrian business cycle dynamics that I mentioned above. First, the strategy which people use when forming their expectations ensures that expectations that people hold about future interest rates are during monetary expansion serially correlated. Second, the strategy ensures that people expect the period of low interest rates to last longer than it really does. And third, since

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all people share the same strategy, their errors become observable at the same

point in time.
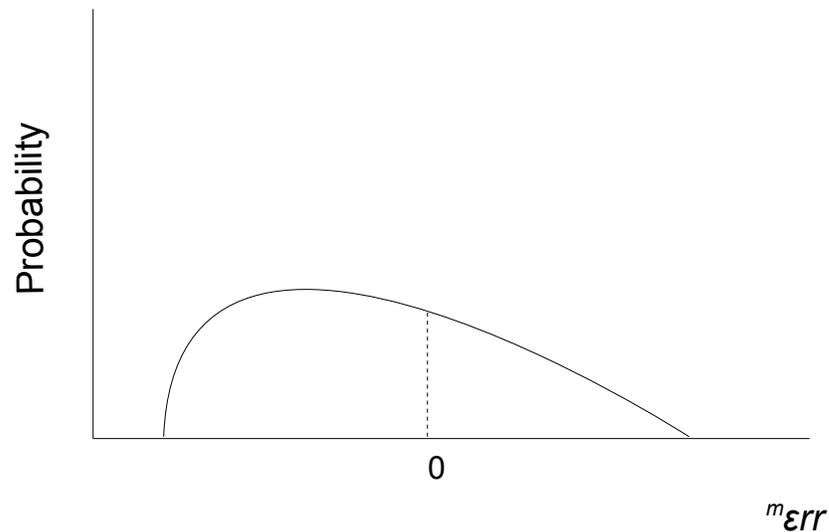
Figure 2.5 Probability mass function of the prediction errors $^{m}\varepsilon rr$

As I have pointed out, the assumption about formation of expectations is

not very plausible. Assuming that people systematically use defective technique

for predicting future interest rates is hard to swallow, particularly for an

economist. However, as I show in the following sections, there is a broader

range of assumptions about expectations which keep the dynamics of the

Austrian business cycle theory intact.

2.4.2 Unbiased expectations and some additional assumptions

I assume that people are heterogenous and that they hold unbiased

expectations about future both as a group and as individuals. The assumption of unbiased expectations means, in the fashion of the previous discussion, that errors are drawn from discrete probability distribution which is single peaked, symmetric, and which has zero mean. The question is what the assumption implies for the dynamics of the business cycle and how it compares to the traditional Austrian business cycle theory.

Taking the preservation of the traditional Austrian business cycle dynamics as the goal, I now have to reconcile the new assumptions about expectations with the three key features of the dynamics. I have to answer how could there be people during monetary expansion who (a) have serially correlated expectations about future real interest rates, (b) who overestimate the period of low real interest rates, and (c) whose errors are revealed together in a cluster.

For (a) to hold, there has to be a common element in one's expectations over time – the element that is not specified by the assumption of unbiased expectations. With unbiased expectations, people also do not systematically overestimate variables, putting feature (b) in question. And feature (c) requires a coordinated error across people, which is also questionable given the heterogeneous expectations that people hold. A situation where monetary expansion leads to (a), (b), and (c) and where at the same time heterogenous people hold unbiased expectations therefore requires some restricting assumptions.

To get the appropriate dynamics, I assume three restrictions. The first

restriction is epistemological and it narrows down the number of models that people use to understand the economy. The restriction makes all people aware of the relationship between changes in the money supply and real interest rates. It is therefore a common knowledge that future monetary expansion, which is injected through the market for loanable funds, also means lower future real interest rate.

The second restriction is both ontological and epistemological and it establishes the existence of two different monetary policy regimes, each regime being a bundle of specific monetary policies with common characteristics. The first is expansionary monetary policy regime, with increasing money supply. The second regime is restrictive monetary policy regime, where the money supply is held constant or it decreases. Unlike it is with specific policies, which change over time rather easily, monetary policy regimes change less often. I assume that people are aware of the distinction between monetary regimes and that they also want to know which monetary policy regime is applicable at particular point in time. Such information is valuable because it narrows down the specific monetary policies that can be possibly taking place at the given point in time.

The third restriction is epistemological and it narrows down situations when person learns about his error with respect to the existing monetary policy regime. I assume that one finds out his previous error and reconsiders personal

expectations only when he is empirically disproved[36] [37].

2.4.3 Unbiased expectations in the light of the three restrictions

I begin the discussion about the business cycle dynamics again with

Person 1, who has unbiased expectations which are constrained by the three

restrictions from the previous section. At time *0*, *Person 1* experiences the

beginning of a new monetary policy regime. He is trying to predict the end of the

regime because it is a useful input for formation of his expectations about future

real short-term interest rates. Expectation of *Person 1* about the end of the

regime is in terms of my framework

$$te_1 = t + \varepsilon t_1,$$

where te_1 is the end date of the current monetary policy regime expected by

Person 1, variable *t* is the actual end of the current monetary policy regime, and

εt_1 is the error of *Person 1's* expectation te_1. Since *Person 1* has unbiased

expectations, his error εt_1 is drawn from a set of expectation errors Et_1 which has

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36 It is important to note that the first two restrictions do not preclude my previous discussion about heterogeneity of expectations. While people understand the relationship between monetary policy and real interest rates and people also distinguish between monetary policy regimes of different types, uses of this knowledge might differ from person to person and case by case. Expectations held by different people with respect to the same variable might therefore still differ. Expectations held by a person with respect to different manifestations of the variable of the same type might correspondingly differ as well.

37 The first two restrictions are also compatible with the rational expectations hypothesis, where people share the correct model of the economy. The restrictions imply that people use the relationship between monetary policy and real interest rates and that people also understand the relative persistence of monetary policy regimes. Since both of the pieces of knowledge associated with the restrictions are assumed to describe the workings of the economy, the rational expectations hypothesis remains intact even after the imposition of the restrictions.

corresponding symmetric single-peaked zero mean discrete probability distribution.

The date te_1 that *Person 1* predicts as the end date of the current monetary policy regime is an input to his expectations of real short-term interest rates. The expectations are in time *0* the following

$$^1rre_1 = \,^1rr + \,^1\varepsilon rr_1, \quad ^1rre_1 = \,^1f_1 \,(^1\mathbf{o_1}, d), \; d=a,$$

$$^2rre_1 = \,^2rr + \,^2\varepsilon rr_1, \quad ^2rre_1 = \,^2f_1 \,(^2\mathbf{o_1}, d) \; d=a,$$

$$\ldots$$

$$^{te}rre_1 = \,^{te}rr + \,^{te}\varepsilon rr_1, \quad ^{te}rre_1 = \,^{te}f_1 \,(^{te}\mathbf{o_1}, d), \; d=b,$$

$$\ldots$$

$$^zrre_1 = \,^zrr + \,^z\varepsilon rr_1, \quad ^zrre_1 = \,^zf_1 \,(^z\mathbf{o_1}, d) \; d=b.$$

$^mrr, m \in \{1, 2 \ldots z\}$, is the real short-term interest rate charged for loans taken for the period between *m* and *m+1*, variable $^mrre_1$ is *Person 1's* expected ^mrr, and $^m\varepsilon rr_1$ is the expectation error. The error is drawn from set of expectation errors Err_1 which has corresponding symmetric single-peaked zero mean discrete probability distribution.

Function $^mf_1(\cdot)$ includes the three restrictions from the previous section. The first restriction makes *Person 1* to understand the downward pressure that expansionary monetary policy imposes on real interest rates. Expansionary monetary policy leads *Person 1* to expect lower real interest rate $^mrre_1$.

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Function $^mf_1(\cdot)$ has two arguments: vector $^m\mathbf{o_1}$, which represents variables that are unimportant for the present analysis and variable d, which is a dummy variable addressing the second restriction and narrowing down the number of monetary policy regimes to two. Variable d has value a as long as the expected interest rate $^mrre_1$ belongs to the period before the expected end of the current monetary policy regime, or as long as $m<te_1$. It changes its value to b once the expected interest rate $^mrre_1$ is related to the period after the expected end of the current monetary policy regime, or as long as $m \geq te_1$.

The third restriction embodied in function $^mf_1(\cdot)$ constrains how *Person 1* changes his expectations about monetary policy regime over time. As long as his initial expectations about monetary policy regime remain confirmed, *Person 1* does not change the expected a or b for the future points in time. He recognizes error only once he observes regime $d=b$ when he expected regime $d=a$ or once he observes regime $d=a$ when he expected regime $d=b$.

2.4.4 Monetary expansion: individual

I assume that the initial monetary policy regime in time *0* is expansionary, or that $d=a$ is expansionary monetary policy regime. Because *Person 1* knows the relationship between real interest rates and monetary policy, he expects lower real interest rate when $d=a$ in contrast to the case when $d=b$, or $^mf_1(^m\mathbf{o_1},$ $d=a)<^mf_1(^m\mathbf{o_1}, d=b)$. Assuming $a>b$, one can also say that

$$\frac{\Delta(^1f_1)}{\Delta d} < 0 \quad , \quad \frac{\Delta(^2f_1)}{\Delta d} < 0 \quad , \dots \quad \frac{\Delta(^zf_1)}{\Delta d} < 0 \quad .$$

Starting at the point at the point in time *0*, *Person 1* forms his expectations. He can either overestimate the length of the expansionary monetary policy regime, or he can underestimate it. I discuss both options.

Person 1 overestimates the length of the current expansionary monetary policy regime when $te_1 > t$ and $\varepsilon t_1 > 0$. The overestimation means that he holds erroneous expectation about the monetary policy regime for the period between *t* and te_1. The error leads him to underestimate the real short-term interest rates during period between *t* and te_1, which means that

$$\frac{\Delta(^t\epsilon\, rr_1)}{\Delta d} < 0 \quad , \quad \frac{\Delta(^{t+1}\epsilon\, rr_1)}{\Delta d} < 0 \quad , \dots \quad \frac{\Delta(^{te}\epsilon\, rr_1)}{\Delta d} < 0 \quad , \quad \text{when} \quad te_1 > t, \text{ assuming } a > b.$$

Person 1, however, still holds unbiased expectations. The set of errors *Err₁*, from which $^m\varepsilon rr_1$, $m \in \{t, t+1, \dots te_1\}$, are drawn, represents a long time period with a number of switches between monetary policy regimes. Since *Person 1* does not have a tendency to systematically underestimate or overestimate the length of monetary policy regimes over time, the corresponding account of his expectations of real interest rates is unbiased.

Assume now that *Person 1* underestimates the length of the current expansionary monetary policy regime in time *0*, which means that $te_1 < t$ and $\varepsilon t_1 < 0$.

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Person 1 mistakenly expects restrictive monetary policy regime between the points in time *te_1* and *t*. The mistake affects real short-term interest rates that *Person 1* expects for the period between *te_1* and *t,* he has a tendency to overestimate them:

$$\frac{\Delta\left(^{te}\epsilon\, rr_1\right)}{\Delta d}>0 \quad, \quad \frac{\Delta\left(^{te+1}\epsilon\, rr_1\right)}{\Delta d}>0 \quad, \ldots \quad \frac{\Delta\left(^{t}\epsilon\, rr_1\right)}{\Delta d}>0 \quad, \quad \text{when} \quad te_1<t, \text{ assuming}$$

a>b.

Since unbiased people like *Person 1* might underestimate or overestimate the length of expansionary monetary policy regime, representative agent has no place in the present framework. Instead, one has to use analytical tools that can capture the heterogeneity of expectations across people. The analysis is therefore not scalable in the same simple way as that of the traditional Austrian business cycle theory, where representative agent overestimates the period of low real interest rates.

2.4.5 Monetary expansion: group of people

I assume a group of *n* people who are heterogenous and who form unbiased expectations at the point in time *0*. The expectations are unbiased both on the individual level as well as on the aggregate level. I impose the three already discussed constraints upon the expectations. First, people understand

the relationship between real interest rates and monetary policy. Second, people are aware of the existence of different potential monetary policy regimes. And third, people do not change their expectations about change in the monetary policy regimes as long as their previous expectations about the regime change are not proven wrong. Let *Te* be the set of expectations that people *1 … n* have about the end date of the current expansionary monetary policy regime, or

$$Te = \{te_1,\ te_2,\ \dots\ te_n\}.$$

The corresponding set of errors *Et* that people *1 … n* commit is then

$$Et = \{\varepsilon t_1,\ \varepsilon t_2,\ \dots\ \varepsilon t_n\}.$$

Since the expectations that people as a group hold are unbiased, the set of errors *Et* translates into a symmetric single-peaked zero mean discrete probability distribution.

People *1 … n* use their expectations about change in the monetary policy regime to form expectations about real short-term interest rates *$^mRRe.$* They form the expectation at time *0* for the future points in time *1 … z* such that

$$^1RRe = \{^1rre_1,\ ^1rre_2,\ \dots\ ^1rre_n\}$$

$$\dots$$

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$$^tRRe = \{^trre_1, {}^trre_2, \ldots {}^trre_n\}$$

$$\ldots$$

$$^zRRe = \{^zrre_1, {}^zrre_2, \ldots {}^zrre_n\}.$$

The corresponding sets of errors ^mErr, $m \in \{1, 2 \ldots z\}$, that people commit are

$$^1Err = \{^1\varepsilon rr_1, {}^1\varepsilon rr_2, \ldots {}^1\varepsilon rr_n\}$$

$$\ldots$$

$$^tErr = \{^t\varepsilon rr_1, {}^t\varepsilon rr_2, \ldots {}^t\varepsilon rr_n\}$$

$$\ldots$$

$$^zErr = \{^z\varepsilon rr_1, {}^z\varepsilon rr_2, \ldots {}^z\varepsilon rr_n\}.$$

Since people as a group are unbiased in predicting the end date of the expansionary monetary policy regime, they are also unbiased when predicting each of the real short-term interest rates ^mRRe. Every set ^mErr therefore has a corresponding symmetric single peaked zero mean discrete probability distribution.

While people have unbiased expectations on a group level as well as on individual level, there are people who commit errors. When forming their expectation about the current expansionary monetary policy regime, there are people who overestimate the length of the regime as well as those who underestimate it. As I have showed in the previous section, overestimation and

underestimation affects one's expectations of real interest rates.

People who overestimate the length of the expansionary monetary policy regime tend to mistakenly believe that the period of low real interest rates is overly long. Errors εrr of each person who underestimates the length of the expansionary monetary policy regime tend to be among the high and positive between the points in time te and t. Correspondingly they tend to be drawn from the right side of the discrete probability distributions characterized by probability mass functions $^{te}\hat{E}rr$ … $^{t}\hat{E}rr$.

People who overestimate the length of the period of low real interest rates also view longer processes during the period as more profitable. Acting on their expectations, overestimating people invest into overly long production processes and realize the mistake at the same point in time – once the expansionary monetary policy regime comes to its end. Upon realizing the error, the expected profitability of the excessively long processes suddenly drops and some of them have to be abandoned. As a result a number of overly specific capital goods become unemployed. The end of the expansionary monetary policy regime thus brings a cluster of visible errors in longer production processes.

Those who underestimate the length of the expansionary monetary policy regime tend to believe that the period of low real interest rate is shorter than it really is. Errors εrr of each person who overestimates the length of the expansionary monetary policy regime tend to be negative between the points in time te and t. In other words, the errors tend to be drawn from the left side of the

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discrete probability distribution characterized by probability mass functions $^t\hat{E}rr$

… $^{te}\hat{E}rr$. The question is whether the existence of underestimating people in some way offsets or changes mistakes of the overestimating people.

One can suggest that the interplay of underestimating and overestimating people at the futures markets leads to prices of futures which correctly predict future interest rates. If it is the case, people can use futures markets as perfect predictors of future interest rates which would allow everyone in the economy to predict future interest rates without errors.

Market prices can, however, fail to predict future outcomes even when market is populated by an unbiased group of people. Even if it is the case that every person overestimating the variable by k can find a counterpart who underestimates the variable by $k,$ the amounts and the extent to which the corresponding underestimating and overestimating people demonstrate their expectations at the market might differ. Preferences, availability of resources, and other factors have an effect on the amount that each particular person spends at the market when he is acting on his expectation. The resulting price therefore does not necessarily have to correctly reflect the future correct price or the future event in question. While markets and the price system can communicate some knowledge, they are not generators of perfect forecasts even if people hold unbiased expectations with respect to the correct values of future variables.

Alternatively, one can claim that the presence of people who

underestimate the length of the expansionary monetary policy regime diverges the dynamics of the cycle from the traditional Austrian business cycle dynamics. To evaluate the claim, it is important to clarify the dynamics of the aggregate manifestation of errors made by the underestimating people.

Those who underestimate the length of the expansionary monetary policy regime learn about their mistakes at their points in time te, where $te<t$ and te can differ from person to person. It is true that the underestimating people regret past choices at the point in time te, once they realize the error. The errors committed by underestimating people, however, do not manifest themselves in a pattern that would distort the traditional Austrian business cycle dynamics. This is for two reasons. First, because the expectation of the length of the expansionary monetary policy regime, te, can differ from person to person, not all underestimating people learn about their errors at the same point in time. The discovery of errors is therefore spread more evenly in the case of people who underestimate the length of the expansionary monetary policy regime when compared to the overestimating people. The pattern where the end of expansionary monetary policy regime is related to one cluster of errors concentrated in overly long production processes therefore remains intact.

And second, the errors of the underestimating people tend to be less visible to external observers and in the data. The projects made by the underestimating people are relatively short and it is likely that some of the projects are already finished when their owners realize the previous mistake.

Since the projects that are finished cannot be restructured or discontinued, the underestimations of the length of the expansionary monetary policy regime lead less likely to reallocations of capital goods or other observable signs of errors. The feature of low visibility contrasts underestimations and overestimations of the length of expansionary monetary policy regime.

I have thereby successfully replicated the dynamics of the Austrian business cycle story for the assumption of heterogenous people with unbiased expectations. My restatement keeps all three key features of the Austrian business cycle dynamics. First, people have serially correlated expectations about future real interest rates as long as they expect the expansionary monetary policy regime to last. It is true that individual people do not share the expected length of the regime but as long as each person expects the regime to last, he tends to expect lower real interest rates. The expected lower interest rate then induces person to invest into longer production processes of the corresponding length.

Second, although not everyone overestimates the length of the expansionary monetary policy regime, a significant part of the population does. The overestimating people tend to invest into overly long production processes in an analogical way to the traditional Austrian theory.

And third, people who overestimate the length of the expansionary monetary policy regime realize their error at the same point in time – with change of the monetary policy regime. The manifestation of errors of overestimating

people is visible and concentrated in a cluster, which leads to a contrast between projects of overestimating and underestimating people.

2.5 Conclusion: hydraulics, kaleidics, and beyond

By relating expansionary monetary policy regime with a cluster of errors that materialize as overly long production processes, I have finished my task. I have proven that the dynamics of the Austrian business cycle theory holds also when individual people as well as people as a group hold unbiased expectations. Such proof makes the traditional Austrian business cycle dynamics as it is presented in the works of the first line of defense more plausible.

I have also created framework that can describe different distributions of individual errors as well as different distributions of errors made by people as a group. While I applied this framework to the case of unbiased expectations, this need not be its only use. One can then asses how different distributions of errors relate to the Austrian business cycle dynamics. The option to use my framework as an assessment tool might be useful for those advocates of the Austrian business cycle theory who represent the second line of defense. These advocates make valid arguments about the relationship between monetary policy and expectation errors that people make, however, they do not specify the link between the errors and the dynamics of the traditional Austrian business cycle theory. My framework imposes analytic constraints that force one to avoid such omissions.

My framework also creates an opportunity for a kaleidic analysis, which I have not exploited. Distributions of errors of expectations – of individual people as well as of people in aggregate, are not a given as the authors of the second and third line of defense correctly suggest. The distributions and the variances of the distributions might be subject to change with respect to time, monetary policy regime, phase of the business cycle, or prevailing social institutions. I consider the study of the distributions of errors, or of the kaleidic features of the cycle, to be of primary importance for the business cycle theory. It is the distributions of errors that determine the importance of errors committed over the cycle and that determine the resulting severity of economic crises. Errors that people make are not a given and in order to have a better theory of the business cycle, we need a better account of how they come. Such non-hydraulic research problem, however, requires analytical apparatus of disequilibrium theorizing (Lachmann 1978 [1973]: 3), or Viennese kaleidics (Wagner 2011), and it should be discussed on its own. It is therefore the part of the story that is still waiting to be told in a comprehensive way and my discussion should be understood as a step in this direction.

Chapter 3: The International Business Cycle as a Coordination Failure

3.1 Introduction

The recession phase of business cycle exhibits not just a decline in aggregate output but it is accompanied by a large rise in business failures (e.g., Altman 1983, Nobuyuki and Kageyama 2011, Platt and Platt 1994, Santoro and Gaffeo 2009). It has also been noted that during the recession marriages fall apart (Arkes and Shen 2010), and people tend to commit suicides at unusually high rates (e.g., Catalano et al. 2011, Luo et al. 2011, Ruhm 2000, Snipes et al. 2011, Stuckler et al. 2009). These can all be viewed as costly adjustments that people make to their long-term plans when previous plans have failed. The increased incidence of such adjustments during the recession has been called a "cluster of errors". A long tradition in macroeconomics seeks to explain the cluster of errors during the recession and the recession itself by a common cause. Recessions, in this view, are accompanied by a spike of observed errors because recessions are outcomes of coordination failures.

Another important stylized fact about business cycles is that they are international. We observe co-movement of macroeconomic aggregates across countries. In this paper, I put coordination failure in the foreground of an explanation of international business cycles.

The concept of coordination failure can be understood in the following way. People make *plans* (Lindahl 1970 [1939]). A plan is a chain of a person's projected actions that depend on the actions of others. A plan can be successfully finished only when the projected contingencies happen and when the person successfully aligns his plan with the actions of others. When plans of a set of agents are mutually compatible and aligned with events so that all plans can be completed, the agents enjoy *coordination success*. Otherwise they suffer *coordination failure*.

Some social institutions are more important in coordinating people than others. In this respect, the important institutions are those which enable the plans of a significant number of people to coordinate. But the coordinative role of institutions would be uninteresting if it was costless to adjust one's plans after a previous error. The two ideas – the idea of the coordinative role of social institutions and the idea that adjusting plans can be costly – are therefore analytic complements. I put these complements in the foreground of an investigation of international business cycles.

Money is one social institution that many economists consider to be a necessary condition for business cycles. After all, money represents one side of all exchanges (Clower 1967: 6) and its effects can be correspondingly broad. In the following argument, I continue in the tradition of monetary business cycle theories. I relate the unsustainability of the boom phase and the co-movement of aggregate economic activities of different countries with two monetary

institutions: the market for loanable funds and the market for foreign exchange.

The market for loanable funds and the market for foreign exchange both differ in certain respect from all other markets. A change in the price of milk, potatoes, and all other goods but these two represents only a change in the relative price of one good with respect to all the other goods. This is not true of a change in the price of loanable funds or foreign exchange. In the market for loanable funds, the interest rate relates the price of all present goods to all future goods. In the market for foreign exchange, the exchange rate determines the relative price of all domestic goods and all foreign goods. A change in the interest rate or a change in the foreign exchange rate therefore changes the price of a large set of goods relative to another large set of goods.

The pivotal role of these two prices and the speed of their responses to monetary expansion, as shown for example in Eichenbaum and Evans (1995), make them good candidates to explain international business cycles. As new money initially enters the domestic market for loanable funds, the foreign market for loanable funds, and the market for foreign exchange, prices in these three markets are affected sooner than prices in other markets. When monetary expansion creates an excess supply of loanable funds at the prevailing interest rate, real domestic and foreign interest rates decline and the domestic currency depreciates against the foreign currency in real terms. The fall in the interest rates makes longer and more capital-intensive production processes more profitable. The depreciation of the domestic currency makes production for

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foreign consumption more profitable. Eventually, the changes in relative prices resulting from the monetary expansion end and the profits are restored to their final equilibrium values. These adjustments are, however, not expected by everyone, which causes costly coordination failures. People who invested too much in cross-border productions or capital-intensive productions lose profits. Some production processes become obsolete; and depending on their specificity, some factors of production have to be reallocated, while other factors remain permanently idle.

The framework that I have described relates to some of the literature on international real business cycle and the new open economy macroeconomics. The main commonality between my framework and the literature is the recognition of the existence of vertical production processes, or the recognition that complementary factors of production enter production at different points of time. Thinking in terms of vertical productions also leads the literature to the recognition of coordination problems that arise across vertical processes. Relative prices of inputs and outputs of different stages of production can change and such changes can translate into a coordination problem. The solution to this problem can affect allocation of resources as well as aggregate output.

International real business cycle models that put emphasis on vertical production processes include Arkolakis and Ramanarayanan (2009), Burstein et al. (2008), or Engel and Wang (2011). All the three models use the idea of the vertical production process to answer puzzles that have their origins in Backus et

al. (1993), one of the first models of the international real business cycle literature. Arkolakis and Ramanarayanan (2009) and Burstein et al. (2008) use vertical production process to explain the co-movement of outputs across countries. Engel and Wang (2011) use it to explain high volatility of imports and exports and high positive co-movement of imports and exports with output. Additionally, Barro and Tenreyro (2006) and Huang and Liu (2007) contribute to the new open economy macroeconomics with the idea of vertical production processes. Both these works try to explain the fact of co-movement of outputs across countries, an observation which has not been fully answered by the new open economy macroeconomics since the "redux" model of Obstfeld and Rogoff (1995).

These five works recognize the potential importance of vertical production links and *coordination problems* involved. In the works, however, the coordination problems do not shed much light on the *coordination failures* that we observe during the *bust* phase of the business cycle. International real business cycle models assume that coordination problems are being solved successfully. Unsuccessful plans are not part of the transmission mechanism and people populating the models therefore do not experience coordination failures, but simply adjust to changes such as productivity shocks. In contrast, the new open economy macroeconomics models include a coordination failure in their transmission mechanisms. The source of the failure is rooted in the assumption of sticky prices. An expansionary monetary shock upsets some producers

because while the nominal demand for their products increases, they have to increase the supplied quantities and keep the price of the products intact. The failure captured by the models of the new open economy macroeconomics is, however, related to the *boom* phase of the cycle and therefore differs from the coordination failures that we see during the *bust*.

My positive analysis is not inconsistent with the insights of the models of international real business cycle and the new open economy macroeconomics. The two types of models might be addressing important parts of reality. But the models do not explain the signs of coordination failure, the cluster of errors. My framework explaining international business cycles puts coordination failures into the center of the analysis. I build the framework on the two ideas that I already mentioned – the idea that some social institutions have an important coordinative role and the idea that it is costly for people to adjust their previous plans. I argue that the market for loanable funds and foreign exchange market can fail in their coordinative roles, which is particularly important in the context of vertical production processes. Such coordination failure is costly to fix and has effects at home as well as abroad. My findings are consistent with the standard empirical characteristics of international business cycles, including the dynamics of real imports and real exports and international co-movements of real output, real consumption, real investment, and employment.

3.2 The international business cycle and some evidence

The international business cycle is a co-movement of economic aggregates across countries. The co-movement is a well-established fact at least since Backus et al. (1993), who find that correlations between U.S. real output and the real outputs of nine other developed countries range between 0.41 and 0.76. While the main results of Backus et al. (1993) are not representative in terms of quantitative magnitudes, the main qualitative features of the results have been confirmed by others. For example, Ambler et al. (2004) find in their more comprehensive study of 20 countries, mostly OECD members, that the average cross-country correlation of real outputs is 0.28. Table 3.1 lists a summary of some main properties of the co-movement that are important for my framework – the positive correlation of real output, real consumption, real investment, and employment across countries.

Table 3.1 Basic characteristics of international business cycles

Variable	Cross-country correlation[a]
Real output	0.28
Real consumption	0.15
Real investment	0.22
Employment	0.2

[a]Source: Ambler et al. (2004), averages of 190 cross-country correlations of mostly OECD countries for the period between 1973-2000. For additional evidence see also: Backus and Kehoe (1992: 876), Backus et al. (1993), Oviedo and Singh (2012: 3), and Ravn (1997).

While the evidence of the existence of international business cycle is generally convincing, the underlying dynamics are unclear. To describe the dynamics requires a theory that allows us to choose from the ample number of existing facts and to assemble the facts into orderly relationships (Sargent 2011: 10 n21). Table 3.2 and Table 3.3 present evidence about structure and dynamics of international trade that is important in the light of the framework I present in the later sections.

Table 3.2 International trade over the cycle

Variables	Correlation
Real imports and real output	0.63[a]
Average cross-country correlation of imports	0.34[b]
Real exports with real output	0.39[a]
Average cross-country correlation of exports	0.25[b]
Real imports and real exports	0.38[a]

[a]Engel and Wang (2011), data for 25 OECD countries for the period of 1973-2006; data for 3 countries of the 25 is limited to a shorter time period. The numerical results are the average correlations for the sample.
[b]Ravn (1997), data for 10 OECD countries for the period of 1970-1992, observations for one country are for the period between 1970-1989. The numerical results are averages.

Table 3.2 provides a general overview of the dynamics of real imports and real exports over the cycle. Real imports and real exports are both pro-cyclical, mutually correlated, and correlated across countries. In their study of 25 OECD

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countries, Engel and Wang (2011) find that on average, correlation between real

imports and real output is 0.63 and between real exports and real output is 0.39.

Table 3 provides additional details regarding structure and dynamics of

real imports and exports.

Table 3.3 Additional characteristics of international trade

Variables	Result
Composition of imports in terms of durable goods	0.68[a]
Composition of exports in terms of durable goods	0.64[a]
Correlation of durable real imports with real output	0.53[b]
Correlation of nondurable real imports with real output	-0.17[b]
Correlation of durable real exports with real output	0.82[b]
Correlation of nondurable real exports with real output	0.65[b]

[a]Engel and Wang (2011), give the shares of durable goods on imports and exports for 25 OECD countries in 2000. The numerical results are the means of the sample (cf. Boileau 2002, Erceg et al. 2008).
[b]Engel and Wang (2011) analyze the correlations of real imports and exports with real output for the U.S. for the period between 1997-2006.

The first two lines of the table highlight the high proportion of durable goods in

international trade. Engel and Wang (2011) look at the cross-section of 25

OECD countries for the year 2000 and find that durables are on average almost

70% of the non-energy imports and exports of the countries. The findings are in

line with Erceg et al. (2008), who confirm that durables exceeded 70% of U.S.

non-energy imports and exports in 2004. The high proportion of durable goods

on international trade has been persistent. Boileau (2002: 972) looks at G7

countries for the period 1960-1991 and computes average trade shares[38] of the

countries for different types of goods. Average shares of trade in the category

called "Equipment", which is a subset of durable goods, for each of the seven

countries range between 39% to 53%, which confirms the high proportion of

durable goods in international trade. Baxter (1995: 6) also contributes to the

evidence and shows the high proportion of durable goods in international trade

for the U.S. during 1970-1988.

I later in this paper argue that the high share of durables in international

trade is an important factor in the dynamics of imports and exports over the

international business cycle. The demand for durables is relatively more

sensitive to changes in real interest rate and this higher sensitivity can explain

the observed correlation of output with imports and exports. The explanation is

consistent with the limited available evidence, which describes the dynamics of

the U.S. durable imports and exports. Baxter (1995: 6) finds that most of the

fluctuations of real U.S. exports and non-oil imports during 1970-1988 are related

to durable goods. Warner (1994) supports this evidence by finding that exports

of capital goods are the highest contributor to the variance of the U.S.

merchandise real exports during 1967-1990. Given the general impact of

durables on the dynamics of U.S. imports and exports, it is not surprising that

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38 Trade share is the ratio of imports and exports of the given good during a given period divided
   by the imports and exports of all goods traded during the given period.

trade in durables is more pro-cyclical and that the dynamics of the trade in

durable goods drives the pro-cyclicality of imports and exports. Engel and Wang

(2011) find higher pro-cyclicality of durables in the US data for 1997-2006. The

correlation of durable real imports with real output is 0.53 and that of durable real

exports with real output is 0.82. The correlations are higher than the correlations

of nondurable real imports and exports with real output which are -0.17 and 0.65

respectively.

In the sections that follow, I build a framework that is consistent with the

international business cycle evidence from this section. But my framework is

capable of more – it can also explain the coordination failures that we observe

during the bust phase of the business cycle.

3.3 Coordination failure in a closed economy

As noted in the introduction, people participating on division of labor face a

problem unknown to a person living in social isolation. This is the problem of

mutual coordination of plans as Hayek explains in his *Economics and Knowledge*

(1937, *cf.* Sargent 1986: x). Participation in division of labor makes people follow

plans that are dependent on plans of other people. Unfortunately, the

consistency or inconsistency of a person's plan with plans of other people shows

up often only with a delay, once the plan is under way. Recognition of the

coordination failure might occur only at an intermediate stage of executing the

plan, which means that the person has to incur additional costs in responding to

the failure. *I intend to relate the idea of a large-scale coordination failure caused by monetary policy with international business cycles.*

I build my framework on the tradition represented by Garrison (2001), Hayek (1975 [1939]), and Mises (1971 [1912]). While the three works discuss business cycle only for closed economy, they view the business cycle as a coordination failure – the position that I take for my international business cycle framework. The works view people as failing to coordinate when monetary expansion induces them to invest into production plans that are too long, too distant from consumption. Once the monetary expansion comes to its end, the overly long investment plans turn out to be too costly to finish. I use the idea of coordination failures along plans of vertical production processes and apply it in the international context[39]. Prior to doing so, I explain the basic properties of the framework for a closed economy.

3.3.1 Framework for closed economy: the assumptions

I begin the discussion with an overview of the main components of the framework, which I divide into the following five categories: (1) people, (2)

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39 Cachanosky (2012) and Hoffmann (2010) are two works that build on the tradition in the international context. Cachanosky (2012) focuses on the relative prices of tradable and non-tradable goods over the cycle. Besides changing interest rate across countries, monetary expansion in one country also changes relative prices of tradable and non-tradable goods at home as well as internationally. The change in the relative prices caused by the monetary expansion then leads to costly re-allocations of capital once the expansion comes to its end. Hoffmann (2010) comes with a similar framework, although he focuses mainly on international transmission of money-induced changes of real interest rate. Although I share a number of starting points with Cachanosky (2012) and Hoffmann (2010), both of them have different goals when compared to the present paper. Unlike Cachanosky (2012) and Hoffmann (2010), I address the prevailing international business cycle theories and some of the related stylized facts. Moreover, I restrict my discussion only to the case of floating exchange rates.

production processes, (3) financial market, (4) equilibrium conditions, and (5) dynamic properties.

First, in the context of *people*, I assume that (1a) the economy consists of a given constant number of infinitely living people. Each person (1b) is a utility maximizer, where consumption is the source of utility and work is the source of disutility. I follow the standard assumption that (1c) everyone is subject to the law of decreasing marginal utility. There are also differences between perceptions of present and future, which mean that (1d) people discount future utilities and disutilities by their subjective discount factor. In addition to the standard assumptions above, it also holds in my framework that (1e) every person uses an estimate of the real interest rate charged for a loan today as the best predictor of the real interest rate of the same type of loan taken tomorrow. This assumption of "static" expectations about real interest rates is not intended to be realistic. It is an analytic tool that I use for highlighting the aspects of human action related to coordination failures. The relevant features described under the assumption of "static" expectations are robust and hold also for the world of rational expectations with heterogenous individuals, as I show in Chapter 2.

Second, I list the assumptions about *production processes.* My framework assumes that (2a) the quantity and structure of the inflow of primary factors of production is constant and (2b) there is no technological change unless I state otherwise. All factors are subject to (2c) the law of diminishing returns. (2d) Factors of production are not all identical – they are often heterogenous and

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specific to certain tasks. Being specific, a factor used as an input of certain stages of the production of a good then bears a lower marginal product in alternative uses. It also holds that (2e) production processes leading to any consumption good take time and different production processes might be of different lengths. For analytical purposes, I divide the time that it takes to consume a factor of production into subsequent stages of production, where earlier stages are relatively more remote from consumption. The distinction between earlier and later stages of production has various manifestations. A factor representing an earlier stage might be one that does not reach the consumption stage in any form for a long period of time. But consumption and production durables tend to represent earlier stages too. Other things held equal, complete transformation of durable goods into acts of consumption takes more time than transformation of non-durable goods. Since they take relatively long time to get fully consumed, durable goods tend to be rather earlier stages of production. And lastly, (2f) a given consumption good can be often produced in a physically more efficient way if one allows for a longer production time. The same amount of factors of production then lead to a higher real physical output. People do not always deploy more efficient and longer production processes because the present discounted value of doing so is too low (Böhm-Bawerk 1959).

Third, I make one assumption about the *financial market.* (3a) The yield curve is flat, which means that loans of all maturities are sold at the same interest

rate. The shape of the yield curve is related to the assumption 1e, which implies that people take the present short term interest rate and predict that it lasts forever. The flat shape of the yield curve also means that people do not assign risk premium to loans of longer maturities.

Fourth, I describe the *equilibrium conditions* of the framework. The conditions do not hold at all points of time; rather, they determine the points of equilibrating tendencies of the economy. In the equilibrium, (4a) the marginal product of capital for a given period of time is equal to the real interest rate that is charged for a loan during the period of time and to the (4b) subjective discount rates of all individuals. By the same token, (4c) the wage rate of a unit of a labor equals to its marginal product. (4d) The classical dichotomy holds in the long run, which means that money is neutral in the long run.

And fifth, I assume with respect to *dynamics* that (5a) there are no frictions associated with spending loanable funds in the broader economy. The economy itself, however, is not frictionless and (5b) changes in the structure of production are costly and take time. The costliness of change is related to the specificity of factors of production that I note in the assumption 2d. The specificity of factors becomes important in conjunction with the dynamics of monetary change. I assume that (5c) increases in the money supply affect people in the economy sequentially. The sequential effects happen because some people receive the new money sooner than other people.

3.3.2 Closed economy without monetary expansion

Using Garrison (2001), I now describe the framework in its equilibrium,

where people have mutually coordinated plans.
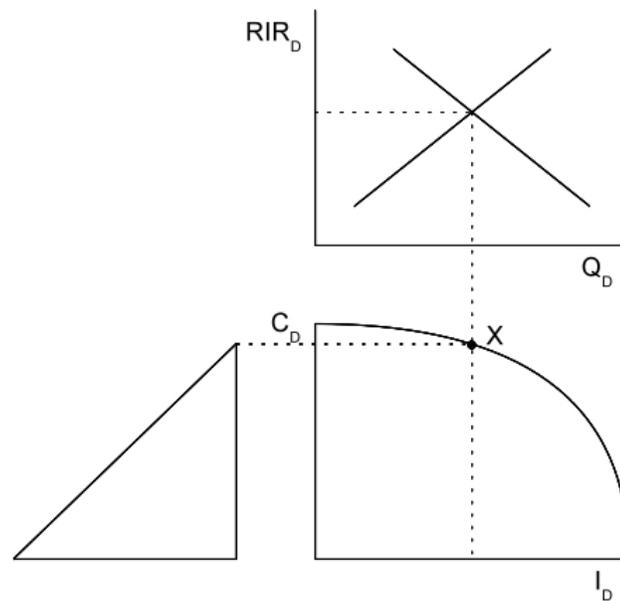
Figure 3.1 Closed economy of country D in an equilibrium

The equilibrated economy of country D at Figure 3.1 consists of three connected

graphs in three quadrants. The upper right quadrant is the market for loanable

funds with real interest rate RIR_D on its vertical axis and real quantity supplied Q_D

on its horizontal axis. As I have already noted, the real rate RIR_D is the only real

interest rate for loans of all maturities. The rate that people pay for a loan today

is therefore also the expected rate for the same type of loan charged tomorrow

and the real yield curve is flat. Assuming that people invest all the funds that

they borrow at a given real interest rate, the real quantity of supplied loanable funds directly enters the lower graph on the right, which is the production possibilities frontier of the economy. The frontier illustrates the aggregate trade-off between current real consumption C_D and current real gross investment I_D, where the law of decreasing returns is responsible for the concavity of the frontier. Point X is the current position of the economy in terms of the trade-off between consumption and investment. The real consumption is a direct link between the production possibilities frontier and the structure of production captured by the triangular graph in the lower left quadrant. The vertical leg of the triangle is then the current real consumption of a given composition and the horizontal leg is a continuum of different stages of production. Output of every stage in combination with primary factors of production, like labor and raw materials, serves as an input of the following stage of production. The causality in production processes, where goods produced in earlier stages serve as inputs towards later stages of production, is captured by the movement from left to the right along the horizontal leg of the triangle.

The hypotenuse of the triangle and its slope deserve special attention. The vertical distance between the hypotenuse and the horizontal leg is the real monetary value of the output of the given stage of production. The hypotenuse follows the increasing slope as one moves from earlier stages to the later stages; the slope increases for two reasons. First, new primary factors of production continuously enter the structure of production and thereby increase the value of

output in every stage. And second, people value the output of every stage based on the present value of its marginal product. Since, in terms of time, earlier stage goods are more distant from becoming consumption goods compared to later stage goods, the marginal product of earlier stages in terms of consumption goods also has to be discounted more heavily than marginal product of later stages. For a given discount rate, an additional dollar of produced consumption goods translates into a lower present value of the marginal product at a relatively early stage. The outputs of different production stages would then have different real monetary values even in the case of a point-input production process where all stages correspond to the same amount of consumption goods. The difference in the time that remains to reach consumption therefore also contributes to the differences in real values of outputs of the different stages of production.

The economy of country D at Figure 3.1 is in a self-reproducing equilibrium, where in every period of time people consume the same consumption goods and make the same production and investment decisions. The triangle representing the structure of production can be viewed in two complementary ways. First, it is the snapshot of all the existing stages of production. Second, the triangle is also the account of outputs of all stages of production that people finish at some particular point of time. The triangle stops playing the dual role when people unexpectedly move from the equilibrium due to an unexpected monetary expansion, as I outline in the following section. Since the existing capital structure is to some extent specific to the initial equilibrium, it

cannot be instantaneously transformed into a form that would correspond to the next equilibrium. The transformation is a process that takes time and involves costs. Being caught in the middle of the transformation, existing early stages of production may be transformed in the future into different later stages of production than the later stages that we see currently.

3.3.3 Monetary expansion in a closed economy

Figure 3.1 is the equilibrium of country D. However, following Hayek (1975 [1939]) I assume that D is not in its equilibrium. Instead of being on its production possibilities frontier, country D is at some point W inside of the frontier. There are a number of reasons why D might not be making the full use of its production possibilities. For example, a previous economic bust might have created a number of specific and non-specific idle resources. Another option might be a recent unexploited productivity shock, like a discovery of a new technology that can increase productivity of the workforce. In either case, the starting assumption is a disequilibrium, while simultaneously the economy is under a continuous tendency to the equilibrium at Figure 3.1.

The monetary authority, presumably to speed up the movement to the production possibilities of the economy, causes an unexpected shock to the nominal money supply. The authority injects new money through an open market operation which means that the money enters the economy through the market for loanable funds and decreases the real interest rate. The liquidity effect of

monetary shocks on the real interest rate is well documented; Eichenbaum and

Evans (1995), Christiano et al. (2005), and Lastrapes and Potts (2006) provide

evidence for the US, Fung and Kasumovich (1998) internationally. While the

monetary authority produces a liquidity effect by injecting nominal money supply,

thinking about it in terms of changes of nominal money supply leads to

complications. Since the demand for money may be changing over time, the

same nominal changes in the money supply may lead to different real effects at

different points of time. For these reasons, I focus on injections of real money

supply, or dMs_D. Figure 3.2 illustrates the liquidity effect which comes from an

injection of real money supply, dMs_D .
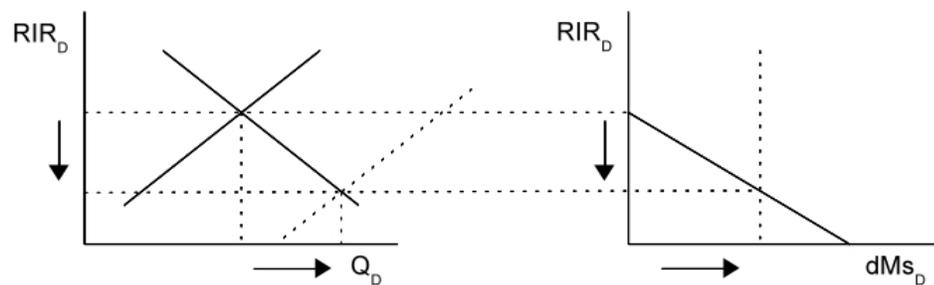
Figure 3.2 The effect of an unexpected increase in the money supply on real

interest rate in country D

The liquidity effect can be explained by Cantillon's argument (2010 [1755]) as

pointed out by Allais (1974: 311-315) and Cagan (1966: 229-230, 1969).

Cantillon argues that people who receive the new money earlier have an

advantage over later recipients. The advantage is in the ability of the early

recipients of the newly injected money to increase their expenditures before anyone else. By entering the economy through the market for loanable funds, the new money gives an advantage to borrowers since, with the monetary injection, the supply of loanable funds goes up, and the real interest rate goes down. The redistributive nature of monetary expansion that causes the decline in the real interest rate can have additional effects on incomes and preferences of individuals besides the liquidity effect. In turn, the additional effects can again affect supply and demand for loanable funds. The size and the direction of the additional effects is, however, indeterminate from the view of economic theory. It is for this indeterminacy that I assume away all the other effects that the change in the money supply has on the market for loanable funds with the exception of the liquidity effect. Assuming away the other effects seems reasonable in the light of the empirical literature on liquidity effects mentioned above, which documents that the liquidity effect is stronger than the counteracting tendencies.

The monetary authority can keep the real interest rate at the lower level only if it keeps the nominal money supply increasing at a sufficient pace. The pace is sustained as long as the newly injected real money supply, dMs_D, remains constant. If the monetary expansion stops, participants at the market for loanable funds lose the advantage from getting new money first. The market for loanable funds then becomes driven only by the demand and supply originating from the preferences of people in country D, which means that the real interest rate has to increase.

The willingness of the monetary authority to keep the real interest rate at the given lower level for an infinite period is, however, questionable as doing so might become too costly. I have already mentioned that the real rate and nominal changes in the money supply do not have a constant link. The instability in the present situation means that monetary authority has to *increase the growth in the nominal money supply* to keep the interest rate down, which is the reason why keeping the real interest rate down might become politically too costly to preserve. Figure 3.3 illustrates the reasons for the unstable link between the real interest rate and nominal changes in the money supply. The instability comes with two equilibrating tendencies represented by the two triangles.
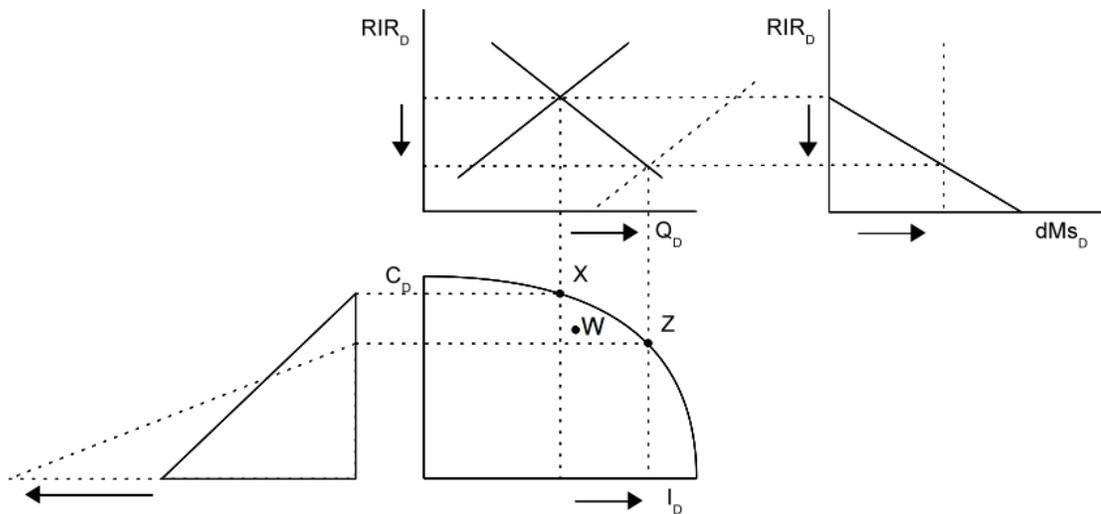
Figure 3.3 Monetary expansion in country D and two conflicting equilibrating tendencies

The first equilibrating tendency corresponds at Figure 3.3 to the dashed

flat triangle and to point Z at the production possibilities frontier. The tendency is

driven by the monetary policy of lowering the real interest rate, which increases

profitability from investing in early stages of production, even in early stages that

have not existed before. The link between the tendency towards the new pattern

of investment and the lower real interest rate is related to the fact that

entrepreneurs use the real interest rate also as the discount rate for computing

the present values of their projects. I have explained why the same discount rate

means a higher discount factor of marginal products of earlier stages of

production in the section 3.3.2 above. The effects that the same discount rate

have on the discounted marginal products in different stages operate also when

the discount rate changes. Therefore, changing the discount rate has over-

proportional implications for the discounted marginal products of earlier stages of

production. A decrease in discount rate, accompanying a decrease in interest

rate, increases the present value of marginal products in earlier stages of

production and increases the profitability of factors of production in earlier stages.

It is the change of relative profitability that gives people the incentive to move

factors of production to earlier stages when real interest rate goes down. The

movement of the factors of production along the structure of production then

tends to a situation where the quantity of consumption goods goes down

temporarily as the structure of production gets longer.

The solid steep triangle and the related point X at the production

possibilities frontier of Figure 3.3 both represent the end-state of the second equilibrating tendency. The tendency is an outcome of saving and consumption preferences of the owners of the production factors, the income earners. Where people divide their incomes between savings and consumption in a ratio that is inconsistent with the first equilibrating tendency, people want to consume more. Without the monetary expansion, the supply of loanable funds shifts left, which leads to a higher real interest rate, shorter structure of production, and higher current consumption.

The two equilibrium tendencies can operate alongside each other at a relatively low inflation rate as long as there remain unused factors of production. Any increased demand from those investing in early stages of production as well as those investing in later stages can be temporarily satisfied from the unused pool of factors. The situation changes once the economy reaches its production possibilities frontier. At this point, the monetary authority may still have the ability to supply a sufficient amount of additional real money supply, dMs_D, to keep the real interest rate down. Exercising the ability, however, becomes more costly because the injection of a given *real* amount of money supply now requires a higher money injection in *nominal* terms.

When the economy is on the production possibilities frontier, all previously unemployed factors of production are employed. The supply curves of the factors are now *more inelastic*, when the price variable is expressed in nominal terms, and so must be the nominal supply curves of their products. An increase

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in the nominal demand for a good then leads to a higher increase in its nominal

price compared to the situation when the economy is not on its production

possibilities frontier. By the same token, increases in nominal demands for

goods that are induced by a given increase in the nominal money supply also

lead to a higher increase in the nominal prices of the goods. A given injection of

the nominal money supply then, *ceteris paribus*, represents lower injection of real

money once the economy reaches the production possibilities frontier. The

change in the relationship between nominal and real money injections bears

important consequences for monetary policies of low real interest rate. To keep

the real amount of loanable funds at the level that is consistent with the desired

lower real interest rate, the monetary authority has to keep increasing the

nominal money supply at a higher pace. The higher increases in the nominal

money supply in turn lead to higher inflation rates.

From the view of the policy-makers, as long as the inflation rate is a

tolerable side-effect of the policy of low real interest rate, the economy is in the

equilibrium of the dashed flat triangle at Figure 3.3. However, the potential

political costs of inflation in conjunction with the tendency to the different

combination of consumption and investment of the solid steep triangle make this

equilibrium unstable. It happens – and quite regularly – that the costs of keeping

the real interest rate at the lower level become too high for policy-makers. Once

the expansion becomes too costly, the monetary authority has to decrease its

expansionary activities and people have to readjust to the new situation.

Slower monetary expansion leads to a decrease in real economic output because people have to reallocate factors of production. The allocation of factors now tends to the pattern that corresponds to the new dominant equilibrium, which is the solid triangle at Figure 3.3. The real interest rate goes up, the profitability of the longer structures of production decreases, and a number of production factors, especially those in the early stages, become obsolete or unemployed. The future of the early-stage factors at this point depends on their specificity. While the nonspecific factors of production have higher chances for re-employment and they move towards later stages of production, some overly specific factors of production become idle, ending up as a proof of the coordination failure. Since restructuring of the economy requires transaction costs and takes time, the economy moves to the inside of the production possibilities frontier. After the previous boom, the economy is now in a bust. Real output, real consumption, real investment, and employment all decrease and a high number of people realize that their previous plans were based on incorrect expectations.

3.4 Coordination failure across two open economies

I now move from the situation of a closed economy to the setting of two open economies of countries A and D. In addition to the assumptions that I spell out in section 3.3. Which hold for each of the two countries, I introduce additional assumptions for the open economy setting.

People in the two countries (6a) use separate fiat currencies – those living in A use $A and those in D use $D. Each of the two countries has (6b) an independent monetary policy, and (6c) none of them imposes legal restrictions on international movement of goods, services, and financial capital. There is also (6d) perfect capital mobility and financial capital moves between the two countries without transactions costs. One implication of the previous assumptions is, in the light of the monetary policy trilemma (e.g. Obstfeld et al. 2005), (6e) A and D are each on the floating exchange rate regime. Another implication is that (6f) the uncovered interest rate parity holds at all times and investment into financial assets in either of the two countries leads to the same rate of return. The parity is then $RIR_D = RIR_A * E[RER]/RER$. The variables RIR_D and RIR_A are the respective interest rates of countries A and D for a given period of time, RER ($D/$A) is the real exchange rate of the currencies of the two countries, and E[RER] is the expected real exchange rate after the given period of time.

Additionally, I assume that (6g) countries trade only in primary factors of production. Such assumed restriction of international trade is necessary as an artifact of the graphical framework. While the assumed restrictions on international trade preserve the analytic clarity of the graphical framework in the context of open economies, they pose a danger of loss of insights. In particular, in the real world, changes in relative prices of intermediate goods might be accompanied by changes in the structure of international trade as well as in

structures of production across countries. Assuming away the possibility of the trade in intermediate goods might correspondingly obscure an understanding of such effects. To take account of the effects, I assume that primary factors of production, which are traded, share certain properties with intermediate factors of production. Primary factors can be heterogenous, of different durability, and of different specificity with respect to different stages of production. Changes in relative prices of goods that are specific to certain stages of production or in relative prices of goods of certain durability still have an effect on international trade and production structures of the two countries.

3.4.1 Monetary expansion in an open economy

Let me again begin with the thought that country D starts inside of its production possibilities frontier. For some reason, the monetary authority of country D decides in favor of an unexpected monetary expansion lasting for an uncertain period of time. Following the standard procedure, the money supply increases through open market purchases and the new money enters the economy through the market for loanable funds. As the participants at this specific market receive the new money first, the amount of resources supplied at the market for loanable funds is suddenly higher than it would otherwise be. The increased supply of money decreases the real interest rate through the liquidity effect and leads to all the effects discussed for the case of a closed economy: output, investment, consumption, and employment of production factors tend to

go all up. The equilibrium to which the structure of production in country D tends

is, however, sustainable only with the appropriate rate of monetary expansion.

Once the monetary authority decides to stop the expansion, people in country D

experience a coordination failure.

In contrast to the previous section, the situation in country D also has

some international aspects that eventually lead to a coordination failure in

country A. By decreasing the real interest rate in country D, the monetary

expansion tends to distort the initial uncovered interest rate parity. The real

interest rate in D tends to be too low when compared to that in country A and the

expansion therefore opens up arbitrage opportunities between the markets for

loanable funds of the two countries. With the initially lower interest rate in

country D, arbitrageurs can take a loan in $D, exchange the money for $A, and

lend the money in country A while taking the advantage of the higher interest

rate. While monetary expansion creates arbitrage opportunities also across

other markets than the markets for loanable funds of the two countries, there are

good reasons to believe that people exploit the other arbitrage opportunities only

relatively later. The markets for loanable funds of countries A and D and also the

foreign exchange market are all centralized and mutually well interconnected.

The low costs of transacting across these financial markets give people the

incentives to exploit the arbitrage opportunities across them relatively sooner,

which also means that the new money enters the markets for loanable funds and

the foreign exchange market sooner than the other markets. Eichenbaum and

Evans (1995) give empirical support to the previous conclusions in a vector autoregression analysis of monetary shocks in the U.S. and the effects of the shocks on Japan, Germany, France, Italy, UK.

Figure 3.4 and Figure 3.5 illustrate the effects of monetary expansion on the markets for loanable funds of the two countries, and on the foreign exchange market. The three horizontally related graphs of Figure 3.4 link monetary expansion with the changes in real interest rates of country A and country D. The graph on the left is D's market for loanable funds during the monetary expansion. The graph in the middle captures the same situation pointing to the cause of the change in the real interest rate – the change in the real money supply dMs_D. The graph on the right then shows the consequences of international transfers of loanable funds to country A. Taking the advantage of the interest rate differential across the two countries, the activities of arbitrageurs lead to a decrease of A's real interest rate. The real interest rates in the two countries become equal, as it is at Figure 3.4, once the real exchange rate reaches a equilibrium. In such equilibrium, present and expected real exchange rates are equal to each other and the uncovered interest rate parity can be simply put as $RIR_D = RIR_A$.
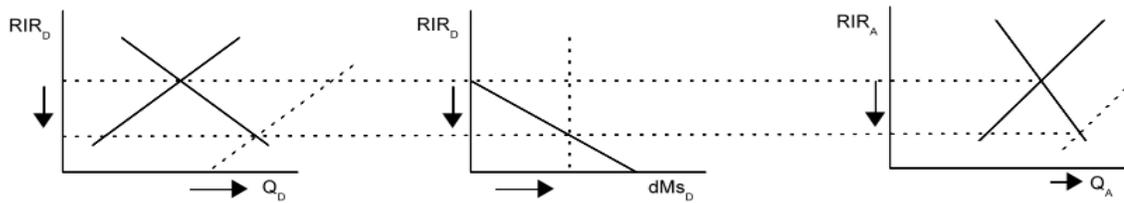
Figure 3.4 Monetary expansion in country D and resulting liquidity effects with international spill-overs

Figure 3.5 illustrates the effects of the monetary expansion on foreign exchange markets, where the inflow of the new money increases the real demand for $A and leads to real depreciation of $D. The causality begins with the top graph of the figure. The graph relates the change in real interest rate with the change in D's real money supply, dMsD, which makes it identical to the middle graph of Figure 3.4. The graph in the middle of Figure 3.5 is the spot foreign exchange market where RER $A/$D is the real exchange rate expressing the amount of $A that one can get for one unit of $D. The monetary expansion in D leads to real depreciation of $D because the new supply of $D comes to the foreign exchange market relatively early. The graph at the bottom of Figure 3.5 shows the same depreciation as the graph in the middle, the only difference being that instead of taking real exchange rate as $A/$D, it reverses the formula to $D/$A. The depreciating $D then rises $D/$A because one unit of $A buys more $D.
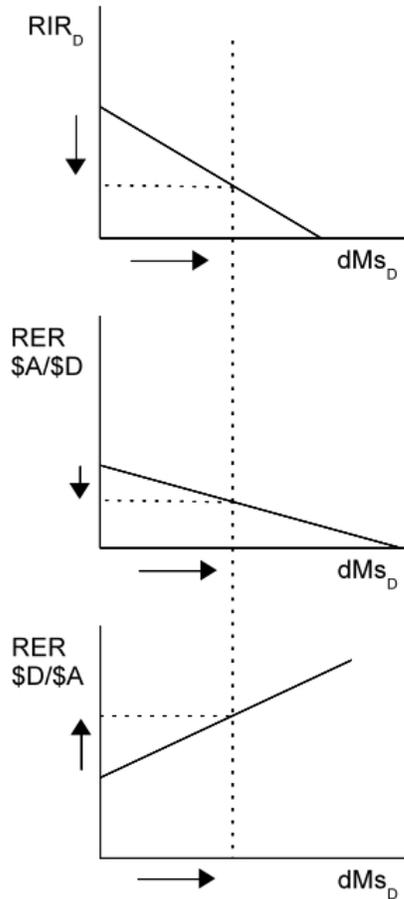
Figure 3.5 Monetary expansion in country D and resulting depreciation of $D with respect to $A

Figures 7, 8, and 9 show the overall effects of the ongoing monetary expansion on the equilibrium of the tendencies operating in country D. The expansion shrinks D's production possibilities frontier as one can see at Figure 3.6. The causality in the figure goes from the right to the left. The graph on the right illustrates how the monetary expansion in country D depreciates $D in real terms because the newly issued units of $D get to the foreign exchange market sooner

when compared to most of the other markets. The ability of sellers of $A for $D

to get to the new money relatively early leaves people in country D with less

resources at hand. The worsening position comes with the increase in prices of

imports from country A as well as with relatively early increases in prices of

goods that people from country A buy in country D.
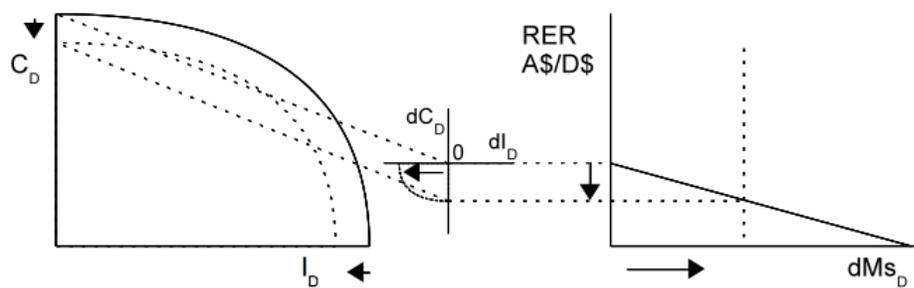
Figure 3.6 Depreciation of real exchange rate in country D and the shrinking

production possibilities frontier

Such international redistribution has an effect on the production possibilities

frontier of country D as Figure 3.6 shows on the remaining two graphs. The

middle graph links the international redistribution during the monetary expansion

on the graph to the right and the inward shift of the production possibilities

frontier on the left graph. Constant money supply in country D and the initial

production possibilities frontier of country D are equivalent to point 0 of the graph

in the middle, as the dashed lines linking the three point out. Increasing money

supply in country D, on the other hand, decreases the possible real investment

and real consumption options of people in country D by the combinations of dI_D and dC_D. The production possibilities frontier then decreases by the appropriate combination of dI_D and dC_D as the dashed line highlights the point of the production possibilities frontier when the country consumes without any investment.

Figure 3.7 shows the consequences of the shrinking production possibilities frontier on the structure of production, to which the country D tends as long as the monetary expansion lasts. Other things held equal, the triangle representing the structure of production shrinks inwards because people in country D have fewer available resources.
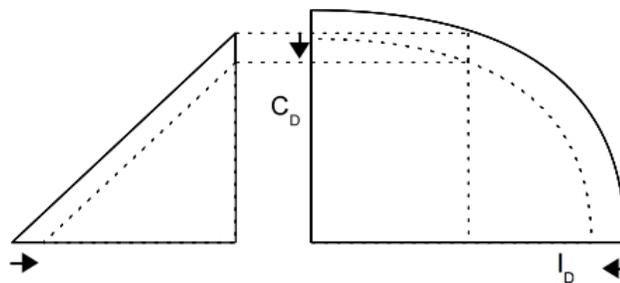
Figure 3.7 The effect of the shrinking production possibilities frontier in country D on its structure of production

Figure 3.8 then combines the two effects resulting from the change in the money supply. This combination remains the equilibrium to which the economy of country D tends during the monetary expansion. The first effect is an increase

in profitability of longer productions which goes hand in hand with the decrease in

the real interest rate. The outcome of the first effect is the equilibrium

represented by the point R at the production possibilities frontier. It is also the

equilibrium to which D would tend if it were a closed economy. There is,

however, also the second effect, which moves the production possibilities frontier

inwards. The outward drain of resources shrinks the equilibrium triangle to which

country D tends to and the growth of output of D is limited more than it would

otherwise be. Point S at the production possibilities frontier represents this

equilibrium.
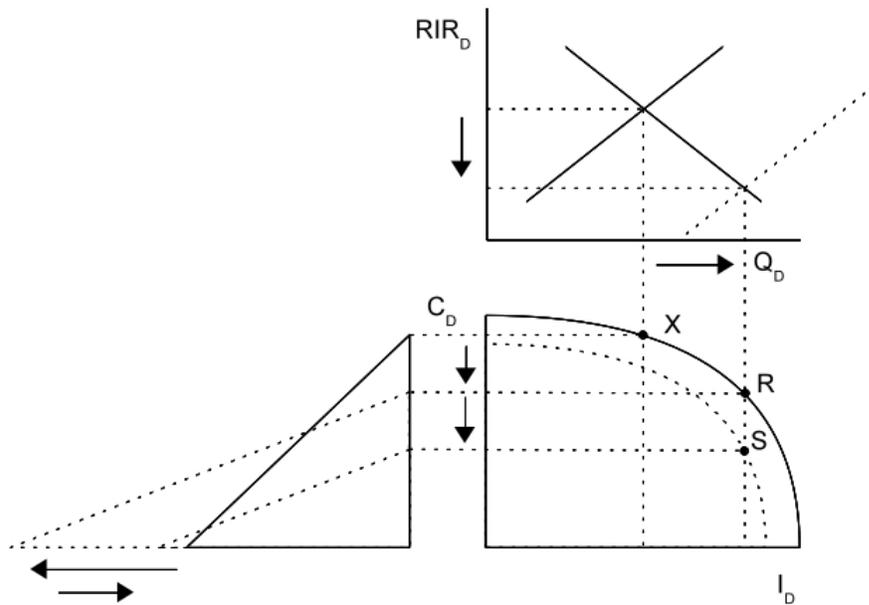
Figure 3.8 The effects of lower real interest rate and of real depreciation of $D on

country D

The distinction between the two effects created by the monetary expansion is relevant to the discussion of the coordination failures that people realize at the end of the expansion. As it is in the case of a closed economy, a higher real interest rate associated with the end of the monetary expansion decreases the profitability of relatively long production processes. Some of the processes have to be liquidated, which means costly reallocations of some factors and abandoning of overly specific factors. The abandoning of the overly specific factors tends to shift the whole production possibilities frontier of country D inwards. Because reallocations of factors take time, country D temporarily also tends to move inside of this shrinking production possibilities frontier and to produce less than its output potential. But as a second effect, the outflow of the resources from country D to country A comes to an end, which means that the production possibilities frontier of country D expands. The expanding production possibilities frontier is, however, not immediately accompanied by an expansion of output because it takes time for the additional resources to enter production processes in country D. Overall, the end of the monetary expansion in country D leads to a decrease in country D's real output. The fall in output is accompanied by a decrease in real investment, real consumption, and real employment and it is again associated with a surge of coordination failures that people perceive.

Figures 3.10, 3.11, and 3.12 show that although countries A and D experience co-movement in terms of a number of aggregates, the situation in country A is in many ways the reverse of that of country D. In Figure 3.9,

monetary expansion in D shifts production possibilities frontier of country A

outwards.
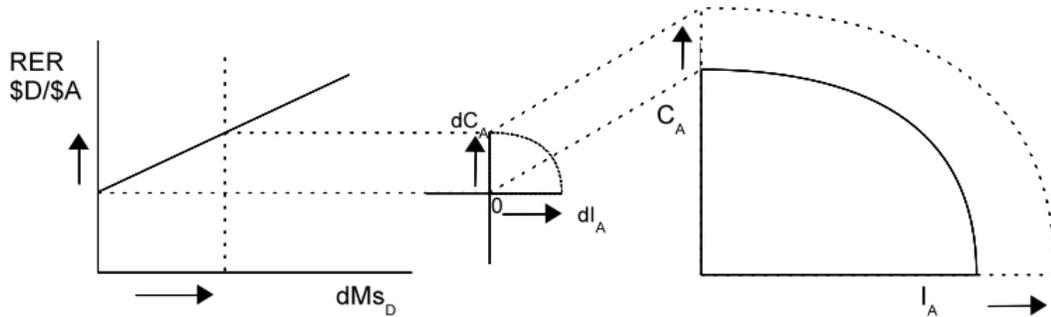
Figure 3.9 Appreciation of real exchange rate of $A and the expansion of A's

production possibilities frontier

The expanding money supply in country D gives an advantage to the holders of

$A, i.e., mostly people living in country A. The advantage comes from the

opportunity to get hold of the additionally injected $D before others because it

comes to the foreign exchange market relatively early. Holders of $A can thus

purchase more resources than otherwise and the production possibilities of

country A expand.

Expanding production possibilities frontier allows, other things held

constant, expansion of both – real consumption and real investment. In terms of

the triangular diagram representing the structure of production of country A, the

hypotenuse shifts outwards as Figure 3.10 shows.
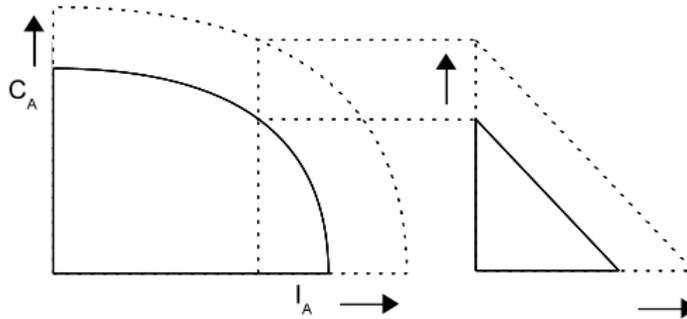
Figure 3.10 The effect of expanding production possibilities frontier of country A on its structure of production

Lastly, Figure 3.11 combines the effect of the lower real interest rate and the effect of expanding production possibilities into one diagram. Without the monetary expansion in country D, the economy of country A tends to the equilibrium of point F. The lower real interest rate in country A, RIR_A, tends to change the proportion of consumption and investment expenditures as represented by point G. The expanding production possibilities frontier means that the new equilibrium of the economy of country A is at point H, which indicates that people in country A can engage in more investment as well as more consumption activities. Real investment, real consumption, and real output in country A increase. Moreover, there is reason to expect that the employment of production factors increases as well. Cheaper complementary factors of production that can be imported from country D increase marginal product of production factors in country A. As long as the supply of the factors of production in country A is upward-sloping, employment in country A goes up. To be sure, H

remains the equilibrium only as long as monetary authority in country D

perpetuates a sufficient pace of monetary expansion. Once the expansionary

policy ends, the center of equilibrium tendencies of country A changes as its

productions possibilities frontier shrinks and the real interest rate goes up. In

their response, people in country A, at least to some extent, suffer from

coordination failure due to specific investment decisions contingent on continuing

of equilibrium H. At this point, real output, real consumption, real investment, and

employment have to go down, at least temporarily.
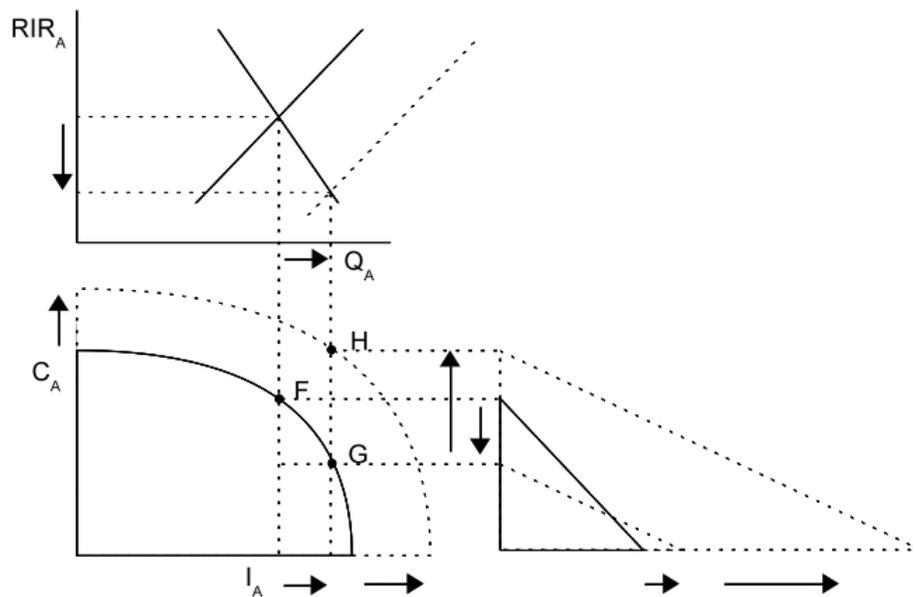
Figure 3.11 The effects of lower real interest rate and of real appreciation of $A
on country A

Figure 3.12 puts the figures 5 to 12 together into a single picture encompassing

all the the discussed events that follow the monetary expansion in country D. The first row of Figure 3.12 relates the monetary expansion in country D and the decrease in real interest rates in the two countries.

The second row of Figure 3.12 illustrates the consequences of the monetary expansion on the equilibrium to which country D tends – the equilibrium shifts from point X to point S. But people in country D experience the beginning of the monetary expansion below point X because of the unemployed resources in D. The existence of available resources explains the increase of real output, real consumption, real investment, and employment while the production possibilities frontier of country D moves inwards.

The last row shows the relationship between the monetary expansion in country D and its impacts on country A. The production possibilities frontier of country A shifts outwards and the equilibrium to which the economy of country A tends to changes from point F to point H. Irrespective of whether A starts at or within its production possibilities frontier, its real output, real consumption, real investment, and employment can all go up.
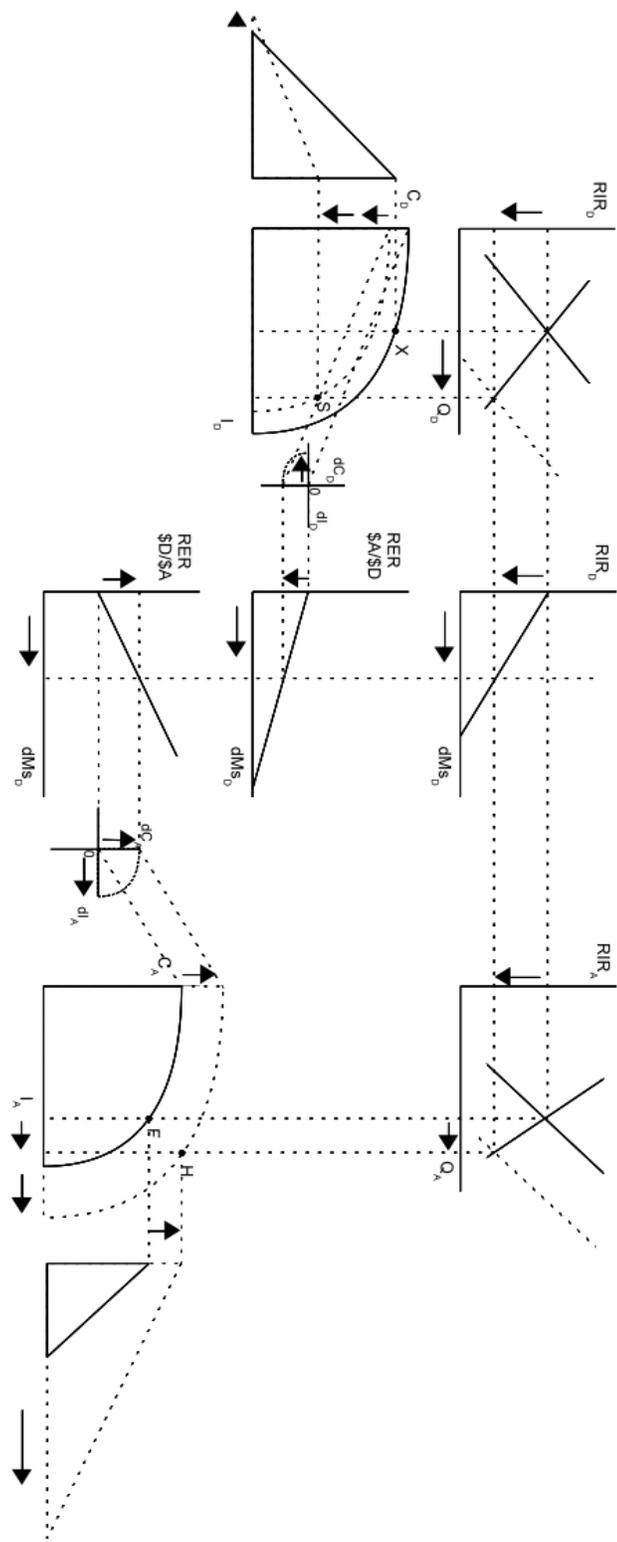
Figure 3.12 Monetary expansion in country D and its international effects

As long as the monetary expansion in D keeps sufficient pace, both countries tend to their new equilibrium points at their new production possibilities frontiers. Country D has a tendency to reach point S and country A moves towards H. The two tendencies are associated with upward co-movement of real outputs, consumptions, investments, and employments across the two countries. The tendencies also bring changes in the structures of production and investments into factors of production that are specific to the new equilibrium points S and H.

The specificity of the new investment in countries D and A happens across two important dimensions – time and international space. The dimension of time is related to the change in real interest rate. With the lower interest rate, it is more profitable to allocate factors of production into earlier stages of production. The dimension of international space is related to the real exchange rate. The real exchange rate is the relative price that affects whether an individual or a firm purchases inputs in one country instead of another country. The monetary expansion in D affects both of the important prices – real interest rate as well as the real exchange rate, and production structures of the countries D and A change correspondingly. The changes in production structures that start with the monetary expansion do not initially seem to be a massive coordination failure because the changes can be, at least partly, facilitated by the unused resources of country D. This is not the case when the monetary expansion ends and both countries, D and A, are sufficiently close to the equilibrium points at their production possibilities, S and H.

The end of the monetary expansion is related to the corresponding changes in real interest rate and real exchange rate. The real interest rate goes up and the previously depreciated $D again appreciates in real terms with respect to $A. Assuming that the end of the monetary expansion is unexpected, many people suddenly realize that they happened to participate in a coordination failure. Realizing their failures, people have to readjust production factors within the structure of production from the unprofitable allocations to profitable ones. Some early stages of production have to be liquidated as the real interest rate goes up and also some production dependent on inputs from another country might need to be readjusted due to a change in the real exchange rate (*cf.* White 1989: 146). The liquidations and reallocations are costly – they take time and specific production factors might have to be abandoned in the readjustment process.

3.4.2 Consistency of the theory with the data

The open-economy framework from the previous subsection is consistent with the stylized facts of Table 3.1. The framework shows how expansionary monetary policy of one country creates an international boom, which is followed by international bust once the policy comes to its end. The framework then describes dynamics that is consistent with Table 3.1 – the international co-movement in real output, real consumption, real investment, and employment.

But the framework is consistent with more of the observed facts than just

the co-movement across the four aggregates of Table 3.1. It can also explain the positive correlation of real imports and real exports with real outputs, and the cross-country correlations of imports and exports that I report in Table 3.2. The expansionary phase in my framework comes with a decline in the real interest rate across the countries and increased demand for goods of early stages of production. I have already explained that durable goods tend to be goods of early stages because, other things held equal, a durable good of a given real value tends to be fully consumed only relatively later in time. The early-stage character of durable goods then means that the demand for durable goods increases with the decrease in the real interest rate too. Other things held equal, people in countries D and A do not purchase more durable goods only domestically, they want to import more durable goods from abroad. In the two-country world of my framework, an increase in imports of one country is necessarily the increase in exports of the other country. Continuing monetary expansion therefore tends to be accompanied by higher durable imports and exports in both of the countries. Table 3.3 shows that durable goods constitute the bulk of the overall international trade, which means that the increases in durable imports and exports likely translate into overall increases in imports and exports. For the same reasons, the end of monetary expansion reverts the tendency in the opposite direction – the demand for durable goods declines with the rising real interest rate, real imports and exports follow the suit, which makes them positively correlated with real output. The importance that my framework

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assigns to durable real imports and exports as the factors that can explain the

correlation between real output and real imports and exports is consistent with

the remaining evidence in Table 3.3. The last two lines of the table report

relatively high positive correlation of durable imports and exports with real

output.[40]

3.5 Conclusion

Coordination problems exist because plans of some people can be

incompatible with plans of others. Our daily experience – when we encounter

arguments, persuasions, or threats from others – exemplifies the presence of

coordination problems. But while we spend considerable resources to solve

problems of coordination, we sometimes happen to fail. While some coordination

failures are barely noticeable, the possibility of failure, however, implies that there

might be situations where dis-coordination takes the center stage in the lives of

many people.

There certainly is an aspect of a large coordination failure related to

business cycles, which should not be too surprising. After all, business cycles

are accompanied with an increase in the number of bankruptcies as well as an

increase in the number of upset and desperate people. These reasons also make

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40 The previous conclusion depends on an implicit assumption for country D. While the
expansionary monetary policy in country D might tend to increase the demand for imports
through the real interest rate, it also has an opposite tendency through the depreciated foreign
exchange rate. The depreciation of $D makes imports more expensive and gives people an
incentive to import less. Imports of country D therefore increase only if the effect of changes
in real interest rate is stronger than the counteracting effect of foreign exchange rate.

it advisable to not set aside the aspect of coordination failure; we should explore it – for which, we need suitable theoretical frameworks.

Building a framework that would capture international business cycle as a coordination failure has been in the center of my previous discussion. My main conclusion points to the link between monetary policy and international coordination failures. The conclusion is somewhat disturbing because it implies that coordination failures induced by expansionary monetary policy in one country transmit across other countries even where the other countries are independent currency areas. Such conclusion then leads to further normative and positive issues.

The implications for economic policy are presumably among the main normative issues related to the framework. The policy issues also highlight the differences between the framework that I discuss here and the frameworks of the international real business cycle theories or of the new open economy macroeconomics. If one, for example, assumes that the policy goal is the maximization of the world real output, the international real business cycle theories noted above (*cf*. Arkolakis and Ramanarayanan 2009, Backus et al. 1993, Burstein et al. 2008, and Engel and Wang 2011) do not have clear policy implications. After all, people already respond to productivity shocks in an optimal way. As long as the shocks are outcomes of the workings of nature, there is not much that a policy maker can do.

In contrast, the new open economy macroeconomics implies specific

policy responses (Barro and Tenreyro 2006, and Huang and Liu 2007) because an expansionary monetary shock can temporarily decrease the inefficiencies of existing monopolistically competitive producers. Monetary expansion then increases output because the prices which producers assign to their products are sticky and such policy is, other things held equal, advisable.

My framework also bears specific policy prescriptions. The prescriptions, however, differ in comparison with the new open economy macroeconomics, given the goal of maximizing of the world output that I chose as an example. Because my framework captures the dis-coordinating features of expansionary monetary policies, it leads to the conclusion that the policy makers should abstain from monetary expansions that end at uncertain points of time. But while the normative conclusions from my framework can differ from those of the other two literatures, one might not necessarily view the three to be in conflict as they are describing different transmissions related to the same phenomenon. It seems more desirable to explore the relative importance of the effects captured by the three types of frameworks.

The need to find the relative importance of different frameworks brings me to the questions of positive economics. In particular, it seems desirable to identify the circumstances that affect the strength of the international transmission of coordination failures. Frankel and Rose (1998) and their followers (especially Burstein et al. 2008, Di Giovanni and Levchenko 2010, and Ng 2010) find evidence suggesting that international trade might play a role in

this respect. They find a significant relationship between the size and structure

of international trade of countries and the output co-movements of countries.

The findings appear consistent with the view that the structure of production

plays an important role in business cycle fluctuations, which is a characteristic of

my framework. To fully incorporate this insight, however, my framework needs an

extension that would account for the international trade in intermediate goods,

rather than restricting the trade to primary factors of production as it does now.

Such an extension looks as a plausible next step of the research program that

views international business cycles as coordination failures.

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Curriculum Vitae

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