The International Business Cycle as a Coordination Failure

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Abstract

The paper explains the overlooked phenomena of coordination failures in the context of the international business cycle. My explanation remains consistent with some main stylized facts. In my explanatory framework, domestic monetary policy leads to real effects at home as well as abroad and causes the observed co-movement of business cycles across different currency areas. Monetary expansion enters through the domestic market for loanable funds where it decreases the real interest rate. Facing low transactions costs, people spend the new money relatively early in the foreign exchange market and in the foreign market for loanable funds. Domestic monetary expansion thereby changes relative prices between domestic and foreign goods and also between goods of earlier and later stages of production. The changes in the relative prices lead to coordination failures as people invest in specific production projects that become unprofitable once the monetary expansion ends.

Keywords: non-neutrality of money, coordination failure, coordination problem, international business cycle, structure of production

JEL classification: F21, F31, F44

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I. Introduction

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. When the person successfully aligns his plan with the actions of others, he solves a particular coordination problem and he experiences a coordination success. If the person fails, he suffers a 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 – a phenomenon of co-movement of macroeconomic aggregates across more than one country.

Money is one social institution that many economists consider to be the general cause of 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 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 relative 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 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 convey some other layers of reality. The bust phase of business cycle comes with signs of coordination failures that need to be accounted for. It is during the bust that businesses fail (e.g., Altman 1983, Nobuyuki and Kageyama 2011, Platt and Platt 1994, Santoro and Gaffeo 2009), marriages fall apart (Arkes and Shen 2010), and people tend to commit suicides (e.g., Catalano et al. 2011, Luo et al. 2011, Ruhm 2000, Snipes et
al. 2011, Stuckler et al. 2009). These are all costly adjustments that people make to their long-term plans. These are also last resort adjustments that people choose under the pressure of mounting coordination failures. The increased incidence of such adjustments during the bust suggests that for some reason, people tend to become aware of the errors in their plans during economic recessions. The existence of the counter-cyclical pattern of errors calls for a framework to account for it.

My framework puts the observed coordination failures into the context of international business cycles. 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.

II. 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 that the average cross-country correlation of real outputs is 0.28. Table 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 1>

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 2 and Table 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 2>

Table 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 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>

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\(^1\) 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

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\(^1\) 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.
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 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.

III. 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. Prior to doing so, I explain the basic properties of the framework for a closed economy.

**III. 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) production

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2 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.
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 Appendix A.

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 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 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.

III. 2 Closed economy without monetary expansion

Using Garrison (2001), I now describe the framework in its equilibrium, where people have mutually coordinated plans.

<Figure 1>

The equilibrated economy of country D at Figure 1 consists of three connected graphs in three quadrants. The upper right quadrant is the market for loanable funds with real interest rate \( R_{IR_D} \) on its vertical axis and real quantity supplied \( Q_D \) on its horizontal axis. As I have already noted, the real rate \( R_{IR_D} \) 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 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.
III. 3 Monetary expansion in a closed economy

Figure 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 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 $dM_D$. 
Figure 2 illustrates the liquidity effect which comes from an injection of real money supply, $dM_s$.

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 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>

The first equilibrating tendency corresponds at Figure 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 III. 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 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, $dM_s$, 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 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. 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. 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.

IV. 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 III. 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 \( \text{RIR}_D = \text{RIR}_A \times E[\text{RER}] / \text{RER} \). The variables \( \text{RIR}_D \) and \( \text{RIR}_A \) are the respective interest rates of countries A and D for a given period of time, \( \text{RER} (\$/A) \) is the real exchange rate of the currencies of the two countries, and \( E[\text{RER}] \) 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. I explain the reasons behind the restriction in Appendix B. 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.

IV. 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 4 and Figure 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 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 $dM_s$. 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 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 4>

Figure 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, $dM_s$, which makes it identical to the middle graph of Figure 4. The graph in the middle of Figure 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 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 5>
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 6.

<Figure 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. Such international redistribution has an effect on the production possibilities frontier of country D as Figure 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 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 7>

Figure 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 8>
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 10, 11, and 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 9, monetary expansion in D shifts production possibilities frontier of country A outwards.
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 10 shows.

Lastly, Figure 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, $\text{RIR}_A$, 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 production 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 12 puts the figures 5 to 12 together into a single picture encompassing all the discussed events that follow the monetary expansion in country D.

The first row of Figure 12 relates the monetary expansion in country D and the decrease in real interest rates in the two countries.

The second row of Figure 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.

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. The liquidations and reallocations are costly – they take time and specific production factors might have to be abandoned in the readjustment process.

**IV. 2 Consistency of the theory with the data**

The open-economy framework from the previous subsection is consistent with the stylized facts of Table 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 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 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 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 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 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. The last two lines of the table report relatively high
positive correlation of durable imports and exports with real output.\(^3\)

**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 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

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\(^3\) 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.
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.
References


Table 1: The basic characteristics of international business cycles

<table>
<thead>
<tr>
<th>Variable</th>
<th>Statistical property in question</th>
<th>The qualitative result</th>
<th>A numerical result^a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real output</td>
<td>Cross-country correlation</td>
<td>Positive correlation</td>
<td>0.28</td>
</tr>
<tr>
<td>Real consumption</td>
<td>Cross-country correlation</td>
<td>Positive correlation for most countries</td>
<td>0.15</td>
</tr>
<tr>
<td>Real investment</td>
<td>Cross-country correlation</td>
<td>Positive correlation for most countries</td>
<td>0.22</td>
</tr>
<tr>
<td>Employment</td>
<td>Cross-country correlation</td>
<td>Positive correlation for most countries</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Sources: Backus et al. (1993) provide correlations between the US variables and those of Australia, Austria, Canada, France, Germany, Italy, Japan, Switzerland, U.K. for the period 1970-1990. Ambler et al. (2004) analyze pairwise cross-country correlations for 20 industrialized countries (Australia, Austria, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, U.K., and U.S.) for the period 1960-2000. For additional supporting evidence see, for example, Backus and Kehoe (1992: 876), Oviedo and Singh (2012: 3), and Ravn (1997).

Notes:
^aAmbler et al. (2004), averages from 190 cross-country correlations for the period between 1973-2000.

Table 2: International trade over the cycle

<table>
<thead>
<tr>
<th>Phenomena in question</th>
<th>The qualitative result</th>
<th>A numerical result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation of real imports with real output</td>
<td>Positive correlation^ab</td>
<td>0.63^a</td>
</tr>
<tr>
<td>Average cross-country correlation of imports</td>
<td>Positive correlation^b</td>
<td>0.34^b</td>
</tr>
<tr>
<td>Correlation of real exports with real output</td>
<td>Positive correlation (small number of exceptions)^ab</td>
<td>0.39^a</td>
</tr>
<tr>
<td>Average cross-country correlation of exports</td>
<td>Positive correlation^b</td>
<td>0.25^b</td>
</tr>
<tr>
<td>Correlation of real imports and real exports</td>
<td>Positive correlation^a</td>
<td>0.38^a</td>
</tr>
</tbody>
</table>

Notes:
^aEngel 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.
<table>
<thead>
<tr>
<th>Phenomena in question</th>
<th>The qualitative result</th>
<th>A numerical result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composition of imports in terms of durable goods</td>
<td>High proportion of durable goods.abc</td>
<td>0.68a</td>
</tr>
<tr>
<td>Composition of exports in terms of durable goods</td>
<td>High proportion of durable goods.abc</td>
<td>0.64a</td>
</tr>
<tr>
<td>Correlation of durable real imports with real output</td>
<td>Correlation of durable real imports with real output is higher that of nondurable real imports with real output. d</td>
<td>0.53d</td>
</tr>
<tr>
<td>Correlation of nondurable real imports with real output</td>
<td></td>
<td>-0.17d</td>
</tr>
<tr>
<td>Correlation of durable real exports with real output</td>
<td>Correlation of durable real exports with real output is higher than that of nondurable real imports with real output. d</td>
<td>0.82d</td>
</tr>
<tr>
<td>Correlation of nondurable real exports with real output</td>
<td></td>
<td>0.65d</td>
</tr>
</tbody>
</table>

Notes:

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.

b Erceg et al. (2008) use the 2004 Bureau of Economic Analysis (BEA) data and compute the share of durable goods on the US imports and exports in 2004.

c Boileau (2002) G7 countries for the period between 1960-1991 and computes the average trade shares for different types of goods. Trade share is the ratio of imports and exports of the given good during the given period divided by the imports and exports of all goods traded by the given period.

d 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.
Figures

Figure 1: Closed economy of country D in an equilibrium.

Figure 2: The effect of an unexpected increase in the money supply on real interest rate in country D.
Figure 3: Monetary expansion in country D and two conflicting equilibrating tendencies.

Figure 4: Monetary expansion in country D and resulting liquidity effects with international spill-overs.
Figure 5: Monetary expansion in country D and resulting depreciation of $D$ with respect to $A$. The graph in the middle shows the depreciation of $D_1$ and the bottom graph shows the corresponding appreciation of $A_1$. 
Figure 6: Depreciation of real exchange rate in country D and the shrinking production possibilities frontier.

Figure 7: The effect of the shrinking production possibilities frontier in country D on its structure of production.
Figure 8: The effects of lower real interest rate and of real depreciation of $D$ on country $D$.

Figure 9: Appreciation of real exchange rate of $A$ and the expansion of $A$'s production possibilities frontier.
Figure 10: The effect of expanding production possibilities frontier of country A on its structure of production.

Figure 11: The effects of lower real interest rate and of real appreciation of $A on country A.
Figure 12: Monetary expansion in country D and its international effects.
Appendix A: Boom, bust, and expectations

One of the possible weaknesses of the international business cycle framework brought above is the underlying assumption about formation of expectations. I assume that monetary expansion in one country makes people believe that the resulting lower real interest rate and depreciated currency of the country will both continue in the future. Such an assumption of “static” expectations is unwarranted in the light of the rational expectations hypothesis. After all, people learn and they should realize that monetary expansions are often come to end.

The conclusions of my framework are, however, not dependent on the convenient assumption of “static” expectations. The assumption can be changed to a rational expectations setting with heterogenous agents while keeping the main insights of the story intact.

To prove this claim, I adjust the setting momentarily and assume that monetary expansion lasts only for period t, while heterogenous people are forming expectations about the length of the period. Expectations of different people with respect to the length of the expansion are normally distributed around the value t. Some people thus underestimate the length of the expansion and some people overestimate it, while on average as a group, people are correct. Based on their expectations, people make their investment decisions. Underestimators tend to invest in relatively shorter productions that depend on the depreciated currency only for a shorter period of time. Overestimators, on the other hand, tend to invest in relatively longer productions that are dependent on currency being depreciated for a longer period of time. While both groups of the people are mistaken, the aggregate pattern of how people learn about their own mistakes differs between the two groups. Different people who underestimate the length of the monetary expansion tend to realize their mistakes at different points of time rather than at the same instant. If person A expects the expansion to last until time t-2 and person B assumes it to last until later, t-1, A realizes his mistake at t-2 and B only at t-1. In aggregate terms, the realization of mistakes by underestimators are dispersed over time and so are the related observable effects. In contrast, the overestimators learn about their mistake at the same point in time – once the monetary expansion stops. The mistakes of the overestimating people are then visible as the large-scale coordination failure of people investing in overly long productions. Failure on the aggregate level pushes the economy inwards of its productions possibilities frontier with all the effects described before – aggregate decrease in real output, real consumption, real investment and employment. The aggregate pattern of the two stories – one where people hold “static” expectations and the other where people hold rational expectations is very similar. This being the case, Occam's razor dictates the use of the simpler and more tractable assumption of “static” expectations, which is the approach that I take in the present paper.
Appendix B: The assumed restriction of international trade

In my framework, I have imposed a restriction on international trade that countries can trade only primary factors of production. The necessity to impose the restriction comes with my intention to take the interpretation of the triangular graph for a closed economy and to retain the interpretation in the context of an open economy. In the case of a closed economy, the triangular graph brings together the intermediate production factors located in the economy and consumption that takes place in the economy. Factors of production and consumption are then in a closed economy two sides of the same coin because they are linked by causal forces of production processes. Correspondingly, a single triangular graph representing a closed economy also captures changes in the alignment of factors of production and changes in consumption. Introducing international trade complicates the interpretation of the triangular graph and its changes. Unlike in a closed economy, intermediate factors of production located in a country that is an open economy do not necessarily lead to consumption in this country. The separation between production and consumption of a country through international trade for example implies that an increase in the number of factors of production in country D might not always lead to an increase in consumption in country D. The additional factors might be in some form transported later to country A and eventually lead to an increase in consumption in A. With international trade in intermediate factors of production, a single triangle thus cannot capture both the production and the consumption taking place in a given country because the two no longer have a causal link. To avoid the pitfall related to interpretation of triangle as a representation of the structure of production of a country, I allow international trade to take place only in primary factors of production. If they are sold abroad, primary factors then do not enter the domestic structure of production, and the corresponding triangle. Conversely, if the primary factors enter the domestic structure of production, they can no longer be sold abroad because they are already intermediate factors of production, which are by assumption non-tradable. The restriction of international trade to only primary factors of production then allows me to interpret the triangle of a given country as the structure of production leading to consumption in the country.