

MICHAEL CARLBERG

International Economic Policy Coordination

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With 94 Tables

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Preface

This book studies the international coordination of monetary and fiscal policies in the world economy. It carefully discusses the process of policy competition and the structure of policy cooperation. As to policy competition, the focus is on monetary and fiscal competition between Europe and America. Similarly, as to policy cooperation, the focus is on monetary and fiscal cooperation between Europe and America. The spillover effects of monetary policy are negative while the spillover effects of fiscal policy are positive. The policy targets are price stability and full employment. The policy makers follow either cold-turkey or gradualist strategies. Policy expectations are adaptive or rational. The world economy consists of two, three or more regions.

The present book is part of a larger research project on European Monetary Union, see the references at the back of the book. Some parts of this project were presented at the World Congress of the International Economic Association in Lisbon. Other parts were presented at the International Institute of Public Finance, at the Macro Study Group of the German Economic Association, at the Annual Meeting of the Austrian Economic Association, at the Göttingen Workshop on International Economics, at the Halle Workshop on Monetary Economics, at the Research Seminar on Macroeconomics in Freiburg, and at the Passau Workshop on International Economics.

Over the years, in working on this project, I have benefited from comments by Iain Begg, Michael Bräuninger, Volker Clausen, Valeria de Bonis, Peter Flaschel, Wilfried Fuhrmann, Michael Funke, Florence Huart, Oliver Landmann, Jay H. Levin, Alfred Maußner, Jochen Michaelis, Manfred J. M. Neumann, Klaus Neusser, Franco Reither, Armin Rohde, Sergio Rossi, Gerhard Rübel, Michael Schmid, Gerhard Schwödiauer, Patrizio Tirelli, Harald Uhlig, Bas van Aarle, Uwe Vollmer, Jürgen von Hagen and Helmut Wagner. In addition,

Torsten Bleich and Alkis Otto carefully discussed with me all parts of the manuscript. Last but not least, Doris Ehrich did the secretarial work as excellently as ever. I would like to thank all of them.

January 2005

Michael Carlberg

Executive Summary

1) Monetary competition between Europe and America. The world consists of two monetary regions, say Europe and America. Now let there be unemployment in Europe and America. Then the process of monetary competition leads to full employment in Europe and America. There are repeated increases in European money supply, as there are in American money supply. There are repeated increases in European output, as there are in American output. Instead let there be overemployment and hence inflation. Then the process of monetary competition leads to full employment and price stability. There are repeated cuts in European money supply, as there are in American money supply. There are repeated cuts in European output, as there are in American output. Monetary competition is a slow process. The reason is the negative external effect of monetary policy.

2) Monetary cooperation between Europe and America. Now let there be unemployment in Europe and America. Then monetary cooperation can achieve full employment in Europe and America. What is needed is an increase in European and American money supply. Instead let there be overemployment and inflation. Then monetary cooperation can achieve full employment and price stability. What is needed is a cut in European and American money supply. Monetary cooperation is a fast process, as compared to monetary competition. The reason is that the negative external effect of monetary policy can be internalized by cooperation. From this perspective, monetary cooperation is superior to monetary competition.

3) Fiscal competition between Europe and America: perfect capital mobility. At the beginning there is unemployment in each of the regions. More precisely, unemployment in Europe exceeds unemployment in America. As a result, the process of fiscal competition does not lead to full employment in Europe and America. The reason is the large external effect of fiscal policy. There is an upward trend in European government purchases. There is a downward trend in American government purchases. There are uniform oscillations in European

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output, as there are in American output. The European economy oscillates between unemployment and overemployment, as does the American economy.

4) Fiscal cooperation between Europe and America: perfect capital mobility. As a result, fiscal cooperation can reduce unemployment in Europe and America to a certain extent. However, it cannot achieve full employment in Europe and America. The reason is the large external effect of fiscal policy.

5) Fiscal competition between Europe and America: imperfect capital mobility. As a result, the process of fiscal competition leads to full employment in Europe and America. There are damped oscillations in European government purchases, as there are in American government purchases. There are damped oscillations in European output, as there are in American output. Fiscal competition is a slow process. The reason is the positive external effect of fiscal policy.

6) Fiscal cooperation between Europe and America: imperfect capital mobility. As a result, fiscal cooperation can achieve full employment in Europe and America. What is needed is an increase in European and American government purchases. Fiscal cooperation is a fast process, as compared to fiscal competition. The reason is that the positive external effect of fiscal policy can be internalized by cooperation. From this point of view, fiscal cooperation is superior to fiscal competition.

7) The anticipation of policy spillovers. The focus here is on monetary competition between Europe and America. The European central bank anticipates the spillovers from monetary policy in America. And the American central bank anticipates the spillovers from monetary policy in Europe. As a result, the anticipation of policy spillovers speeds up the process of monetary competition. Thus there is no need for monetary cooperation.

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Introduction

1. Subject and Approach

This book studies the international coordination of monetary and fiscal policies in the world economy. It carefully discusses the process of policy competition and the structure of policy cooperation. With respect to policy competition, the focus is on:

- monetary competition between Europe and America
- fiscal competition between Europe and America.

With respect to policy cooperation, the focus is on:

- monetary cooperation between Europe and America
- fiscal cooperation between Europe and America.

The targets of the European central bank are price stability and full employment in Europe. The targets of the American central bank are price stability and full employment in America. Monetary policy in one of the regions has a large external effect on the other region. For instance, an increase in European money supply lowers American output. The target of the European government is full employment in Europe. The target of the American government is full employment in America. Fiscal policy in one of the regions has a large external effect on the other region. For instance, an increase in European government purchases raises American output. The key questions are:

- Does the process of policy competition lead to full employment and price stability?
- Can policy cooperation achieve full employment and price stability?
- Is policy cooperation superior to policy competition?

This book takes new approaches that are firmly grounded on modern macroeconomics. The framework of analysis is as follows. The world economy consists of a certain number of monetary regions. A monetary region is defined by having a currency of its own. A monetary region is an open economy with international trade and capital mobility. The exchange rates between the

monetary regions are flexible. Special features of this book are numerical simulations of policy competition and numerical solutions to policy cooperation. To illustrate all of this there are lots of tables.

This book consists of six major parts:

- The World of Two Monetary Regions:
Basic Models
- The World of Two Monetary Regions:
Intermediate Models
- The World of Two Monetary Regions:
Advanced Models
- The World of Three Monetary Regions
- The World of N Monetary Regions
- Rational Policy Expectations.

Now the approach will be presented in greater detail.

2. Basic Models

1) Monetary competition between Europe and America. First consider the static model. The world consists of two monetary regions, say Europe and America. The exchange rate between Europe and America is flexible. There is international trade between Europe and America. There is perfect capital mobility between Europe and America. European goods and American goods are imperfect substitutes for each other. European output is determined by the demand for European goods. American output is determined by the demand for American goods. European money demand equals European money supply. And American money demand equals American money supply. The monetary regions are the same size and have the same behavioural functions. Nominal wages and prices adjust slowly.

As a result, an increase in European money supply raises European output. On the other hand, it lowers American output. Here the rise in European output

exceeds the fall in American output. Correspondingly, an increase in American money supply raises American output. On the other hand, it lowers European output. Here the rise in American output exceeds the fall in European output. In the numerical example, a 1 percent increase in European money supply causes a 0.75 percent increase in European output and a 0.25 percent decline in American output. Similarly, a 1 percent increase in American money supply causes a 0.75 percent increase in American output and a 0.25 percent decline in European output. That is to say, the internal effect of monetary policy is very large, and the external effect of monetary policy is large. Now have a closer look at the process of adjustment. An increase in European money supply causes a depreciation of the euro, an appreciation of the dollar, and a decline in the world interest rate. The depreciation of the euro raises European exports. The appreciation of the dollar lowers American exports. And the decline in the world interest rate raises both European investment and American investment. The net effect is that European output goes up. However, American output goes down. This model is in the tradition of the Mundell-Fleming model.

Second consider the dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European central bank is full employment in Europe. The instrument of the European central bank is European money supply. The European central bank raises European money supply so as to close the output gap in Europe. The target of the American central bank is full employment in America. The instrument of the American central bank is American money supply. The American central bank raises American money supply so as to close the output gap in America. We assume that the European central bank and the American central bank decide simultaneously and independently. In addition there is an output lag. European output next period is determined by European money supply this period as well as by American money supply this period. In the same way, American output next period is determined by American money supply this period as well as by European money supply this period. The key questions are: Is there a steady state of monetary competition? Is the steady state of monetary competition stable? In other words, does monetary competition lead to full employment in Europe and America? Besides, what are the dynamic characteristics of this process? Taking the sum over all periods, what is the total increase in European money supply, as compared to the initial output gap in Europe? And what is the total increase in American money supply, as compared to the initial output gap in America?

2) Monetary cooperation between Europe and America. At the start there is unemployment in both Europe and America. The targets of monetary cooperation are full employment in Europe and full employment in America. The instruments of monetary cooperation are European money supply and American money supply. So there are two targets and two instruments. Here the key questions are: Is there a solution to monetary cooperation? Put differently, can monetary cooperation achieve full employment in Europe and America? What is the required increase in European money supply, as compared to the initial output gap in Europe? And what is the required increase in American money supply, as compared to the initial output gap in America? Moreover, is monetary cooperation superior to monetary cooperation?

3) Fiscal competition between Europe and America. First consider the static model. An increase in European government purchases raises both European output and American output. And what is more, the rise in European output equals the rise in American output. Correspondingly, an increase in American government purchases raises both American output and European output. And what is more, the rise in American output equals the rise in European output. In the numerical example, an increase in European government purchases of 100 causes an increase in European output of 100 and an increase in American output of equally 100. Likewise, an increase in American government purchases of 100 causes an increase in American output of 100 and an increase in European output of equally 100. In a sense, the internal effect of fiscal policy is rather small, whereas the external effect of fiscal policy is quite large. Now have a closer look at the process of adjustment. An increase in European government purchases causes an appreciation of the euro, a depreciation of the dollar, and an increase in the world interest rate. The appreciation of the euro lowers European exports. The depreciation of the dollar raises American exports. And the increase in the world interest rate lowers both European investment and American investment. The net effect is that European output and American output go up, to the same extent respectively. This model is in the tradition of the Mundell-Fleming model.

Second consider the dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European government is full employment in Europe. The instrument of the European government is European government purchases. The European government raises European government purchases so as to close the output gap in Europe. The target of the American

government is full employment in America. The instrument of the American government is American government purchases. The American government raises American government purchases so as to close the output gap in America. We assume that the European government and the American government decide simultaneously and independently. In addition there is an output lag. European output next period is determined by European government purchases this period as well as by American government purchases this period. In the same way, American output next period is determined by American government purchases this period as well as by European government purchases this period. The key questions are: Is there a steady state of fiscal competition? Is the steady state of fiscal competition stable? In other words, does fiscal competition lead to full employment in Europe and America? Besides, what are the dynamic characteristics of this process? Taking the sum over all periods, what is the total increase in European government purchases, as compared to the initial output gap in Europe? And what is the total increase in American government purchases, as compared to the initial output gap in America? Last but not least, is monetary competition superior to fiscal competition?

4) Fiscal cooperation between Europe and America. At the start there is unemployment in Europe and America. The targets of fiscal cooperation are full employment in Europe and full employment in America. The instruments of fiscal cooperation are European government purchases and American government purchases. So there are two targets and two instruments. Here the key questions are: Is there a solution to fiscal cooperation? Put differently, can fiscal cooperation achieve full employment in Europe and America? What is the required increase in European government purchases, as compared to the initial output gap in Europe? And what is the required increase in American government purchases, as compared to the initial output gap in America? Finally, is fiscal cooperation superior to fiscal competition? And is monetary cooperation superior to fiscal cooperation?

3. Imperfect Capital Mobility

1) Monetary competition and monetary cooperation. To illustrate this, consider a numerical example. Under perfect capital mobility, an increase in European money supply of 100 causes an increase in European output of 300 and a decline in American output of 100. Under zero capital mobility, by contrast, an increase in European money supply of 100 causes an increase in European output of 200 and a decline in American output of zero. On this basis we assume that, under imperfect capital mobility, an increase in European money supply of 100 causes an increase in European output of 250 and a decline in American output of 50.

That means, under high capital mobility, monetary spillovers are large. On the other hand, under zero capital mobility, monetary spillovers are zero. And under low capital mobility, monetary spillovers are small. What does this imply for monetary competition and monetary cooperation? Given imperfect capital mobility, is monetary competition a slow process or a fast one? The answer is that imperfect capital mobility speeds up the process of monetary competition. The other way round, perfect capital mobility slows down the process of monetary competition.

2) Fiscal competition and fiscal cooperation. Under perfect capital mobility, an increase in European government purchases raises both European output and American output, to the same extent respectively. Under zero capital mobility, an increase in European government purchases raises European output to a much larger degree. However, it has no effect on American output. Under imperfect capital mobility, an increase in European government purchases raises both European output and American output. Here the rise in European output exceeds the rise in American output.

To illustrate this, consider a numerical example. Under perfect capital mobility, an increase in European government purchases of 100 causes an increase in European output of 100 and an increase in American output of equally 100. Under zero capital mobility, by contrast, an increase in European government purchases of 100 causes an increase in European output of 200 and

an increase in American output of zero. On this basis we assume that, under imperfect capital mobility, an increase in European government purchases of 100 causes an increase in European output of 150 and an increase in American output of 50.

That means, under high capital mobility, fiscal spillovers are very large. On the other hand, under zero capital mobility, fiscal spillovers are zero. And under low capital mobility, fiscal spillovers are medium size. What does this imply for fiscal competition and fiscal cooperation? Given imperfect capital mobility, is fiscal competition a slow process or a fast one?

4. Gradualist Policies

1) Monetary competition between Europe and America. So far we have assumed that the central banks follow a cold-turkey strategy. Now we assume that the central banks follow a gradualist strategy. At the beginning there is unemployment in Europe and America. The general target of the European central bank is full employment in Europe. We assume that the European central bank follows a gradualist strategy. The specific target of the European central bank is to close the output gap in Europe by the fraction μ_1 . The general target of the American central bank is full employment in America. We assume that the American central bank follows a gradualist strategy. The specific target of the American central bank is to close the output gap in America by the fraction μ_2 . Under a gradualist strategy, is monetary competition a slow process or a fast one? Surprisingly, the answer depends upon initial conditions.

2) Fiscal competition between Europe and America. So far we have assumed that the governments follow a cold-turkey strategy. Now we assume that the governments follow a gradualist strategy. At the start there is unemployment in Europe and America. The general target of the European government is full employment in Europe. We assume that the European government follows a gradualist strategy. The specific target of the European government is to close the

output gap in Europe by the fraction λ_1 . The general target of the American government is full employment in America. We assume that the American government follows a gradualist strategy. The specific target of the American government is to close the output gap in America by the fraction λ_2 . Under a gradualist strategy, is fiscal competition a slow process or a fast one?

3) Monetary and fiscal competition. More precisely, we have competition between the European central bank, the American central bank, the European government, and the American government. At the beginning there is unemployment in Europe and America. The specific target of the European central bank is to close the output gap in Europe by the fraction μ_1 . The specific target of the American central bank is to close the output gap in America by the fraction μ_2 . The specific target of the European government is to close the output gap in Europe by the fraction λ_1 . And the specific target of the American government is to close the output gap in America by the fraction λ_2 . We assume that the European central bank, the American central bank, the European government, and the American government decide simultaneously and independently.

Is there a stable steady state of monetary and fiscal competition? In other words, does the process of monetary and fiscal competition lead to full employment? Taking the sum over all periods, does the increase in European money supply, American money supply, European government purchases, and American government purchases depend on the relative speed of adjustment?

Part One

The World of Two Monetary Regions

Basic Models

Chapter 1

Monetary Competition between Europe and America

1. The Dynamic Model

1) The static model. As a point of reference, consider the static model. The world consists of two monetary regions, say Europe and America. The exchange rate between Europe and America is flexible. There is international trade between Europe and America. There is perfect capital mobility between Europe and America. European goods and American goods are imperfect substitutes for each other. European output is determined by the demand for European goods. American output is determined by the demand for American goods. European money demand equals European money supply. And American money demand equals American money supply. The monetary regions are the same size and have the same behavioural functions. Nominal wages and prices adjust slowly.

As a result, an increase in European money supply raises European output. On the other hand, it lowers American output. Here the rise in European output exceeds the fall in American output. Correspondingly, an increase in American money supply raises American output. On the other hand, it lowers European output. Here the rise in American output exceeds the fall in European output. In the numerical example, a 1 percent increase in European money supply causes a 0.75 percent increase in European output and a 0.25 percent decline in American output. Similarly, a 1 percent increase in American money supply causes a 0.75 percent increase in American output and a 0.25 percent decline in European output. That is to say, the internal effect of monetary policy is very large, and the external effect of monetary policy is large. Now have a closer look at the process of adjustment. An increase in European money supply causes a depreciation of the euro, an appreciation of the dollar, and a decline in the world interest rate. The depreciation of the euro raises European exports. The appreciation of the dollar lowers American exports. And the decline in the world interest rate raises both European investment and American investment. The net effect is that European output goes up. However, American output goes down. This model is

in the tradition of the Mundell-Fleming model, see Carlberg (2000) p. 189 and Carlberg (2001) p. 147.

The static model can be represented by a system of two equations:

$$Y_1 = A_1 + \alpha M_1 - \beta M_2 \quad (1)$$

$$Y_2 = A_2 + \alpha M_2 - \beta M_1 \quad (2)$$

According to equation (1), European output Y_1 is determined by European money supply M_1 , American money supply M_2 , and some other factors called A_1 . According to equation (2), American output Y_2 is determined by American money supply M_2 , European money supply M_1 , and some other factors called A_2 . Here α and β denote the monetary policy multipliers. The internal effect of monetary policy is positive $\alpha > 0$. By contrast, the external effect of monetary policy is negative $\beta > 0$. In absolute values, the internal effect is larger than the external effect $\alpha > \beta$. The endogenous variables are European output and American output.

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European central bank is full employment in Europe. The instrument of the European central bank is European money supply. The European central bank raises European money supply so as to close the output gap in Europe:

$$M_1 - M_1^{-1} = \frac{\bar{Y}_1 - Y_1}{\alpha} \quad (3)$$

Here is a list of the new symbols:

Y_1	European output this period
\bar{Y}_1	full-employment output in Europe
$\bar{Y}_1 - Y_1$	output gap in Europe this period
M_1^{-1}	European money supply last period
M_1	European money supply this period
$M_1 - M_1^{-1}$	increase in European money supply.

Here the endogenous variable is European money supply this period M_1 .

The target of the American central bank is full employment in America. The instrument of the American central bank is American money supply. The American central bank raises American money supply so as to close the output gap in America:

$$M_2 - M_2^{-1} = \frac{\bar{Y}_2 - Y_2}{\alpha} \quad (4)$$

Here is a list of the new symbols:

Y_2	American output this period
\bar{Y}_2	full-employment output in America
$\bar{Y}_2 - Y_2$	output gap in America this period
M_2^{-1}	American money supply last period
M_2	American money supply this period
$M_2 - M_2^{-1}$	increase in American money supply.

Here the endogenous variable is American money supply this period M_2 . We assume that the European central bank and the American central bank decide simultaneously and independently.

In addition there is an output lag. European output next period is determined by European money supply this period as well as by American money supply this period:

$$Y_1^{+1} = A_1 + \alpha M_1 - \beta M_2 \quad (5)$$

Here Y_1^{+1} denotes European output next period. In the same way, American output next period is determined by American money supply this period as well as by European money supply this period:

$$Y_2^{+1} = A_2 + \alpha M_2 - \beta M_1 \quad (6)$$

Here Y_2^{+1} denotes American output next period.

On this basis, the dynamic model can be characterized by a system of four equations:

$$M_1 - M_1^{-1} = \frac{\bar{Y}_1 - Y_1}{\alpha} \quad (7)$$

$$M_2 - M_2^{-1} = \frac{\bar{Y}_2 - Y_2}{\alpha} \quad (8)$$

$$Y_1^{+1} = A_1 + \alpha M_1 - \beta M_2 \quad (9)$$

$$Y_2^{+1} = A_2 + \alpha M_2 - \beta M_1 \quad (10)$$

Equation (7) shows the policy response in Europe, (8) shows the policy response in America, (9) shows the output lag in Europe, and (10) shows the output lag in America. The endogenous variables are European money supply this period M_1 , American money supply this period M_2 , European output next period Y_1^{+1} , and American output next period Y_2^{+1} .

3) The steady state. In the steady state by definition we have:

$$M_1 = M_1^{-1} \quad (11)$$

$$M_2 = M_2^{-1} \quad (12)$$

Equation (11) has it that European money supply does not change any more. Similarly, equation (12) has it that American money supply does not change any more. Therefore the steady state can be captured by a system of four equations:

$$Y_1 = \bar{Y}_1 \quad (13)$$

$$Y_2 = \bar{Y}_2 \quad (14)$$

$$Y_1 = A_1 + \alpha M_1 - \beta M_2 \quad (15)$$

$$Y_2 = A_2 + \alpha M_2 - \beta M_1 \quad (16)$$

Here the endogenous variables are European output Y_1 , American output Y_2 , European money supply M_1 , and American money supply M_2 . According to equation (13) there is full employment in Europe, so European output is constant. According to equation (14) there is full employment in America, so American

output is constant too. Further, equations (15) and (16) give the steady-state levels of European and American money supply.

The model of the steady state can be compressed to a system of only two equations:

$$\bar{Y}_1 = A_1 + \alpha M_1 - \beta M_2 \quad (17)$$

$$\bar{Y}_2 = A_2 + \alpha M_2 - \beta M_1 \quad (18)$$

Here the endogenous variables are European money supply and American money supply. To simplify notation we introduce:

$$B_1 = \bar{Y}_1 - A_1 \quad (19)$$

$$B_2 = \bar{Y}_2 - A_2 \quad (20)$$

With this, the model of the steady state can be written as follows:

$$B_1 = \alpha M_1 - \beta M_2 \quad (21)$$

$$B_2 = \alpha M_2 - \beta M_1 \quad (22)$$

The endogenous variables are still M_1 and M_2 .

Next we solve the model for the endogenous variables:

$$M_1 = \frac{\alpha B_1 + \beta B_2}{\alpha^2 - \beta^2} \quad (23)$$

$$M_2 = \frac{\alpha B_2 + \beta B_1}{\alpha^2 - \beta^2} \quad (24)$$

Equation (23) shows the steady-state level of European money supply, and equation (24) shows the steady-state level of American money supply. As a result, there is a steady state if and only if $\alpha \neq \beta$. Owing to the assumption $\alpha > \beta$, this condition is fulfilled.

As an alternative, the steady state can be represented in terms of the initial output gap and the total increase in money supply. Taking differences in equations (1) and (2), the model of the steady state can be written as follows:

$$\Delta Y_1 = \alpha \Delta M_1 - \beta \Delta M_2 \quad (25)$$

$$\Delta Y_2 = \alpha \Delta M_2 - \beta \Delta M_1 \quad (26)$$

Here ΔY_1 is the initial output gap in Europe, ΔY_2 is the initial output gap in America, ΔM_1 is the total increase in European money supply, and ΔM_2 is the total increase in American money supply. The endogenous variables are ΔM_1 and ΔM_2 . The solution to the system (25) and (26) is:

$$\Delta M_1 = \frac{\alpha \Delta Y_1 + \beta \Delta Y_2}{\alpha^2 - \beta^2} \quad (27)$$

$$\Delta M_2 = \frac{\alpha \Delta Y_2 + \beta \Delta Y_1}{\alpha^2 - \beta^2} \quad (28)$$

According to equation (27), the total increase in European money supply depends on the initial output gap in Europe, the initial output gap in America, the direct multiplier α , and the cross multiplier β . The larger the initial output gap in Europe, the larger is the total increase in European money supply. Moreover, the larger the initial output gap in America, the larger is the total increase in European money supply. At first glance this comes as a surprise. According to equation (28), the total increase in American money supply depends on the initial output gap in America, the initial output gap in Europe, the direct multiplier α , and the cross multiplier β .

4) Stability. Eliminate Y_1 in equation (7) by means of equation (9) and rearrange terms $\bar{Y}_1 = A_1 + \alpha M_1 - \beta M_2^{-1}$. By analogy, eliminate Y_2 in equation (8) by means of equation (10) to arrive at $\bar{Y}_2 = A_2 + \alpha M_2 - \beta M_1^{-1}$. On this basis, the dynamic model can be described by a system of two equations:

$$\bar{Y}_1 = A_1 + \alpha M_1 - \beta M_2^{-1} \quad (29)$$

$$\bar{Y}_2 = A_2 + \alpha M_2 - \beta M_1^{-1} \quad (30)$$

Here the endogenous variables are European money supply this period M_1 and American money supply this period M_2 . To simplify notation we make use of equations (19) and (20). With this, the dynamic model can be written as follows:

$$B_1 = \alpha M_1 - \beta M_2^{-1} \quad (31)$$

$$B_2 = \alpha M_2 - \beta M_1^{-1} \quad (32)$$

The endogenous variables are still M_1 and M_2 .

Now substitute equation (32) into equation (31) and solve for:

$$\alpha M_1 = B_1 + \frac{\beta B_2}{\alpha} + \frac{\beta^2 M_1^{-2}}{\alpha} \quad (33)$$

Then differentiate equation (33) for M_1^{-2} :

$$\frac{dM_1}{dM_1^{-2}} = \frac{\beta^2}{\alpha^2} \quad (34)$$

Finally the stability condition is $\beta^2 / \alpha^2 < 1$ or:

$$\alpha > \beta \quad (35)$$

That means, the steady state is stable if and only if the internal effect of monetary policy is larger than the external effect of monetary policy. This condition is satisfied. As a result, there is a stable steady state of monetary competition. In other words, monetary competition between Europe and America leads to full employment in Europe and America.

2. Some Numerical Examples

To illustrate the dynamic model, have a look at some numerical examples. For ease of exposition, without loss of generality, assume $\alpha = 3$ and $\beta = 1$, see Carlberg (2000) p. 201 and Carlberg (2001) p. 161. On this assumption, the static model can be written as follows:

$$Y_1 = A_1 + 3M_1 - M_2 \quad (1)$$

$$Y_2 = A_2 + 3M_2 - M_1 \quad (2)$$

The endogenous variables are European output and American output. Obviously, an increase in European money supply of 100 causes an increase in European output of 300 and a decline in American output of 100. Correspondingly, an increase in American money supply of 100 causes an increase in American output of 300 and a decline in European output of 100. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

It proves useful to study seven distinct cases:

- unemployment in Europe equals unemployment in America
- unemployment in Europe exceeds unemployment in America
- unemployment in Europe, full employment in America
- unemployment in Europe exceeds overemployment in America
- unemployment in Europe equals overemployment in America
- inflation in Europe exceeds inflation in America
- inflation in Europe equals inflation in America.

1) Unemployment in Europe equals unemployment in America. At the beginning there is unemployment in both Europe and America. More precisely, unemployment in Europe equals unemployment in America. Let initial output in Europe be 940, and let initial output in America be the same. Step 1 refers to the policy response. The output gap in Europe is 60. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 20. The output gap in America is 60. The monetary policy multiplier in

America is 3. So what is needed in America is an increase in American money supply of 20.

Step 2 refers to the output lag. The increase in European money supply of 20 causes an increase in European output of 60. As a side effect, it causes a decline in American output of 20. The increase in American money supply of 20 causes an increase in American output of 60. As a side effect, it causes a decline in European output of 20. The net effect is an increase in European output of 40 and an increase in American output of equally 40. As a consequence, European output goes from 940 to 980, as does American output. Put another way, the output gap in Europe narrows from 60 to 20, as does the output gap in America.

Why does the European central bank not succeed in closing the output gap in Europe? The underlying reason is the negative external effect of the increase in American money supply. And why does the American central bank not succeed in closing the output gap in America? The underlying reason is the negative external effect of the increase in European money supply.

Step 3 refers to the policy response. The output gap in Europe is 20. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 6.7. The output gap in America is 20. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 6.7.

Step 4 refers to the output lag. The increase in European money supply of 6.7 causes an increase in European output of 20. As a side effect, it causes a decline in American output of 6.7. The increase in American money supply of 6.7 causes an increase in American output of 20. As a side effect, it causes a decline in European output of 6.7. The net effect is an increase in European output of 13.3 and an increase in American output of equally 13.3. As a consequence, European output goes from 980 to 993.3, as does American output. And so on. Table 1.1 presents a synopsis.

Table 1.1**Monetary Competition between Europe and America**

Unemployment in Europe Equals Unemployment in America

	Europe	America
Initial Output	940	940
Change in Money Supply	20	20
Output	980	980
Change in Money Supply	6.7	6.7
Output	993.3	993.3
<i>and so on</i>	...	...

What are the dynamic characteristics of this process? There are repeated increases in European money supply, as there are in American money supply. There are repeated increases in European output, as there are in American output. In each round, the output gap declines by 67 percent. There are repeated cuts in the world interest rate. There are repeated increases in European investment, as there are in American investment. There are repeated cuts in budget deficits and public debts. As a result, monetary competition between Europe and America leads to full employment in Europe and America.

Taking the sum over all periods, the increase in European money supply is 30, as is the increase in American money supply, see equations (27) and (28) in the preceding section. That means, the total increase in European money supply is large, as compared to the initial output gap in Europe of 60. And the same applies to the total increase in American money supply, as compared to the initial output gap in America of 60. The effective multiplier in Europe is $60 / 30 = 2$, as is the effective multiplier in America. In other words, the effective multiplier in Europe is small. And the same holds for the effective multiplier in America.

2) Unemployment in Europe exceeds unemployment in America. Let initial output in Europe be 940, and let initial output in America be 970. Step 1 refers to

the policy response. The output gap in Europe is 60. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 20. The output gap in America is 30. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 10.

Step 2 refers to the output lag. The increase in European money supply of 20 causes an increase in European output of 60. As a side effect, it causes a decline in American output of 20. The increase in American money supply of 10 causes an increase in American output of 30. As a side effect, it causes a decline in European output of 10. The net effect is an increase in European output of 50 and an increase in American output of 10. As a consequence, European output goes from 940 to 990, and American output goes from 970 to 980.

Step 3 refers to the policy response. The output gap in Europe is 10. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 3.3. The output gap in America is 20. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 6.7.

Step 4 refers to the output lag. The increase in European money supply of 3.3 causes an increase in European output of 10. As a side effect, it causes a decline in American output of 3.3. The increase in American money supply of 6.7 causes an increase in American output of 20. As a side effect, it causes a decline in European output of 6.7. The net effect is an increase in European output of 3.3 and an increase in American output of 16.7. As a consequence, European output goes from 990 to 993.3, and American output goes from 980 to 996.7. And so on. Table 1.2 gives an overview.

What are the dynamic characteristics of this process? There are repeated increases in European money supply, as there are in American money supply. There are repeated increases in European output, as there are in American output. As a result, the process of monetary competition leads to full employment.

Table 1.2**Monetary Competition between Europe and America**

Unemployment in Europe Exceeds Unemployment in America

	Europe	America
Initial Output	940	970
Change in Money Supply	20	10
Output	990	980
Change in Money Supply	3.3	6.7
Output	993.3	996.7
Change in Money Supply	2.2	1.1
Output	998.9	997.8
<i>and so on</i>	...	...

Taking the sum over all periods, the increase in European money supply is 26.25, and the increase in American money supply is 18.75, see equations (27) and (28) from the previous section. The total increase in European money supply is large, as compared to the initial output gap in Europe of 60. And the total increase in American money supply is even larger, as compared to the initial output gap in America of 30. The effective multiplier in Europe is $60/26.25 = 2.3$, and the effective multiplier in America is $30/18.75 = 1.6$. That is to say, the effective multiplier in Europe is small, and the effective multiplier in America is even smaller.

Table 1.3 differs in initial conditions. Initial output in Europe is 940, and initial output in America is 990. Table 1.3 shows the resulting process of monetary competition. There are repeated increases in European money supply, as there are in American money supply. There are damped oscillations in European output, as there are in American output. The European economy oscillates between high and low unemployment, as does the American economy. As a result, monetary competition leads to full employment. The total increase in European money supply is 23.75, and the total increase in American money

supply is 11.25. The effective multiplier in Europe is 2.5, and the effective multiplier in America is 0.9.

Table 1.3

Monetary Competition between Europe and America

Unemployment in Europe Exceeds Unemployment in America

	Europe	America
Initial Output	940	990
Change in Money Supply	20	3.3
Output	996.7	980
Change in Money Supply	1.1	6.7
Output	993.3	998.9
Change in Money Supply	2.2	0.4
Output	999.6	997.8
<i>and so on</i>	...	...

3) Unemployment in Europe, full employment in America. Let initial output in Europe be 940, and let initial output in America be 1000. Step 1 refers to the policy response. The output gap in Europe is 60. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 20. The output gap in America is zero. So there is no need for a change in American money supply. Step 2 refers to the output lag. The increase in European money supply of 20 causes an increase in European output of 60. As a side effect, it causes a decline in American output of 20. As a consequence, European output goes from 940 to 1000, and American output goes from 1000 to 980.

Step 3 refers to the policy response. The output gap in Europe is zero. So there is no need for a change in European money supply. The output gap in America is 20. The monetary policy multiplier in America is 3. So what is

needed in America is an increase in American money supply of 6.7. Step 4 refers to the output lag. The increase in American money supply of 6.7 causes an increase in American output of 20. As a side effect, it causes a decline in European output of 6.7. As a consequence, American output goes from 980 to 1000, and European output goes from 1000 to 993.3. And so on. Table 1.4 presents a synopsis.

What are the dynamic characteristics? There are repeated increases in European money supply, as there are in American money supply. There are damped oscillations in European output, as there are in American output. The European economy oscillates between unemployment and full employment, as does the American economy. The total increase in European money supply is 22.5, and the total increase in American money supply is 7.5. The effective multiplier in Europe is 2.7, and the effective multiplier in America is zero.

Table 1.4
Monetary Competition between Europe and America
 Unemployment in Europe, Full Employment in America

	Europe	America
Initial Output	940	1000
Change in Money Supply	20	0
Output	1000	980
Change in Money Supply	0	6.7
Output	993.3	1000
Change in Money Supply	2.2	0
Output	1000	997.8
<i>and so on</i>	...	...

4) Unemployment in Europe exceeds overemployment in America. At the beginning there is unemployment in Europe but overemployment in America. Thus there is inflation in America. Let initial output in Europe be 940, and let initial output in America be 1030. Step 1 refers to the policy response. The output gap in Europe is 60. The target of the European central bank is full employment in Europe. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 20. The inflationary gap in America is 30. The target of the American central bank is price stability in America. The monetary policy multiplier in America is 3. So what is needed in America is a reduction in American money supply of 10.

Step 2 refers to the output lag. The increase in European money supply of 20 causes an increase in European output of 60. As a side effect, it causes a decline in American output of 20. The reduction in American money supply of 10 causes a decline in American output of 30. As a side effect, it causes an increase in European output of 10. The total effect is an increase in European output of 70 and a decline in American output of 50. As a consequence, European output goes from 940 to 1010, and American output goes from 1030 to 980.

Step 3 refers to the policy response. The inflationary gap in Europe is 10. The monetary policy multiplier in Europe is 3. So what is needed in Europe is a reduction in European money supply of 3.3. The output gap in America is 20. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 6.7.

Step 4 refers to the output lag. The reduction in European money supply of 3.3 causes a decline in European output of 10. As a side effect, it causes an increase in American output of 3.3. The increase in American money supply of 6.7 causes an increase in American output of 20. As a side effect, it causes a decline in European output of 6.7. The total effect is a decline in European output of 16.7 and an increase in American output of 23.3. As a consequence, European output goes from 1010 to 993.3, and American output goes from 980 to 1003.3. And so on. For an overview see Table 1.5.

What are the dynamic characteristics of this process? There are damped oscillations in European money supply, as there are in American money supply. There are damped oscillations in European output, as there are in American

output. The European economy oscillates between unemployment and overemployment, and the same holds for the American economy. As a result, the process of monetary competition leads to both price stability and full employment. The total increase in European money supply is 18.75, and the total reduction in American money supply is 3.75. The effective multiplier in Europe is 3.2, and the effective multiplier in America is 8.

Table 1.5**Monetary Competition between Europe and America**

Unemployment in Europe Exceeds Overemployment in America

	Europe	America
Initial Output	940	1030
Change in Money Supply	20	- 10
Output	1010	980
Change in Money Supply	- 3.3	6.7
Output	993.3	1003.3
Change in Money Supply	2.2	- 1.1
Output	1001.1	997.8
<i>and so on</i>	...	...

5) Unemployment in Europe equals overemployment in America. Let initial output in Europe be 940, and let initial output in America be 1060. Table 1.6 shows the resulting process of monetary competition. In each round, in absolute values, the output gap declines by 67 percent. Taking the sum over all periods, the increase in European money supply is 15, and the reduction in American money supply is equally 15. The total increase in European money supply is small, as compared to the initial output gap in Europe of 60. Correspondingly, the total reduction in American money supply is small, as compared to the initial inflationary gap in America of 60. The effective multiplier in Europe is $60/15 = 4$, and the effective multiplier in America is equally $60/15 = 4$. That

means, the effective multiplier in Europe is large. And the same is true of the effective multiplier in America.

Table 1.6

Monetary Competition between Europe and America

Unemployment in Europe Equals Overemployment in America

	Europe	America
Initial Output	940	1060
Change in Money Supply	20	- 20
Output	1020	980
Change in Money Supply	- 6.7	6.7
Output	993.3	1006.7
Change in Money Supply	2.2	- 2.2
Output	1002.2	997.8
<i>and so on</i>	...	...

6) Inflation in Europe exceeds inflation in America. At the start there is overemployment in both Europe and America. For that reason there is inflation in both Europe and America. Let overemployment in Europe exceed overemployment in America. Let initial output in Europe be 1060, and let initial output in America be 1030. Step 1 refers to the policy response. The inflationary gap in Europe is 60. The target of the European central bank is price stability in Europe. The monetary policy multiplier in Europe is 3. So what is needed in Europe is a reduction in European money supply of 20. The inflationary gap in America is 30. The target of the American central bank is price stability in America. The monetary policy multiplier in America is 3. So what is needed in America is a reduction in American money supply of 10.

Step 2 refers to the output lag. The reduction in European money supply of 20 causes a decline in European output of 60. As a side effect, it causes an increase

in American output of 20. The reduction in American money supply of 10 causes a decline in American output of 30. As a side effect, it causes an increase in European output of 10. The net effect is a decline in European output of 50 and a decline in American output of 10. As a consequence, European output goes from 1060 to 1010, and American output goes from 1030 to 1020.

Step 3 refers to the policy response. The inflationary gap in Europe is 10. The monetary policy multiplier in Europe is 3. So what is needed in Europe is a reduction in European money supply of 3.3. The inflationary gap in America is 20. The monetary policy multiplier in America is 3. So what is needed in America is a reduction in American money supply of 6.7.

Step 4 refers to the output lag. The reduction in European money supply of 3.3 causes a decline in European output of 10. As a side effect, it causes an increase in American output of 3.3. The reduction in American money supply of 6.7 causes a decline in American output of 20. As a side effect, it causes an increase in European output of 6.7. The net effect is a decline in European output of 3.3 and a decline in American output of 16.7. As a consequence, European output goes from 1010 to 1006.7, and American output goes from 1020 to 1003.3. And so on. For a synopsis see Table 1.7.

What are the dynamic characteristics of this process? There are repeated cuts in European money supply, as there are in American money supply. There are repeated cuts in European output, as there are in American output. As a result, the process of monetary competition leads to both price stability and full employment.

Taking the sum over all periods, the reduction in European money supply is 26.25, and the reduction in American money supply is 18.75. The total reduction in European money supply is large, as compared to the initial inflationary gap in Europe of 60. And the total reduction in American money supply is even larger, as compared to the initial inflationary gap in America of 30. The effective multiplier in Europe is 2.3, and the effective multiplier in America is 1.6. That is to say, the effective multiplier in Europe is small, and the effective multiplier in America is even smaller.

Table 1.7
Monetary Competition between Europe and America
 Inflation in Europe Exceeds Inflation in America

	Europe	America
Initial Output	1060	1030
Change in Money Supply	- 20	- 10
Output	1010	1020
Change in Money Supply	- 3.3	- 6.7
Output	1006.7	1003.3
Change in Money Supply	- 2.2	- 1.1
Output	1001.1	1002.2
<i>and so on</i>	...	...

7) Inflation in Europe equals inflation in America. Let initial output in Europe be 1060, and let initial output in America be the same. Table 1.8 shows the resulting process of monetary competition. In each round, the inflationary gap declines by 67 percent. The total reduction in European money supply is 30, and the same holds for the total reduction in American money supply. The effective multiplier in Europe is 2, as is the effective multiplier in America.

Table 1.8**Monetary Competition between Europe and America**

Inflation in Europe Equals Inflation in America

	Europe	America
Initial Output	1060	1060
Change in Money Supply	- 20	- 20
Output	1020	1020
Change in Money Supply	- 6.7	- 6.7
Output	1006.7	1006.7
<i>and so on</i>	...	...

Chapter 2

Monetary Cooperation between Europe and America

1. The Model

1) Introduction. As a starting point, take the output model. It can be represented by a system of two equations:

$$Y_1 = A_1 + \alpha M_1 - \beta M_2 \quad (1)$$

$$Y_2 = A_2 + \alpha M_2 - \beta M_1 \quad (2)$$

Here Y_1 denotes European output, Y_2 is American output, M_1 is European money supply, and M_2 is American money supply. The endogenous variables are European output and American output. At the beginning there is unemployment in both Europe and America. The targets of monetary cooperation are full employment in Europe and full employment in America. The instruments of monetary cooperation are European money supply and American money supply. So there are two targets and two instruments.

2) The policy model. On this basis, the policy model can be characterized by a system of two equations:

$$\bar{Y}_1 = A_1 + \alpha M_1 - \beta M_2 \quad (3)$$

$$\bar{Y}_2 = A_2 + \alpha M_2 - \beta M_1 \quad (4)$$

Here \bar{Y}_1 denotes full-employment output in Europe, and \bar{Y}_2 denotes full-employment output in America. The endogenous variables are European money supply and American money supply.

To simplify notation, we introduce $B_1 = \bar{Y}_1 - A_1$ and $B_2 = \bar{Y}_2 - A_2$. Then we solve the model for the endogenous variables:

$$M_1 = \frac{\alpha B_1 + \beta B_2}{\alpha^2 - \beta^2} \quad (5)$$

$$M_2 = \frac{\alpha B_2 + \beta B_1}{\alpha^2 - \beta^2} \quad (6)$$

Equation (5) shows the required level of European money supply, and equation (6) shows the required level of American money supply. There is a solution if and only if $\alpha \neq \beta$. Due to the assumption $\alpha > \beta$, this condition is met. As a result, monetary cooperation between Europe and America can achieve full employment in Europe and America. It is worth pointing out here that the solution to monetary cooperation is identical to the steady state of monetary competition.

3) Another version of the policy model. As an alternative, the policy model can be stated in terms of the initial output gap and the required increase in money supply. Taking differences in equations (1) and (2), the policy model can be written as follows:

$$\Delta Y_1 = \alpha \Delta M_1 - \beta \Delta M_2 \quad (7)$$

$$\Delta Y_2 = \alpha \Delta M_2 - \beta \Delta M_1 \quad (8)$$

Here ΔY_1 denotes the initial output gap in Europe, ΔY_2 is the initial output gap in America, ΔM_1 is the required increase in European money supply, and ΔM_2 is the required increase in American money supply. The endogenous variables are ΔM_1 and ΔM_2 . The solution to the system (7) and (8) is:

$$\Delta M_1 = \frac{\alpha \Delta Y_1 + \beta \Delta Y_2}{\alpha^2 - \beta^2} \quad (9)$$

$$\Delta M_2 = \frac{\alpha \Delta Y_2 + \beta \Delta Y_1}{\alpha^2 - \beta^2} \quad (10)$$

According to equation (9), the required increase in European money supply depends on the initial output gap in Europe, the initial output gap in America, the direct multiplier α , and the cross multiplier β . The larger the initial output gap in

Europe, the larger is the required increase in European money supply. Moreover, the larger the initial output gap in America, the larger is the required increase in European money supply. At first glance this comes as a surprise. According to equation (10), the required increase in American money supply depends on the initial output gap in America, the initial output gap in Europe, the direct multiplier α , and the cross multiplier β .

2. Some Numerical Examples

To illustrate the policy model, have a look at some numerical examples. For ease of exposition, without losing generality, assume $\alpha = 3$ and $\beta = 1$. On this assumption, the output model can be written as follows:

$$Y_1 = A_1 + 3M_1 - M_2 \quad (1)$$

$$Y_2 = A_2 + 3M_2 - M_1 \quad (2)$$

The endogenous variables are European output and American output. Evidently, an increase in European money supply of 100 causes an increase in European output of 300 and a decline in American output of 100. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

It proves useful to consider seven distinct cases:

- unemployment in Europe equals unemployment in America
- unemployment in Europe exceeds unemployment in America
- unemployment in Europe, full employment in America
- unemployment in Europe exceeds overemployment in America
- unemployment in Europe equals overemployment in America
- inflation in Europe exceeds inflation in America
- inflation in Europe equals inflation in America.

1) Unemployment in Europe equals unemployment in America. Let initial output in Europe be 940, and let initial output in America be the same. The output gap in Europe is 60, as is the output gap in America. So what is needed, according to equations (9) and (10) from the preceding section, is an increase in European money supply of 30 and an increase in American money supply of equally 30. The increase in European money supply of 30 raises European output by 90 and lowers American output by 30. The increase in American money supply of 30 raises American output by 90 and lowers European output by 30. The net effect is an increase in European output of 60 and an increase in American output of equally 60. As a consequence, European output goes from 940 to 1000, as does American output. In Europe there is now full employment, and the same holds for America. As a result, monetary cooperation can achieve full employment.

The required increase in European money supply is large, as compared to the initial output gap in Europe. And the same applies to the required increase in American money supply, as compared to the initial output gap in America. The effective multiplier in Europe is $60/30 = 2$, as is the effective multiplier in America. That is to say, the effective multiplier in Europe is small. And the same is true of the effective multiplier in America. Table 1.9 presents a synopsis.

Table 1.9

Monetary Cooperation between Europe and America

Unemployment in Europe Equals Unemployment in America

	Europe	America
Initial Output	940	940
Change in Money Supply	30	30
Output	1000	1000

2) Unemployment in Europe exceeds unemployment in America. Let initial output in Europe be 940, and let initial output in America be 970. The output gap

in Europe is 60, and the output gap in America is 30. So what is needed, according to equations (9) and (10) from the previous section, is an increase in European money supply of 26.25 and an increase in American money supply of 18.75. The increase in European money supply of 26.25 raises European output by 78.75 and lowers American output by 26.25. The increase in American money supply of 18.75 raises American output by 56.25 and lowers European output by 18.75. The net effect is an increase in European output of 60 and an increase in American output of 30. As a consequence, European output goes from 940 to 1000, and American output goes from 970 to 1000. In Europe there is now full employment, and the same holds for America. As a result, monetary cooperation can achieve full employment.

The required increase in European money supply is large, as compared to the initial output gap in Europe. And the required increase in American money supply is even larger, as compared to the initial output gap in America. The effective multiplier in Europe is $60/26.25 = 2.3$, and the effective multiplier in America is $30/18.75 = 1.6$. That means, the effective multiplier in Europe is small, and the effective multiplier in America is even smaller. Table 1.10 gives an overview.

Table 1.10

Monetary Cooperation between Europe and America

Unemployment in Europe Exceeds Unemployment in America

	Europe	America
Initial Output	940	970
Change in Money Supply	26.25	18.75
Output	1000	1000

3) Unemployment in Europe, full employment in America. Let initial output in Europe be 940, and let initial output in America be 1000. The output gap in Europe is 60, and the output gap in America is zero. What is needed, then, is an

increase in European money supply of 22.5 and an increase in American money supply of 7.5. The increase in European money supply of 22.5 raises European output by 67.5 and lowers American output by 22.5. The increase in American money supply of 7.5 raises American output by 22.5 and lowers European output by 7.5. The net effect is an increase in European output of 60 and an increase in American output of zero. The effective multiplier in Europe is 2.7, and the effective multiplier in America is zero. For a synopsis see Table 1.11.

Table 1.11
Monetary Cooperation between Europe and America
 Unemployment in Europe, Full Employment in America

	Europe	America
Initial Output	940	1000
Change in Money Supply	22.5	7.5
Output	1000	1000

4) Unemployment in Europe exceeds overemployment in America. At the beginning there is unemployment in Europe but overemployment in America. Thus there is inflation in America. Let initial output in Europe be 940, and let initial output in America be 1030. The output gap in Europe is 60, and the output gap in America is -30 . What is needed, then, is an increase in European money supply of 18.75 and a reduction in American money supply of 3.75. The increase in European money supply of 18.75 raises European output by 56.25 and lowers American output by 18.75. The reduction in American money supply of 3.75 lowers American output by 11.25 and raises European output by 3.75. The total effect is an increase in European output of 60 and a decline in American output of 30. The effective multiplier in Europe is 3.2, and the effective multiplier in America is 8. For an overview see Table 1.12.

Table 1.12**Monetary Cooperation between Europe and America**

Unemployment in Europe Exceeds Overemployment in America

	Europe	America
Initial Output	940	1030
Change in Money Supply	18.75	- 3.75
Output	1000	1000

5) Unemployment in Europe equals overemployment in America. Let initial output in Europe be 940, and let initial output in America be 1060. The output gap in Europe is 60, and the output gap in America is -60. What is needed, then, is an increase in European money supply of 15 and a reduction in American money supply of equally 15. The increase in European money supply of 15 raises European output by 45 and lowers American output by 15. The reduction in American money supply of 15 lowers American output by 45 and raises European output by 15. The total effect is an increase in European output of 60 and a decline in American output of equally 60.

The required increase in European money supply is small, as compared to the initial output gap in Europe. Correspondingly, the required cut in American money supply is small, as compared to the initial inflationary gap in America. The effective multiplier in Europe is $60/15 = 4$, and the effective multiplier in America is equally $60/15 = 4$. That is to say, the effective multiplier in Europe is large. And the same is true of the effective multiplier in America. Table 1.13 presents a synopsis.

Table 1.13**Monetary Cooperation between Europe and America**

Unemployment in Europe Equals Overemployment in America

	Europe	America
Initial Output	940	1060
Change in Money Supply	15	- 15
Output	1000	1000

6) Inflation in Europe exceeds inflation in America. At the start there is overemployment in both Europe and America. For that reason there is inflation in both Europe and America. Let overemployment in Europe exceed overemployment in America. Let initial output in Europe be 1060, and let initial output in America be 1030. The inflationary gap in Europe is 60, and the inflationary gap in America is 30. The targets of monetary cooperation are price stability in Europe and price stability in America. What is needed, then, is a reduction in European money supply of 26.25 and a reduction in American money supply of 18.75. The reduction in European money supply of 26.25 lowers European output by 78.75 and raises American output by 26.25. The reduction in American money supply of 18.75 lowers American output by 56.25 and raises European output by 18.75. The net effect is a decline in European output of 60 and a decline in American output of 30. As a consequence, European output goes from 1060 to 1000, and American output goes from 1030 to 1000. There is now full employment in both Europe and America. For that reason there is now price stability in both Europe and America. As a result, monetary cooperation can achieve full employment and price stability.

The required cut in European money supply is large, as compared to the initial inflationary gap in Europe. And the required cut in American money supply is even larger, as compared to the initial inflationary gap in America. The effective multiplier in Europe is $60/26.25 = 2.3$, and the effective multiplier in America is $30/18.75 = 1.6$. That means, the effective multiplier in Europe is

small, and the effective multiplier in America is even smaller. Table 1.14 gives an overview.

Table 1.14
Monetary Cooperation between Europe and America
 Inflation in Europe Exceeds Inflation in America

	Europe	America
Initial Output	1060	1030
Change in Money Supply	- 26.25	- 18.75
Output	1000	1000

7) Inflation in Europe equals inflation in America. Let initial output in Europe be 1060, and let initial output in America be the same. The inflationary gap in Europe is 60, as is the inflationary gap in America. What is needed, then, is a reduction in European money supply of 30 and a reduction in American money supply of equally 30. The reduction in European money supply of 30 lowers European output by 90 and raises American output by 30. The reduction in American money supply of 30 lowers American output by 90 and raises European output by 30. The net effect is a decline in European output of 60 and a decline in American output of equally 60. The effective multiplier in Europe is 2, as is the effective multiplier in America. For a synopsis see Table 1.15.

8) Comparing monetary cooperation with monetary competition. Monetary competition can achieve full employment. The same applies to monetary cooperation. Monetary competition is a slow process. By contrast, monetary cooperation is a fast process. Judging from these points of view, monetary cooperation seems to be superior to monetary competition.

Table 1.15**Monetary Cooperation between Europe and America**

Inflation in Europe Equals Inflation in America

	Europe	America
Initial Output	1060	1060
Change in Money Supply	- 30	- 30
Output	1000	1000

Chapter 3

Fiscal Competition between Europe and America

1. The Dynamic Model

1) The static model. As a point of reference, consider the static model. The world consists of two monetary regions, say Europe and America. The exchange rate between Europe and America is flexible. There is international trade between Europe and America. There is perfect capital mobility between Europe and America. European goods and American goods are imperfect substitutes for each other. European output is determined by the demand for European goods. American output is determined by the demand for American goods. European money demand equals European money supply. And American money demand equals American money supply. The monetary regions are the same size and have the same behavioural functions. Nominal wages and prices adjust slowly.

As a result, an increase in European government purchases raises both European output and American output. And what is more, the rise in European output equals the rise in American output. Correspondingly, an increase in American government purchases raises both American output and European output. And what is more, the rise in American output equals the rise in European output. In the numerical example, an increase in European government purchases of 100 causes an increase in European output of 100 and an increase in American output of equally 100. Likewise, an increase in American government purchases of 100 causes an increase in American output of 100 and an increase in European output of equally 100. In a sense, the internal effect of fiscal policy is rather small, whereas the external effect of fiscal policy is quite large. Now have a closer look at the process of adjustment. An increase in European government purchases causes an appreciation of the euro, a depreciation of the dollar, and an increase in the world interest rate. The appreciation of the euro lowers European exports. The depreciation of the dollar raises American exports. And the increase in the world interest rate lowers both European investment and American investment. The net effect is that European output and American output go up, to

the same extent respectively. This model is in the tradition of the Mundell-Fleming model, see Carlberg (2000) p. 189 and Carlberg (2001) p. 147.

The static model can be represented by a system of two equations:

$$Y_1 = A_1 + \gamma G_1 + \delta G_2 \quad (1)$$

$$Y_2 = A_2 + \gamma G_2 + \delta G_1 \quad (2)$$

According to equation (1), European output Y_1 is determined by European government purchases G_1 , American government purchases G_2 , and some other factors called A_1 . According to equation (2), American output Y_2 is determined by American government purchases G_2 , European government purchases G_1 , and some other factors called A_2 . Here γ and δ denote the fiscal policy multipliers. The internal effect of fiscal policy is positive $\gamma > 0$. The external effect of fiscal policy is positive too $\delta > 0$. And what is more, the internal effect and the external effect are the same size $\gamma = \delta$. The endogenous variables are European output and American output. Along these lines, the static model can be rewritten as follows:

$$Y_1 = A_1 + \gamma G_1 + \gamma G_2 \quad (3)$$

$$Y_2 = A_2 + \gamma G_2 + \gamma G_1 \quad (4)$$

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European government is full employment in Europe. The instrument of the European government is European government purchases. The European government raises European government purchases so as to close the output gap in Europe:

$$G_1 - G_1^{-1} = \frac{\bar{Y}_1 - Y_1}{\gamma} \quad (5)$$

Here is a list of the new symbols:

Y_1	European output this period
\bar{Y}_1	full-employment output in Europe
$\bar{Y}_1 - Y_1$	output gap in Europe this period
G_1^{-1}	European government purchases last period

G_1 European government purchases this period

$G_1 - G_1^{-1}$ increase in European government purchases.

Here the endogenous variable is European government purchases this period G_1 .

The target of the American government is full employment in America. The instrument of the American government is American government purchases. The American government raises American government purchases so as to close the output gap in America:

$$G_2 - G_2^{-1} = \frac{\bar{Y}_2 - Y_2}{\gamma} \quad (6)$$

Here is a list of the new symbols:

Y_2 American output this period

\bar{Y}_2 full-employment output in America

$\bar{Y}_2 - Y_2$ output gap in America this period

G_2^{-1} American government purchases last period

G_2 American government purchases this period

$G_2 - G_2^{-1}$ increase in American government purchases.

Here the endogenous variable is American government purchases this period G_2 .

We assume that the European government and the American government decide simultaneously and independently.

In addition there is an output lag. European output next period is determined by European government purchases this period as well as by American government purchases this period:

$$Y_1^{+1} = A_1 + \gamma G_1 + \gamma G_2 \quad (7)$$

Here Y_1^{+1} denotes European output next period. In the same way, American output next period is determined by American government purchases this period as well as by European government purchases this period:

$$Y_2^{+1} = A_2 + \gamma G_2 + \gamma G_1 \quad (8)$$

Here Y_2^{+1} denotes American output next period.

On this basis, the dynamic model can be characterized by a system of four equations:

$$G_1 - G_1^{-1} = \frac{\bar{Y}_1 - Y_1}{\gamma} \quad (9)$$

$$G_2 - G_2^{-1} = \frac{\bar{Y}_2 - Y_2}{\gamma} \quad (10)$$

$$Y_1^{+1} = A_1 + \gamma G_1 + \gamma G_2 \quad (11)$$

$$Y_2^{+1} = A_2 + \gamma G_2 + \gamma G_1 \quad (12)$$

Equation (9) shows the policy response in Europe, (10) shows the policy response in America, (11) shows the output lag in Europe, and (12) shows the output lag in America. The endogenous variables are European government purchases this period G_1 , American government purchases this period G_2 , European output next period Y_1^{+1} , and American output next period Y_2^{+1} .

3) The steady state. In the steady state by definition we have:

$$G_1 = G_1^{-1} \quad (13)$$

$$G_2 = G_2^{-1} \quad (14)$$

Equation (13) has it that European government purchases do not change any more. Similarly, equation (14) has it that American government purchases do not change any more. Therefore the steady state can be captured by a system of four equations:

$$Y_1 = \bar{Y}_1 \quad (15)$$

$$Y_2 = \bar{Y}_2 \quad (16)$$

$$Y_1 = A_1 + \gamma G_1 + \gamma G_2 \quad (17)$$

$$Y_2 = A_2 + \gamma G_2 + \gamma G_1 \quad (18)$$

Here the endogenous variables are European output Y_1 , American output Y_2 , European government purchases G_1 , and American government purchases G_2 . According to equation (15) there is full employment in Europe, so European output is constant. According to equation (16) there is full employment in America, so American output is constant too. Further, equations (17) and (18) give the steady state levels of European and American government purchases.

Now subtract equation (18) from equation (17), taking account of equations (15) and (16), to reach:

$$\bar{Y}_1 - \bar{Y}_2 = A_1 - A_2 \quad (19)$$

However, this is in direct contradiction to the assumption that \bar{Y}_1 , \bar{Y}_2 , A_1 and A_2 are given independently. As a result, there is no steady state of fiscal competition. In other words, fiscal competition between Europe and America does not lead to full employment in Europe and America. The underlying reason is the large external effect of fiscal policy.

2. Some Numerical Examples

To illustrate the dynamic model, have a look at some numerical examples. For ease of exposition, without loss of generality, assume $\gamma = 1$, see Carlberg (2000) p. 199 and Carlberg (2001) p. 163. On this assumption, the static model can be written as follows:

$$Y_1 = A_1 + G_1 + G_2 \quad (1)$$

$$Y_2 = A_2 + G_2 + G_1 \quad (2)$$

The endogenous variables are European output and American output. Obviously, an increase in European government purchases of 100 causes an increase in European output of 100 and an increase in American output of equally 100.

Correspondingly, an increase in American government purchases of 100 causes an increase in American output of 100 and an increase in European output of equally 100. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

It proves useful to study four distinct cases:

- unemployment in Europe exceeds unemployment in America
- unemployment in Europe equals unemployment in America
- unemployment in Europe exceeds overemployment in America
- unemployment in Europe equals overemployment in America.

1) Unemployment in Europe exceeds unemployment in America. At the beginning there is unemployment in both Europe and America. More precisely, unemployment in Europe exceeds unemployment in America. Let initial output in Europe be 940, and let initial output in America be 970. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 1. So what is needed in Europe is an increase in European government purchases of 60. The output gap in America is 30. The fiscal policy multiplier in America is 1. So what is needed in America is an increase in American government purchases of 30.

Step 2 refers to the output lag. The increase in European government purchases of 60 causes an increase in European output of 60. As a side effect, it causes an increase in American output of equally 60. The increase in American government purchases of 30 causes an increase in American output of 30. As a side effect, it causes an increase in European output of equally 30. The total effect is an increase in European output of 90 and an increase in American output of equally 90. As a consequence, European output goes from 940 to 1030, and American output goes from 970 to 1060. Put another way, the output gap in Europe of 60 turns into an inflationary gap of 30. And the output gap in America of 30 turns into an inflationary gap of 60.

Why does the European government not succeed in closing the output gap in Europe (or, for that matter, the inflationary gap in Europe)? The underlying reason is the positive external effect of the increase in American government purchases. And why does the American government not succeed in closing the output gap in America (or the inflationary gap in America)? The underlying

reason is the positive external effect of the increase in European government purchases.

Step 3 refers to the policy response. The inflationary gap in Europe is 30. The fiscal policy multiplier in Europe is 1. So what is needed in Europe is a reduction in European government purchases of 30. The inflationary gap in America is 60. The fiscal policy multiplier in America is 1. So what is needed in America is a reduction in American government purchases of 60.

Step 4 refers to the output lag. The reduction in European government purchases of 30 causes a decline in European output of 30. As a side effect, it causes a decline in American output of equally 30. The reduction in American government purchases of 60 causes a decline in American output of 60. As a side effect, it causes a decline in European output of equally 60. The total effect is a decline in European output of 90 and a decline in American output of equally 90. As a consequence, European output goes from 1030 to 940, and American output goes from 1060 to 970. With this, European output and American output are back at their initial levels. That means, this process will repeat itself step by step. Table 1.16 presents a synopsis.

Table 1.16

Fiscal Competition between Europe and America

Unemployment in Europe Exceeds Unemployment in America

	Europe	America
Initial Output	940	970
Change in Government Purchases	60	30
Output	1030	1060
Change in Government Purchases	- 30	- 60
Output	940	970
<i>and so on</i>	...	...

What are the dynamic characteristics of this process? There is an upward trend in European government purchases. By contrast, there is a downward trend in American government purchases. There are uniform oscillations in European output, as there are in American output. The European economy oscillates between unemployment and overemployment, as does the American economy. There are repeated appreciations of the euro and repeated depreciations of the dollar. Accordingly, there are repeated cuts in European exports and repeated increases in American exports. Moreover, after a certain number of steps, American government purchases are down to zero. As a result, fiscal competition between Europe and America does not lead to full employment in Europe and America.

2) Unemployment in Europe equals unemployment in America. Let initial output in Europe be 940, and let initial output in America be the same. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 1. So what is needed in Europe is an increase in European government purchases of 60. The output gap in America is 60. The fiscal policy multiplier in America is 1. So what is needed in America is an increase in American government purchases of 60.

Step 2 refers to the output lag. The increase in European government purchases of 60 causes an increase in European output of 60. As a side effect, it causes an increase in American output of equally 60. The increase in American government purchases of 60 causes an increase in American output of 60. As a side effect, it causes an increase in European output of equally 60. The total effect is an increase in European output of 120 and an increase in American output of equally 120. As a consequence, European output goes from 940 to 1060, as does American output.

Step 3 refers to the policy response. The inflationary gap in Europe is 60. The fiscal policy multiplier in Europe is 1. So what is needed in Europe is a reduction in European government purchases of 60. The inflationary gap in America is 60. The fiscal policy multiplier in America is 1. So what is needed in America is a reduction in American government purchases of 60.

Step 4 refers to the output lag. The reduction in European government purchases of 60 causes a decline in European output of 60. As a side effect, it

causes a decline in American output of equally 60. The reduction in American government purchases of 60 causes a decline in American output of 60. As a side effect, it causes a decline in European output of equally 60. The total effect is a decline in European output of 120 and a decline in American output of equally 120. As a consequence, European output goes from 1060 to 940, as does American output.

With this, output is back at its initial level, hence this process will repeat itself. Table 1.17 gives an overview. There are uniform oscillations in European government purchases, and the same holds for American government purchases. There are uniform oscillations in European output, and the same holds for American output. As a result, the process of fiscal competition does not lead to full employment.

Table 1.17

Fiscal Competition between Europe and America

Unemployment in Europe Equals Unemployment in America

	Europe	America
Initial Output	940	940
Change in Government Purchases	60	60
Output	1060	1060
Change in Government Purchases	- 60	- 60
Output	940	940
<i>and so on</i>	...	...

3) Unemployment in Europe exceeds overemployment in America. At the start there is unemployment in Europe but overemployment in America. Thus there is inflation in America. Let initial output in Europe be 940, and let initial output in America be 1030. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 1. So what is needed in

Europe is an increase in European government purchases of 60. The inflationary gap in America is 30. The fiscal policy multiplier in America is 1. So what is needed in America is a reduction in American government purchases of 30.

Step 2 refers to the output lag. The increase in European government purchases of 60 causes an increase in European output of 60. As a side effect, it causes an increase in American output of equally 60. The reduction in American government purchases of 30 causes a decline in American output of 30. As a side effect, it causes a decline in European output of equally 30. The net effect is an increase in European output of 30 and an increase in American output of equally 30. As a consequence, European output goes from 940 to 970, and American output goes from 1030 to 1060.

Step 3 refers to the policy response. The output gap in Europe is 30. The fiscal policy multiplier in Europe is 1. So what is needed in Europe is an increase in European government purchases of 30. The inflationary gap in America is 60. The fiscal policy multiplier in America is 1. So what is needed in America is a reduction in American government purchases of 60.

Step 4 refers to the output lag. The increase in European government purchases of 30 causes an increase in European output of 30. As a side effect, it causes an increase in American output of equally 30. The reduction in American government purchases of 60 causes a decline in American output of 60. As a side effect, it causes a decline in European output of equally 60. The net effect is a decline in European output of 30 and a decline in American output of equally 30. As a consequence, European output goes from 970 to 940, and American output goes from 1060 to 1030.

At this point in time, output is back at its initial level. So this process will repeat itself. For a synopsis see Table 1.18. What are the dynamic characteristics? There are repeated increases in European government purchases. On the other hand, there are repeated cuts in American government purchases. There are uniform oscillations in European output, as there are in American output. The European economy oscillates between high and low unemployment. The American economy oscillates between high and low overemployment. As a result, fiscal competition does not lead to full employment.

Table 1.18**Fiscal Competition between Europe and America**

Unemployment in Europe Exceeds Overemployment in America

	Europe	America
Initial Output	940	1030
Change in Government Purchases	60	- 30
Output	970	1060
Change in Government Purchases	30	- 60
Output	940	1030
<i>and so on</i>	...	...

4) Unemployment in Europe equals overemployment in America. Let initial output in Europe be 940, and let initial output in America be 1060. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 1. So what is needed in Europe is an increase in European government purchases of 60. The inflationary gap in America is 60. The fiscal policy multiplier in America is 1. So what is needed in America is a reduction in American government purchases of 60.

Step 2 refers to the output lag. The increase in European government purchases of 60 causes an increase in European output of 60. As a side effect, it causes an increase in American output of equally 60. The reduction in American government purchases of 60 causes a decline in American output of 60. As a side effect, it causes a decline in European output of equally 60. The net effect is that European output does not change, and neither does American output. As a consequence, European output is still 940, and American output is still 1060.

Step 3 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 1. So what is needed in Europe is an increase in European government purchases of 60. The inflationary gap in America is 60.

The fiscal policy multiplier in America is 1. So what is needed in America is a reduction in American government purchases of 60.

Step 4 refers to the output lag. The increase in European government purchases of 60 causes an increase in European output of 60. As a side effect, it causes an increase in American output of equally 60. The reduction in American government purchases of 60 causes a decline in American output of 60. As a side effect, it causes a decline in European output of equally 60. The net effect is that European output does not change, and neither does American output. As a consequence, European output is still 940, and American output is still 1060.

That means, European output and American output stay at their initial levels. This process will repeat itself step by step. For an overview see Table 1.19. There are repeated increases in European government purchases. By contrast, there are repeated cuts in American government purchases. However, there is no change in European output, and the same applies to American output. In Europe there is unemployment, and in America there is overemployment. As a result, fiscal competition does not lead to full employment.

Table 1.19

Fiscal Competition between Europe and America

Unemployment in Europe Equals Overemployment in America

	Europe	America
Initial Output	940	1060
Change in Government Purchases	60	- 60
Output	940	1060
Change in Government Purchases	60	- 60
Output	940	1060
<i>and so on</i>	...	...

5) Summary. There is an upward trend in European government purchases. On the other hand, there is a downward trend in American government purchases. There are uniform oscillations in European output, and there are uniform oscillations in American output. As a finding, fiscal competition between Europe and America does not lead to full employment.

6) Comparing fiscal competition with monetary competition. Monetary competition can achieve full employment, but fiscal competition cannot do so. Judging from this point of view, monetary competition is superior to fiscal competition.

Chapter 4

Fiscal Cooperation between Europe and America

1. The Model

As a starting point, take the output model. It can be represented by a system of two equations:

$$Y_1 = A_1 + \gamma G_1 + \gamma G_2 \quad (1)$$

$$Y_2 = A_2 + \gamma G_2 + \gamma G_1 \quad (2)$$

Here Y_1 denotes European output, Y_2 is American output, G_1 is European government purchases, and G_2 is American government purchases. The endogenous variables are European output and American output. At the beginning there is unemployment in both Europe and America. More precisely, unemployment in Europe exceeds unemployment in America. The targets of fiscal cooperation are full employment in Europe and full employment in America. The instruments of fiscal cooperation are European government purchases and American government purchases. So there are two targets and two instruments.

On this basis, the policy model can be characterized by a system of two equations:

$$\bar{Y}_1 = A_1 + \gamma G_1 + \gamma G_2 \quad (3)$$

$$\bar{Y}_2 = A_2 + \gamma G_2 + \gamma G_1 \quad (4)$$

Here \bar{Y}_1 denotes full-employment output in Europe, and \bar{Y}_2 denotes full-employment output in America. The endogenous variables are European government purchases and American government purchases. Now take the difference between equations (3) and (4) to find out:

$$\bar{Y}_1 - \bar{Y}_2 = A_1 - A_2 \quad (5)$$

However, this is in direct contradiction to the assumption that \bar{Y}_1 , \bar{Y}_2 , A_1 and A_2 are given independently. As a result, there is no solution to fiscal cooperation. That is to say, fiscal cooperation between Europe and America cannot achieve full employment in Europe and America. The underlying reason is the large external effect of fiscal policy.

2. Some Numerical Examples

To illustrate the policy model, have a look at some numerical examples. For ease of exposition, without losing generality, assume $\gamma = 1$. On this assumption, the output model can be written as follows:

$$Y_1 = A_1 + G_1 + G_2 \quad (1)$$

$$Y_2 = A_2 + G_2 + G_1 \quad (2)$$

The endogenous variables are European output and American output. Evidently, an increase in European government purchases of 100 causes an increase in European output of 100 and an increase in American output of equally 100. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

It proves useful to consider three distinct cases:

- unemployment in Europe exceeds unemployment in America
- unemployment in Europe equals unemployment in America
- unemployment in Europe, overemployment in America.

1) Unemployment in Europe exceeds unemployment in America. Let initial output in Europe be 940, and let initial output in America be 970. In this case, the specific target of fiscal cooperation is full employment in America. Aiming for

full employment in Europe would imply overemployment in America and, hence, inflation in America. So what is needed is an increase in American output of 30. What is needed, for instance, is an increase in European government purchases of 15 and an increase in American government purchases of equally 15.

The increase in European government purchases of 15 raises European output and American output by 15 each. Similarly, the increase in American government purchases of 15 raises American output and European output by 15 each. The total effect is an increase in European output of 30 and an increase in American output of equally 30. As a consequence, European output goes from 940 to 970, and American output goes from 970 to 1000. In Europe unemployment comes down, but there is still some unemployment left. In America there is now full employment. As a result, in this case, fiscal cooperation can reduce unemployment in Europe and America to a certain extent. On the other hand, fiscal cooperation cannot achieve full employment in both Europe and America. Table 1.20 presents a synopsis.

Table 1.20

Fiscal Cooperation between Europe and America

Unemployment in Europe Exceeds Unemployment in America

	Europe	America
Initial Output	940	970
Change in Government Purchases	15	15
Output	970	1000

2) Unemployment in Europe equals unemployment in America. Let initial output in Europe be 940, and let initial output in America be the same. In this case, the specific targets of fiscal cooperation are full employment in Europe and full employment in America. What is needed, then, is an increase in European output of 60 and an increase in American output of equally 60. What is needed, for instance, is an increase in European government purchases of 30 and an

increase in American government purchases of equally 30. The total effect is to raise European output and American output by 60 each. As a consequence, European output goes from 940 to 1000, as does American output. In this special case, fiscal cooperation can in fact achieve full employment in both Europe and America. Table 1.21 gives an overview.

Table 1.21

Fiscal Cooperation between Europe and America

Unemployment in Europe Equals Unemployment in America

	Europe	America
Initial Output	940	940
Change in Government Purchases	30	30
Output	1000	1000

3) Unemployment in Europe, overemployment in America. At the start there is unemployment in Europe but overemployment in America. Thus there is inflation in America. Let initial output in Europe be 940, and let initial output in America be 1030. First consider an increase in European government purchases of 60. This policy action raises European output and American output by 60 each. As a consequence, European output goes from 940 to 1000, and American output goes from 1030 to 1090. In Europe, unemployment comes down. In America, however, inflation goes up. So this cannot be a solution to fiscal cooperation.

Second consider a reduction in American government purchases of 30. This policy action lowers American output and European output by 30 each. As a consequence, American output goes from 1030 to 1000, and European output goes from 940 to 910. In America, inflation comes down. In Europe, however, unemployment goes up. So this cannot be a solution to fiscal cooperation either. For a synopsis see Table 1.22. The general point is that fiscal cooperation cannot

raise European output and lower American output at the same time. As a result, in this case, there is no solution to fiscal cooperation.

Table 1.22

Fiscal Cooperation between Europe and America

Unemployment in Europe, Overemployment in America

	Europe	America
Initial Output	940	1030
Change in Government Purchases	0	- 30
Output	910	1000

4) Summary. Fiscal cooperation between Europe and America generally cannot achieve full employment in Europe and America. On the other hand, it can reduce unemployment in Europe and America to a certain extent.

5) Comparing fiscal cooperation with fiscal competition. Fiscal competition cannot achieve full employment. The same is true of fiscal cooperation. Fiscal competition cannot reduce unemployment. Fiscal cooperation can reduce unemployment to a certain extent. Under fiscal competition there is a tendency for government purchases to explode. And there is a tendency for output to oscillate uniformly. Under fiscal cooperation there are no such tendencies. Judging from these points of view, fiscal cooperation seems to be superior to fiscal competition.

6) Comparing fiscal cooperation with monetary cooperation. Monetary cooperation can achieve full employment. By contrast, fiscal cooperation cannot achieve full employment. From this perspective, monetary cooperation is superior to fiscal cooperation.

Chapter 5

The Anticipation of Policy Spillovers

The focus here is on monetary competition between Europe and America. The European central bank closely observes the measures taken by the American central bank. And what is more, the European central bank can respond immediately to the measures taken by the American central bank. The other way round, the American central bank closely observes the measures taken by the European central bank. And what is more, the American central bank can respond immediately to the measures taken by the European central bank. That means, the inside lag of monetary policy is short. On the other hand, the outside lag of monetary policy is long and variable.

In the current chapter we assume that the European central bank anticipates the spillovers from monetary policy in America. Likewise we assume that the American central bank anticipates the spillovers from monetary policy in Europe. To illustrate this, have a look at some numerical examples. An increase in European money supply of 100 causes an increase in European output of 300 and a decline in American output of 100. Similarly, an increase in American money supply of 100 causes an increase in American output of 300 and a decline in European output of 100. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

It proves useful to study three distinct cases:

- unemployment in Europe equals unemployment in America
- unemployment in Europe exceeds unemployment in America
- unemployment in Europe equals overemployment in America.

1) Unemployment in Europe equals unemployment in America. Let initial output in Europe be 940, and let initial output in America be the same. Steps 1, 2 and 3 refer to a series of policy responses. Then step 4 refers to the output lag. Let us begin with step 1. The output gap in Europe is 60. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 20. The output gap in America is 60. The monetary policy

multiplier in America is 3. So what is needed in America is an increase in American money supply of 20.

In step 2, the European central bank anticipates the effect of the increase in American money supply. And the American central bank anticipates the effect of the increase in European money supply. The European central bank expects that, due to the increase in American money supply of 20, European output will only rise to 980. And the American central bank expects that, due to the increase in European money supply of 20, American output will only rise to 980. The expected output gap in Europe is 20. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 6.7. The expected output gap in America is 20. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 6.7.

We now come to step 3. The European central bank expects that, due to the increase in American money supply of 6.7, European output will only rise to 993.3. And the American central bank expects that, due to the increase in European money supply of 6.7, American output will only rise to 993.3. The expected output gap in Europe is 6.7. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 2.2. The expected output gap in America is 6.7. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 2.2.

Step 4 refers to the output lag. The accumulated increase in European money supply of 28.9 causes an increase in European output of 86.7. As a side effect, it causes a decline in American output of 28.9. The accumulated increase in American money supply of 28.9 causes an increase in American output of 86.7. As a side effect, it causes a decline in European output of 28.9. The net effect is an increase in European output of 57.8 and an increase in American output of equally 57.8. As a consequence, European output goes from 940 to 997.8, as does American output. Table 1.23 presents a synopsis. As a result, the anticipation of policy spillovers speeds up the process of monetary competition.

Table 1.23**Monetary Competition between Europe and America**

The Anticipation of Policy Spillovers

	Europe	America
Initial Output	940	940
Change in Money Supply	20	20
Change in Money Supply	6.7	6.7
Change in Money Supply	2.2	2.2
Output	997.8	997.8

2) Unemployment in Europe exceeds unemployment in America. Let initial output in Europe be 940, and let initial output in America be 970. Steps 1, 2 and 3 refer to a series of policy responses. Then step 4 refers to the output lag. Let us begin with step 1. The output gap in Europe is 60. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 20. The output gap in America is 30. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 10.

In step 2, the European central bank anticipates the effect of the increase in American money supply. And the American central bank anticipates the effect of the increase in European money supply. The European central bank expects that, due to the increase in American money supply of 10, European output will only rise to 990. And the American central bank expects that, due to the increase in European money supply of 20, American output will only rise to 980. The expected output gap in Europe is 10. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 3.3. The expected output gap in America is 20. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 6.7.

We now come to step 3. The European central bank expects that, due to the increase in American money supply of 6.7, European output will only rise to 993.3. And the American central bank expects that, due to the increase in European money supply of 3.3, American output will only rise to 996.7. The expected output gap in Europe is 6.7. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 2.2. The expected output gap in America is 3.3. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 1.1.

Step 4 refers to the output lag. The accumulated increase in European money supply of 25.6 causes an increase in European output of 76.7. As a side effect, it causes a decline in American output of 25.6. The accumulated increase in American money supply of 17.8 causes an increase in American output of 53.3. As a side effect, it causes a decline in European output of 17.8. The net effect is an increase in European output of 58.9 and an increase in American output of 27.8. As a consequence, European output goes from 940 to 998.9, and American output goes from 970 to 997.8. Table 1.24 gives an overview.

Table 1.24
Monetary Competition between Europe and America
 The Anticipation of Policy Spillovers

	Europe	America
Initial Output	940	970
Change in Money Supply	20	10
Change in Money Supply	3.3	6.7
Change in Money Supply	2.2	1.1
Output	998.9	997.8

3) Unemployment in Europe equals overemployment in America. Let initial output in Europe be 940, and let initial output in America be 1060. Steps 1, 2 and 3 refer to a series of policy responses. Then step 4 refers to the output lag. Let us begin with step 1. The output gap in Europe is 60. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 20. The inflationary gap in America is 60. The monetary policy multiplier in America is 3. So what is needed in America is a reduction in American money supply of 20.

In step 2, the European central bank anticipates the effect of the reduction in American money supply. And the American central bank anticipates the effect of the increase in European money supply. The European central bank expects that, due to the reduction in American money supply of 20, European output will go to 1020. And the American central bank expects that, due to the increase in European money supply of 20, American output will go to 980. The expected inflationary gap in Europe is 20. The monetary policy multiplier in Europe is 3. So what is needed in Europe is a reduction in European money supply of 6.7. The expected output gap in America is 20. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 6.7.

We now come to step 3. The European central bank expects that, due to the increase in American money supply of 6.7, European output will go to 993.3. And the American central bank expects that, due to the reduction in European money supply of 6.7, American output will go to 1006.7. The expected output gap in Europe is 6.7. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 2.2. The expected inflationary gap in America is 6.7. The monetary policy multiplier in America is 3. So what is needed in America is a reduction in American money supply of 2.2.

Step 4 refers to the output lag. The accumulated increase in European money supply of 15.6 causes an increase in European output of 46.7. As a side effect, it causes a decline in American output of 15.6. The accumulated reduction in American money supply of 15.6 causes a decline in American output of 46.7. As a side effect, it causes an increase in European output of 15.6. The total effect is an increase in European output of 62.2 and a decline in American output of equally 62.2. As a consequence, European output goes from 940 to 1002.2, and

American output goes from 1060 to 997.8. For a synopsis see Table 1.25. As a result, the anticipation of policy spillovers speeds up the process of monetary competition. In a sense, it prevents output from oscillating.

Table 1.25
Monetary Competition between Europe and America
 The Anticipation of Policy Spillovers

	Europe	America
Initial Output	940	1060
Change in Money Supply	20	- 20
Change in Money Supply	- 6.7	6.7
Change in Money Supply	2.2	- 2.2
Output	1002.2	997.8

4) Comparing anticipation and non-anticipation. Without anticipation, monetary competition is a slow process. With anticipation, by contrast, monetary competition is a fast process. Without anticipation, there can be damped oscillations in output. With anticipation, there cannot be damped oscillations in output. Judging from these points of view, anticipation is superior to non-anticipation.

5) Comparing monetary competition and monetary cooperation, given anticipation. Monetary competition can achieve full employment. The same is true of monetary cooperation. Monetary competition is a fast process. Again, the same is true of monetary cooperation. From these perspectives, there seems to be no need for monetary cooperation.

Part Two

The World of Two Monetary Regions

Intermediate Models

Chapter 1

Zero Capital Mobility

1. Fiscal Competition between Europe and America

In the preceding chapters we assumed perfect capital mobility between Europe and America. In the current chapter, instead, we assume zero capital mobility between Europe and America. As a point of reference, consider the static model. It can be represented by a system of two equations:

$$Y_1 = A_1 + 2G_1 \quad (1)$$

$$Y_2 = A_2 + 2G_2 \quad (2)$$

According to equation (1), European output Y_1 is determined by European government purchases G_1 and by some other factors called A_1 . According to equation (2), American output Y_2 is determined by American government purchases G_2 and by some other factors called A_2 .

In the numerical example, an increase in European government purchases of 100 causes an increase in European output of 200 and an increase in American output of zero. Correspondingly, an increase in American government purchases of 100 causes an increase in American output of 200 and an increase in European output of zero. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same. For the model see Carlberg (1999) p. 185.

At the beginning there is unemployment in both Europe and America. The target of the European government is full employment in Europe. The target of the American government is full employment in America. Let initial output in Europe be 940, and let initial output in America be 970. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 2. So what is needed in Europe is an increase in European government purchases of 30. The output gap in America is 30. The fiscal policy multiplier in

America is 2. So what is needed in America is an increase in American government purchases of 15.

Step 2 refers to the output lag. The increase in European government purchases of 30 causes an increase in European output of 60. There is no side effect on American output. The increase in American government purchases of 15 causes an increase in American output of 30. There is no side effect on European output. As a consequence, European output goes from 940 to 1000, and American output goes from 970 to 1000. In Europe there is now full employment, and the same holds for America. Table 2.1 presents a synopsis.

Table 2.1
Fiscal Competition between Europe and America
 Zero Capital Mobility

	Europe	America
Initial Output	940	970
Change in Government Purchases	30	15
Output	1000	1000

What are the dynamic characteristics of this process? There is a one-step increase in European government purchases, as there is in American government purchases. There is a one-step increase in European output, as there is in American output. To sum up, under zero capital mobility, fiscal competition leads to full employment immediately. The underlying reason is that, under zero capital mobility, there are no spillovers of fiscal policy. Finally compare zero capital mobility with perfect capital mobility. Under perfect capital mobility, fiscal competition does not lead to full employment at all. Under zero capital mobility, however, fiscal competition leads to full employment immediately.

2. Monetary Competition between Europe and America

As a point of reference, consider the static model. It can be represented by a system of two equations:

$$Y_1 = A_1 + 2M_1 \quad (1)$$

$$Y_2 = A_2 + 2M_2 \quad (2)$$

According to equation (1), European output Y_1 is determined by European money supply M_1 and by some other factors called A_1 . According to equation (2), American output Y_2 is determined by American money supply M_2 and by some other factors called A_2 .

In the numerical example, an increase in European money supply of 100 causes an increase in European output of 200 and a decline in American output of zero. Correspondingly, an increase in American money supply of 100 causes an increase in American output of 200 and a decline in European output of zero. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same. For the model see Carlberg (1999) p. 185.

At the start there is unemployment in both Europe and America. The target of the European central bank is full employment in Europe. The target of the American central bank is full employment in America. Let initial output in Europe be 940, and let initial output in America be 970. Step 1 refers to the policy response. The output gap in Europe is 60. The monetary policy multiplier in Europe is 2. So what is needed in Europe is an increase in European money supply of 30. The output gap in America is 30. The monetary policy multiplier in America is 2. So what is needed in America is an increase in American money supply of 15.

Step 2 refers to the output lag. The increase in European money supply of 30 causes an increase in European output of 60. There is no side effect on American output. The increase in American money supply of 15 causes an increase in American output of 30. There is no side effect on European output. As a

consequence, European output goes from 940 to 1000, and American output goes from 970 to 1000. In Europe there is now full employment, and the same applies to America. Table 2.2 gives an overview.

Table 2.2
Monetary Competition between Europe and America
 Zero Capital Mobility

	Europe	America
Initial Output	940	970
Change in Money Supply	30	15
Output	1000	1000

What are the dynamic characteristics of this process? There is a one-step increase in European money supply, as there is in American money supply. There is a one-step increase in European output, as there is in American output. To sum up, under zero capital mobility, monetary competition leads to full employment immediately. The underlying reason is that, under zero capital mobility, there are no spillovers of monetary policy. Coming to an end, compare zero capital mobility with perfect capital mobility. Under perfect capital mobility, monetary competition is a slow process. Under zero capital mobility, however, monetary competition is a fast process.

Chapter 2

Imperfect Capital Mobility

1. Fiscal Competition between Europe and America

1.1. The Dynamic Model

1) The static model. In this chapter we assume imperfect capital mobility between Europe and America. Under perfect capital mobility, an increase in European government purchases raises both European output and American output, to the same extent respectively. Under zero capital mobility, an increase in European government purchases raises European output to a much larger degree. On the other hand, it has no effect on American output. Under imperfect capital mobility, an increase in European government purchases raises both European output and American output. However, the rise in European output is relatively large, and the rise in American output is relatively small.

To illustrate this, consider a numerical example. Under perfect capital mobility, an increase in European government purchases of 100 causes an increase in European output of 100 and an increase in American output of equally 100. So the increase in world output is 200. Under zero capital mobility, by contrast, an increase in European government purchases of 100 causes an increase in European output of 200 and an increase in American output of zero. So the increase in world output is 200 again. On this basis we assume that, under imperfect capital mobility, an increase in European government purchases of 100 causes an increase in European output of 150 and an increase in American output of 50. So the increase in world output is still 200.

That means, under perfect capital mobility, fiscal spillovers are very large. Under zero capital mobility, fiscal spillovers are zero. And under imperfect capital mobility, fiscal spillovers are medium size. What does this imply for fiscal competition and fiscal cooperation? Given imperfect capital mobility, is fiscal competition a slow process or a fast one?

The static model can be represented by a system of two equations:

$$Y_1 = A_1 + \gamma G_1 + \delta G_2 \quad (1)$$

$$Y_2 = A_2 + \gamma G_2 + \delta G_1 \quad (2)$$

According to equation (1), European output Y_1 is determined by European government purchases G_1 , American government purchases G_2 , and some other factors called A_1 . According to equation (2), American output Y_2 is determined by American government purchases G_2 , European government purchases G_1 , and some other factors called A_2 . Here γ and δ denote the fiscal policy multipliers. The internal effect of fiscal policy is positive $\gamma > 0$. The external effect of fiscal policy is positive too $\delta > 0$. And what is more, the internal effect is larger than the external effect $\gamma > \delta$.

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European government is full employment in Europe. The instrument of the European government is European government purchases. The European government raises European government purchases so as to close the output gap in Europe:

$$G_1 - G_1^{-1} = \frac{\bar{Y}_1 - Y_1}{\gamma} \quad (3)$$

Here is a list of the new symbols:

Y_1	European output this period
\bar{Y}_1	full-employment output in Europe
$\bar{Y}_1 - Y_1$	output gap in Europe this period
G_1^{-1}	European government purchases last period
G_1	European government purchases this period
$G_1 - G_1^{-1}$	increase in European government purchases.

Here the endogenous variable is European government purchases this period G_1 .

The target of the American government is full employment in America. The instrument of the American government is American government purchases. The American government raises American government purchases so as to close the output gap in America:

$$G_2 - G_2^{-1} = \frac{\bar{Y}_2 - Y_2}{\gamma} \quad (4)$$

Here is a list of the new symbols:

Y_2	American output this period
\bar{Y}_2	full-employment output in America
$\bar{Y}_2 - Y_2$	output gap in America this period
G_2^{-1}	American government purchases last period
G_2	American government purchases this period
$G_2 - G_2^{-1}$	increase in American government purchases.

Here the endogenous variable is American government purchases this period G_2 . We assume that the European government and the American government decide simultaneously and independently.

In addition there is an output lag. European output next period is determined by European government purchases this period as well as by American government purchases this period:

$$Y_1^{+1} = A_1 + \gamma G_1 + \delta G_2 \quad (5)$$

Here Y_1^{+1} denotes European output next period. In the same way, American output next period is determined by American government purchases this period as well as by European government purchases this period:

$$Y_2^{+1} = A_2 + \gamma G_2 + \delta G_1 \quad (6)$$

Here Y_2^{+1} denotes American output next period.

On this basis, the dynamic model can be characterized by a system of four equations:

$$G_1 - G_1^{-1} = \frac{\bar{Y}_1 - Y_1}{\gamma} \quad (7)$$

$$G_2 - G_2^{-1} = \frac{\bar{Y}_2 - Y_2}{\gamma} \quad (8)$$

$$Y_1^{+1} = A_1 + \gamma G_1 + \delta G_2 \quad (9)$$

$$Y_2^{+1} = A_2 + \gamma G_2 + \delta G_1 \quad (10)$$

Equation (7) shows the policy response in Europe, (8) shows the policy response in America, (9) shows the output lag in Europe, and (10) shows the output lag in America. The endogenous variables are European government purchases this period G_1 , American government purchases this period G_2 , European output next period Y_1^{+1} , and American output next period Y_2^{+1} .

3) The steady state. In the steady state by definition we have:

$$G_1 = G_1^{-1} \quad (11)$$

$$G_2 = G_2^{-1} \quad (12)$$

Equation (11) has it that European government purchases do not change any more. Similarly, equation (12) has it that American government purchases do not change any more. Therefore the steady state can be captured by a system of four equations:

$$Y_1 = \bar{Y}_1 \quad (13)$$

$$Y_2 = \bar{Y}_2 \quad (14)$$

$$Y_1 = A_1 + \gamma G_1 + \delta G_2 \quad (15)$$

$$Y_2 = A_2 + \gamma G_2 + \delta G_1 \quad (16)$$

Here the endogenous variables are European output Y_1 , American output Y_2 , European government purchases G_1 , and American government purchases G_2 . According to equation (13) there is full employment in Europe, so European output is constant. According to equation (14) there is full employment in America, so American output is constant too. Further, equations (15) and (16) give the steady state levels of European and American government purchases.

The model of the steady state can be compressed to a system of only two equations:

$$\bar{Y}_1 = A_1 + \gamma G_1 + \delta G_2 \quad (17)$$

$$\bar{Y}_2 = A_2 + \gamma G_2 + \delta G_1 \quad (18)$$

Here the endogenous variables are European government purchases and American government purchases. To simplify notation we introduce:

$$B_1 = \bar{Y}_1 - A_1 \quad (19)$$

$$B_2 = \bar{Y}_2 - A_2 \quad (20)$$

With this, the model of the steady state can be written as follows:

$$B_1 = \gamma G_1 + \delta G_2 \quad (21)$$

$$B_2 = \gamma G_2 + \delta G_1 \quad (22)$$

The endogenous variables are still G_1 and G_2 .

Next we solve the model for the endogenous variables:

$$G_1 = \frac{\gamma B_1 - \delta B_2}{\gamma^2 - \delta^2} \quad (23)$$

$$G_2 = \frac{\gamma B_2 - \delta B_1}{\gamma^2 - \delta^2} \quad (24)$$

Equation (23) shows the steady-state level of European government purchases, and equation (24) shows the steady-state level of American government purchases. As a result, there is a steady state if and only if $\gamma \neq \delta$. Owing to the assumption $\gamma > \delta$, this condition is fulfilled.

As an alternative, the steady state can be represented in terms of the initial output gap and the total increase in government purchases. Taking differences in equations (1) and (2), the model of the steady state can be written as follows:

$$\Delta Y_1 = \gamma \Delta G_1 + \delta \Delta G_2 \quad (25)$$

$$\Delta Y_2 = \gamma \Delta G_2 + \delta \Delta G_1 \quad (26)$$

Here ΔY_1 is the initial output gap in Europe, ΔY_2 is the initial output gap in America, ΔG_1 is the total increase in European government purchases, and ΔG_2 is the total increase in American government purchases. The endogenous variables are ΔG_1 and ΔG_2 . The solution to the system (25) and (26) is:

$$\Delta G_1 = \frac{\gamma \Delta Y_1 - \delta \Delta Y_2}{\gamma^2 - \delta^2} \quad (27)$$

$$\Delta G_2 = \frac{\gamma \Delta Y_2 - \delta \Delta Y_1}{\gamma^2 - \delta^2} \quad (28)$$

According to equation (27), the total increase in European government purchases depends on the initial output gap in Europe, the initial output gap in America, the direct multiplier γ , and the cross multiplier δ . The larger the initial output gap in Europe, the larger is the total increase in European government purchases. Moreover, the larger the initial output gap in America, the smaller is the total increase in European government purchases. At first glance this comes as a surprise. According to equation (28), the total increase in American government purchases depends on the initial output gap in America, the initial output gap in Europe, the direct multiplier γ , and the cross multiplier δ .

4) Stability. Eliminate Y_1 in equation (7) by means of equation (9) and rearrange terms $\bar{Y}_1 = A_1 + \gamma G_1 + \delta G_2^{-1}$. By analogy, eliminate Y_2 in equation (8) by means of equation (10) to arrive at $\bar{Y}_2 = A_2 + \gamma G_2 + \delta G_1^{-1}$. On this basis, the dynamic model can be described by a system of two equations:

$$\bar{Y}_1 = A_1 + \gamma G_1 + \delta G_2^{-1} \quad (29)$$

$$\bar{Y}_2 = A_2 + \gamma G_2 + \delta G_1^{-1} \quad (30)$$

Here the endogenous variables are European government purchases this period G_1 and American government purchases this period G_2 . To simplify notation we make use of equations (19) and (20). With this, the dynamic model can be written as follows:

$$B_1 = \gamma G_1 + \delta G_2^{-1} \quad (31)$$

$$B_2 = \gamma G_2 + \delta G_1^{-1} \quad (32)$$

The endogenous variables are still G_1 and G_2 .

Now substitute equation (32) into equation (31) and solve for:

$$\gamma G_1 = B_1 - \frac{\delta B_2}{\gamma} + \frac{\delta^2 G_1^{-2}}{\gamma} \quad (33)$$

Then differentiate equation (33) for G_1^{-2} :

$$\frac{dG_1}{dG_1^{-2}} = \frac{\delta^2}{\gamma^2} \quad (34)$$

Finally the stability condition is $\delta^2 / \gamma^2 < 1$ or:

$$\gamma > \delta \quad (35)$$

That means, the steady state is stable if and only if the internal effect of fiscal policy is larger than the external effect of fiscal policy. This condition is satisfied. As a result, there is a stable steady state of fiscal competition. In other words, fiscal competition between Europe and America leads to full employment in Europe and America.

1.2. Some Numerical Examples

To illustrate the dynamic model, have a look at some numerical examples. For ease of exposition, without loss of generality, assume $\gamma = 1.5$ and $\delta = 0.5$. On this assumption, the static model can be written as follows:

$$Y_1 = A_1 + 1.5G_1 + 0.5G_2 \quad (1)$$

$$Y_2 = A_2 + 1.5G_2 + 0.5G_1 \quad (2)$$

The endogenous variables are European output and American output. Obviously, an increase in European government purchases of 100 causes an increase in European output of 150 and an increase in American output of 50. Correspondingly, an increase in American government purchases of 100 causes an increase in American output of 150 and an increase in European output of 50. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

It proves useful to study three distinct cases:

- unemployment in Europe equals unemployment in America
- unemployment in Europe exceeds unemployment in America
- unemployment in Europe equals overemployment in America.

1) Unemployment in Europe equals unemployment in America. At the beginning there is unemployment in both Europe and America. More precisely, unemployment in Europe equals unemployment in America. Let initial output in Europe be 940, and let initial output in America be the same. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 1.5. So what is needed in Europe is an increase in European government purchases of 40. The output gap in America is 60. The fiscal policy multiplier in America is 1.5. So what is needed in America is an increase in American government purchases of 40.

Step 2 refers to the output lag. The increase in European government purchases of 40 causes an increase in European output of 60. As a side effect, it

causes an increase in American output of 20. The increase in American government purchases of 40 causes an increase in American output of 60. As a side effect, it causes an increase in European output of 20. The total effect is an increase in European output of 80 and an increase in American output of equally 80. As a consequence, European output goes from 940 to 1020, as does American output.

Step 3 refers to the policy response. The inflationary gap in Europe is 20. The fiscal policy multiplier in Europe is 1.5. So what is needed in Europe is a reduction in European government purchases of 13.3. The inflationary gap in America is 20. The fiscal policy multiplier in America is 1.5. So what is needed in America is a reduction in American government purchases of 13.3.

Step 4 refers to the output lag. The reduction in European government purchases of 13.3 causes a decline in European output of 20. As a side effect, it causes a decline in American output of 6.7. The reduction in American government purchases of 13.3 causes a decline in American output of 20. As a side effect, it causes a decline in European output of 6.7. The total effect is a decline in European output of 26.7 and a decline in American output of equally 26.7. As a consequence, European output goes from 1020 to 993.3, as does American output. And so on. Table 2.3 presents a synopsis.

What are the dynamic characteristics of this process? There are damped oscillations in European government purchases, as there are in American government purchases. There are damped oscillations in European output, as there are in American output. The European economy oscillates between unemployment and overemployment, as does the American economy. In each round, in absolute values, the output gap declines by 67 percent. There are damped oscillations in the world interest rate. Accordingly, there are damped oscillations in European investment, as there are in American investment. As a result, fiscal competition between Europe and America leads to full employment in Europe and America.

Taking the sum over all periods, the increase in European government purchases is 30, as is the increase in American government purchases, see equations (27) and (28) in the preceding section. That means, the total increase in European government purchases is small, as compared to the initial output gap in

Europe of 60. And the same applies to the total increase in American government purchases, as compared to the initial output gap in America of 60. The effective multiplier in Europe is $60/30 = 2$, as is the effective multiplier in America. In other words, the effective multiplier in Europe is large. And the same holds for the effective multiplier in America.

Table 2.3
Fiscal Competition between Europe and America
 Imperfect Capital Mobility

	Europe	America
Initial Output	940	940
Change in Government Purchases	40	40
Output	1020	1020
Change in Government Purchases	- 13.3	- 13.3
Output	993.3	993.3
Change in Government Purchases	4.4	4.4
Output	1002.2	1002.2
<i>and so on</i>	...	...

2) Unemployment in Europe exceeds unemployment in America. Let initial output in Europe be 940, and let initial output in America be 970. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 1.5. So what is needed in Europe is an increase in European government purchases of 40. The output gap in America is 30. The fiscal policy multiplier in America is 1.5. So what is needed in America is an increase in American government purchases of 20.

Step 2 refers to the output lag. The increase in European government purchases of 40 causes an increase in European output of 60. As a side effect, it causes an increase in American output of 20. The increase in American

government purchases of 20 causes an increase in American output of 30. As a side effect, it causes an increase in European output of 10. The total effect is an increase in European output of 70 and an increase in American output of 50. As a consequence, European output goes from 940 to 1010, and American output goes from 970 to 1020.

Step 3 refers to the policy response. The inflationary gap in Europe is 10. The fiscal policy multiplier in Europe is 1.5. So what is needed in Europe is a reduction in European government purchases of 6.7. The inflationary gap in America is 20. The fiscal policy multiplier in America is 1.5. So what is needed in America is a reduction in American government purchases of 13.3.

Step 4 refers to the output lag. The reduction in European government purchases of 6.7 causes a decline in European output of 10. As a side effect, it causes a decline in American output of 3.3. The reduction in American government purchases of 13.3 causes a decline in American output of 20. As a side effect, it causes a decline in European output of 6.7. The total effect is a decline in European output of 16.7 and a decline in American output of 23.3. As a consequence, European output goes from 1010 to 993.3, and American output goes from 1020 to 996.7. And so on. Table 2.4 gives an overview.

What are the dynamic characteristics of this process? There are damped oscillations in European government purchases, as there are in American government purchases. There are damped oscillations in European output, as there are in American output. As a result, the process of fiscal competition leads to full employment.

Taking the sum over all periods, the increase in European government purchases is 37.5, and the increase in American government purchases is 7.5, see equations (27) and (28) from the previous section. The total increase in European government purchases is small, as compared to the initial output gap in Europe of 60. And the total increase in American government purchases is even smaller, as compared to the initial output gap in America of 30. The effective multiplier in Europe is $60/37.5 = 1.6$, and the effective multiplier in America is $30/7.5 = 4$. That is to say, the effective multiplier in Europe is large, and the effective multiplier in America is even larger.

Table 2.4
Fiscal Competition between Europe and America
 Imperfect Capital Mobility

	Europe	America
Initial Output	940	970
Change in Government Purchases	40	20
Output	1010	1020
Change in Government Purchases	- 6.7	- 13.3
Output	993.3	996.7
Change in Government Purchases	4.4	2.2
Output	1001.1	1002.2
<i>and so on</i>	...	...

3) Unemployment in Europe equals overemployment in America. Let initial output in Europe be 940, and let initial output in America be 1060. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 1.5. So what is needed in Europe is an increase in European government purchases of 40. The inflationary gap in America is 60. The fiscal policy multiplier in America is 1.5. So what is needed in America is a reduction in American government purchases of 40.

Step 2 refers to the output lag. The increase in European government purchases of 40 causes an increase in European output of 60. As a side effect, it causes an increase in American output of 20. The reduction in American government purchases of 40 causes a decline in American output of 60. As a side effect, it causes a decline in European output of 20. The net effect is an increase in European output of 40 and a decline in American output of equally 40. As a consequence, European output goes from 940 to 980, and American output goes from 1060 to 1020.

Step 3 refers to the policy response. The output gap in Europe is 20. The fiscal policy multiplier in Europe is 1.5. So what is needed in Europe is an increase in European government purchases of 13.3. The inflationary gap in America is 20. The fiscal policy multiplier in America is 1.5. So what is needed in America is a reduction in American government purchases of 13.3.

Step 4 refers to the output lag. The increase in European government purchases of 13.3 causes an increase in European output of 20. As a side effect, it causes an increase in American output of 6.7. The reduction in American government purchases of 13.3 causes a decline in American output of 20. As a side effect, it causes a decline in European output of 6.7. The net effect is an increase in European output of 13.3 and decline in American output of equally 13.3. As a consequence, European output goes from 980 to 993.3, and American output goes from 1020 to 1006.7. And so on. For a synopsis see Table 2.5.

What are the dynamic characteristics? There are repeated increases in European government purchases. There are repeated cuts in American government purchases. There are repeated increases in European output. There are repeated cuts in American output. In each round, in absolute values, the gap declines by 67 percent.

Taking the sum over all periods, the increase in European government purchases is 60, and the reduction in American government purchases is equally 60. The total increase in European government purchases is large, as compared to the initial output gap in Europe of 60. Correspondingly, the total reduction in American government purchases is large, as compared to the initial inflationary gap in America of 60. The effective multiplier in Europe is $60/60 = 1$, and the effective multiplier in America is equally $60/60 = 1$. That means, the effective multiplier in Europe is small. And the same is true of the effective multiplier in America.

4) Comparing imperfect capital mobility with perfect capital mobility. Under perfect capital mobility, fiscal competition does not lead to full employment. Under imperfect capital mobility, by contrast, fiscal competition does lead to full employment.

Table 2.5
Fiscal Competition between Europe and America
 Imperfect Capital Mobility

	Europe	America
Initial Output	940	1060
Change in Government Purchases	40	- 40
Output	980	1020
Change in Government Purchases	13.3	- 13.3
Output	993.3	1006.7
<i>and so on</i>	...	...

2. Fiscal Cooperation between Europe and America

2.1. The Model

1) Introduction. As a starting point, take the output model. It can be represented by a system of two equations:

$$Y_1 = A_1 + \gamma G_1 + \delta G_2 \quad (1)$$

$$Y_2 = A_2 + \gamma G_2 + \delta G_1 \quad (2)$$

Here Y_1 denotes European output, Y_2 is American output, G_1 is European government purchases, and G_2 is American government purchases. The endogenous variables are European output and American output. At the beginning there is unemployment in both Europe and America. The targets of fiscal cooperation are full employment in Europe and full employment in

America. The instruments of fiscal cooperation are European government purchases and American government purchases. So there are two targets and two instruments.

2) The policy model. On this basis, the policy model can be characterized by a system of two equations:

$$\bar{Y}_1 = A_1 + \gamma G_1 + \delta G_2 \quad (3)$$

$$\bar{Y}_2 = A_2 + \gamma G_2 + \delta G_1 \quad (4)$$

Here \bar{Y}_1 denotes full-employment output in Europe, and \bar{Y}_2 denotes full-employment output in America. The endogenous variables are European government purchases and American government purchases.

To simplify notation, we introduce $B_1 = \bar{Y}_1 - A_1$ and $B_2 = \bar{Y}_2 - A_2$. Then we solve the model for the endogenous variables:

$$G_1 = \frac{\gamma B_1 - \delta B_2}{\gamma^2 - \delta^2} \quad (5)$$

$$G_2 = \frac{\gamma B_2 - \delta B_1}{\gamma^2 - \delta^2} \quad (6)$$

Equation (5) shows the required level of European government purchases, and equation (6) shows the required level of American government purchases. There is a solution if and only if $\gamma \neq \delta$. Due to the assumption $\gamma > \delta$, this condition is met. As a result, fiscal cooperation between Europe and America can achieve full employment in Europe and America. It is worth pointing out here that the solution to fiscal cooperation is identical to the steady state of fiscal competition.

3) Another version of the policy model. As an alternative, the policy model can be stated in terms of the initial output gap and the required increase in government purchases. Taking differences in equations (1) and (2), the policy model can be written as follows:

$$\Delta Y_1 = \gamma \Delta G_1 + \delta \Delta G_2 \quad (7)$$

$$\Delta Y_2 = \gamma \Delta G_2 + \delta \Delta G_1 \quad (8)$$

Here ΔY_1 denotes the initial output gap in Europe, ΔY_2 is the initial output gap in America, ΔG_1 is the required increase in European government purchases, and ΔG_2 is the required increase in American government purchases. The endogenous variables are ΔG_1 and ΔG_2 . The solution to the system (7) and (8) is:

$$\Delta G_1 = \frac{\gamma \Delta Y_1 - \delta \Delta Y_2}{\gamma^2 - \delta^2} \quad (9)$$

$$\Delta G_2 = \frac{\gamma \Delta Y_2 - \delta \Delta Y_1}{\gamma^2 - \delta^2} \quad (10)$$

According to equation (9), the required increase in European government purchases depends on the initial output gap in Europe, the initial output gap in America, the direct multiplier γ , and the cross multiplier δ . The larger the initial output gap in Europe, the larger is the required increase in European government purchases. Moreover, the larger the initial output gap in America, the smaller is the required increase in European government purchases. At first glance this comes as a surprise. According to equation (10), the required increase in American government purchases depends on the initial output gap in America, the initial output gap in Europe, the direct multiplier γ , and the cross multiplier δ .

2.2. Some Numerical Examples

To illustrate the policy model, have a look at some numerical examples. For ease of exposition, without losing generality, assume $\gamma = 1.5$ and $\delta = 0.5$. On this assumption, the output model can be written as follows:

$$Y_1 = A_1 + 1.5G_1 + 0.5G_2 \quad (1)$$

$$Y_2 = A_2 + 1.5G_2 + 0.5G_1 \quad (2)$$

The endogenous variables are European output and American output. Evidently, an increase in European government purchases of 100 causes an increase in European output of 150 and an increase in American output of 50. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

It proves useful to consider five distinct cases:

- unemployment in Europe equals unemployment in America
- unemployment in Europe exceeds unemployment in America
- unemployment in Europe, full employment in America
- unemployment in Europe exceeds overemployment in America
- unemployment in Europe equals overemployment in America.

1) Unemployment in Europe equals unemployment in America. Let initial output in Europe be 940, and let initial output in America be the same. The output gap in Europe is 60, as is the output gap in America. So what is needed, according to equations (9) and (10) from the preceding section, is an increase in European government purchases of 30 and an increase in American government purchases of equally 30. The increase in European government purchases of 30 raises European output by 45 and American output by 15. The increase in American government purchases of 30 raises American output by 45 and European output by 15. The total effect is an increase in European output of 60 and an increase in American output of equally 60. As a consequence, European output goes from 940 to 1000, as does American output. In Europe there is now full employment, and the same holds for America. As a result, fiscal cooperation can achieve full employment.

The required increase in European government purchases is small, as compared to the initial output gap in Europe. And the same applies to the required increase in American government purchases, as compared to the initial output gap in America. The effective multiplier in Europe is $60/30 = 2$, as is the effective multiplier in America. That is to say, the effective multiplier in Europe

is large. And the same is true of the effective multiplier in America. Table 2.6 presents a synopsis.

2) Unemployment in Europe exceeds unemployment in America. Let initial output in Europe be 940, and let initial output in America be 970. The output gap in Europe is 60, and the output gap in America is 30. So what is needed, according to equations (9) and (10) from the previous section, is an increase in European government purchases of 37.5 and an increase in American government purchases of 7.5. The increase in European government purchases of 37.5 raises European output by 56.25 and American output by 18.75. The increase in American government purchases of 7.5 raises American output by 11.25 and European output by 3.75. The total effect is an increase in European output of 60 and an increase in American output of 30. As a consequence, European output goes from 940 to 1000, and American output goes from 970 to 1000. In Europe there is now full employment, and the same holds for America. As a result, fiscal cooperation can achieve full employment.

The required increase in European government purchases is small, as compared to the initial output gap in Europe. And the required increase in American government purchases is even smaller, as compared to the initial output gap in America. The effective multiplier in Europe is $60/37.5 = 1.6$, and the effective multiplier in America is $30/7.5 = 4$. That means, the effective multiplier in Europe is large, and the effective multiplier in America is even larger. Table 2.7 gives an overview.

3) Unemployment in Europe, full employment in America. Let initial output in Europe be 940, and let initial output in America be 1000. The output gap in Europe is 60, and the output gap in America is zero. What is needed, then, is an increase in European government purchases of 45 and a reduction in American government purchases of 15. The increase in European government purchases of 45 raises European output by 67.5 and American output by 22.5. The reduction in American government purchases of 15 lowers American output by 22.5 and European output by 7.5. The net effect is an increase in European output of 60 and a decline in American output of zero. The effective multiplier in Europe is 1.3, and the effective multiplier in America is zero. For a synopsis see Table 2.8.

Table 2.6
Fiscal Cooperation between Europe and America
 Imperfect Capital Mobility

	Europe	America
Initial Output	940	940
Change in Government Purchases	30	30
Output	1000	1000

Table 2.7
Fiscal Cooperation between Europe and America
 Imperfect Capital Mobility

	Europe	America
Initial Output	940	970
Change in Government Purchases	37.5	7.5
Output	1000	1000

Table 2.8
Fiscal Cooperation between Europe and America
 Imperfect Capital Mobility

	Europe	America
Initial Output	940	1000
Change in Government Purchases	45	- 15
Output	1000	1000

4) Unemployment in Europe exceeds overemployment in America. Let initial output in Europe be 940, and let initial output in America be 1030. The output gap in Europe is 60, and the output gap in America is -30 . What is needed, then, is an increase in European government purchases of 52.5 and a reduction in American government purchases of 37.5. The increase in European government purchases of 52.5 raises European output by 78.75 and American output by 26.25. The reduction in American government purchases of 37.5 lowers American output by 56.25 and European output by 18.75. The net effect is an increase in European output of 60 and a decline in American output of 30. As a result, fiscal cooperation can achieve full employment.

However, the required increase in European government purchases is large, as compared to the initial output gap in Europe. And the required cut in American government purchases is even larger, as compared to the initial inflationary gap in America. The effective multiplier in Europe is 1.1, and the effective multiplier in America is 0.8. That is to say, the effective multiplier in Europe is small, and the effective multiplier in America is even smaller. For an overview see Table 2.9.

5) Unemployment in Europe equals overemployment in America. Let initial output in Europe be 940, and let initial output in America be 1060. The output gap in Europe is 60, and the output gap in America is -60 . What is needed, then, is an increase in European government purchases of 60 and a reduction in American government purchases of equally 60. The increase in European government purchases of 60 raises European output by 90 and American output by 30. The reduction in American government purchases of 60 lowers American output by 90 and European output by 30. The net effect is an increase in European output of 60 and a decline in American output of equally 60. As a result, fiscal cooperation can achieve full employment.

However, the required increase in European government purchases is large, as compared to the initial output gap in Europe. Correspondingly, the required cut in American government purchases is large, as compared to the initial inflationary gap in America. The effective multiplier in Europe is $60/60 = 1$, and the effective multiplier in America is equally $60/60 = 1$. That means, the effective multiplier in Europe is small. And the same is true of the effective multiplier in America. Table 2.10 presents a synopsis.

6) Comparing imperfect capital mobility with perfect capital mobility. Under perfect capital mobility, fiscal cooperation cannot achieve full employment. Under imperfect capital mobility, by contrast, fiscal cooperation can indeed achieve full employment.

7) Comparing fiscal cooperation with fiscal competition, given imperfect capital mobility. Fiscal competition can achieve full employment. The same applies to fiscal cooperation. Fiscal competition is a slow process. On the other hand, fiscal cooperation is a fast process. Judging from these points of view, fiscal cooperation seems to be superior to fiscal competition.

Table 2.9
Fiscal Cooperation between Europe and America
Imperfect Capital Mobility

	Europe	America
Initial Output	940	1030
Change in Government Purchases	52.5	- 37.5
Output	1000	1000

Table 2.10
Fiscal Cooperation between Europe and America
Imperfect Capital Mobility

	Europe	America
Initial Output	940	1060
Change in Government Purchases	60	- 60
Output	1000	1000

3. Monetary Competition between Europe and America

1) The static model. To illustrate this, consider a numerical example. Under perfect capital mobility, an increase in European money supply of 100 causes an increase in European output of 300 and a decline in American output of 100. So the increase in world output is 200. Under zero capital mobility, by contrast, an increase in European money supply of 100 causes an increase in European output of 200 and a decline in American output of zero. So the increase in world output is 200 again. On this basis we assume that, under imperfect capital mobility, an increase in European money supply of 100 causes an increase in European output of 250 and a decline in American output of 50. So the increase in world output is still 200.

That means, under high capital mobility, monetary spillovers are large. On the other hand, under zero capital mobility, monetary spillovers are zero. And under low capital mobility, monetary spillovers are small. What does this imply for monetary competition and monetary cooperation? Given imperfect capital mobility, is monetary competition a slow process or a fast one?

The static model can be represented by a system of two equations:

$$Y_1 = A_1 + 2.5M_1 - 0.5M_2 \quad (1)$$

$$Y_2 = A_2 + 2.5M_2 - 0.5M_1 \quad (2)$$

Obviously, an increase in European money supply of 100 causes an increase in European output of 250 and a decline in American output of 50. Correspondingly, an increase in American money supply of 100 causes an increase in American output of 250 and a decline in European output of 50. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European central bank is full employment in Europe. The European central bank raises European money supply so as to

close the output gap in Europe. The target of the American central bank is full employment in America. The American central bank raises American money supply so as to close the output gap in America. We assume that the European central bank and the American central bank decide simultaneously and independently. For the details see Chapter 1 of Part One. As a result, there is a stable steady state of monetary competition. In other words, monetary competition between Europe and America leads to full employment in Europe and America.

- 3) Some numerical examples. It proves useful to study two distinct cases:
- unemployment in Europe equals unemployment in America
 - unemployment in Europe equals overemployment in America.

First consider the case that unemployment in Europe equals unemployment in America. Let initial output in Europe be 940, and let initial output in America be the same. Step 1 refers to the policy response. The output gap in Europe is 60. The monetary policy multiplier in Europe is 2.5. So what is needed in Europe is an increase in European money supply of 24. The output gap in America is 60. The monetary policy multiplier in America is 2.5. So what is needed in America is an increase in American money supply of 24.

Step 2 refers to the output lag. The increase in European money supply of 24 causes an increase in European output of 60. As a side effect, it causes a decline in American output of 12. The increase in American money supply of 24 causes an increase in American output of 60. As a side effect, it causes a decline in European output of 12. The net effect is an increase in European output of 48 and an increase in American output of equally 48. As a consequence, European output goes from 940 to 988, as does American output. And so on.

Table 2.11 shows the process of monetary competition between Europe and America. In each round, the output gap declines by 80 percent. This clearly differs from the conclusions drawn under perfect capital mobility. There, in each round, the output gap declined by 67 percent. As a result, under low capital mobility, monetary competition is a fast process. By contrast, under high capital mobility, monetary competition is a slow process. Taking the sum over all periods, the increase in European money supply is 30, as is the increase in

American money supply. This confirms the conclusions drawn under perfect capital mobility.

Table 2.11
Monetary Competition between Europe and America
 Imperfect Capital Mobility

	Europe	America
Initial Output	940	940
Change in Money Supply	24	24
Output	988	988
Change in Money Supply	4.8	4.8
Output	997.6	997.6
<i>and so on</i>	...	...

Second consider the case that unemployment in Europe equals overemployment in America. Let initial output in Europe be 940, and let initial output in America be 1060. Step 1 refers to the policy response. The output gap in Europe is 60. The monetary policy multiplier in Europe is 2.5. So what is needed in Europe is an increase in European money supply of 24. The inflationary gap in America is 60. The monetary policy multiplier in America is 2.5. So what is needed in America is a reduction in American money supply of 24.

Step 2 refers to the output lag. The increase in European money supply of 24 causes an increase in European output of 60. As a side effect, it causes a decline in American output of 12. The reduction in American money supply of 24 causes a decline in American output of 60. As a side effect, it causes an increase in European output of 12. The total effect is an increase in European output of 72 and a decline in American output of equally 72. As a consequence, European

output goes from 940 to 1012, and American output goes from 1060 to 988. And so on.

Table 2.12 shows the process of monetary competition. In each round, in absolute values, the output gap declines by 80 percent. This clearly differs from the conclusions drawn under perfect capital mobility. There, in each round, the output gap declined by 67 percent. As a result, under low capital mobility, monetary competition is a fast process. By contrast, under high capital mobility, monetary competition is a slow process. Taking the sum over all periods, the increase in European money supply is 20, and the reduction in American money supply is equally 20. Again, this clearly differs from the conclusions drawn under perfect capital mobility. There the total increase in European money supply was 15, and the total reduction in American money supply was equally 15.

Table 2.12
Monetary Competition between Europe and America
 Imperfect Capital Mobility

	Europe	America
Initial Output	940	1060
Change in Money Supply	24	- 24
Output	1012	988
Change in Money Supply	- 4.8	4.8
Output	997.6	1002.4
<i>and so on</i>	...	...

4) Summary. Imperfect capital mobility speeds up the process of monetary competition. On the other hand, imperfect capital mobility can increase the total change in money supply.

5) Comparing monetary competition with fiscal competition. Monetary competition leads to full employment. The same is true of fiscal competition. Monetary competition is a relatively fast process. By contrast, fiscal competition is a relatively slow process. Judging from this perspective, monetary competition seems to be superior to fiscal competition.

4. Monetary Cooperation between Europe and America

It proves useful to consider two distinct cases:

- unemployment in Europe equals unemployment in America
- unemployment in Europe equals overemployment in America.

1) Unemployment in Europe equals unemployment in America. Let initial output in Europe be 940, and let initial output in America be the same. What is needed, then, is an increase in European money supply of 30 and an increase in American money supply of equally 30. This confirms the conclusions reached under perfect capital mobility. Table 2.13 presents a synopsis.

2) Unemployment in Europe equals overemployment in America. Let initial output in Europe be 940, and let initial output in America be 1060. What is needed, then, is an increase in European money supply of 20 and a reduction in American money supply of equally 20. This clearly differs from the conclusions reached under perfect capital mobility. What was needed, there, was an increase in European money supply of 15 and a reduction in American money supply of equally 15. As a result, what is needed under low capital mobility, is a large change in money supply. By contrast, what is needed under high capital mobility, is a small change in money supply. Table 2.14 gives an overview.

3) Comparing monetary cooperation with fiscal cooperation. Fiscal cooperation can achieve full employment. The same is true of monetary cooperation. Fiscal cooperation is a fast process. The same is true of monetary cooperation. Fiscal cooperation can require large changes in government

purchases. On the other hand, monetary cooperation cannot require any changes in government purchases. Judging from these points of view, monetary cooperation seems to be superior to fiscal cooperation.

Table 2.13**Monetary Cooperation between Europe and America**

Imperfect Capital Mobility

	Europe	America
Initial Output	940	940
Change in Money Supply	30	30
Output	1000	1000

Table 2.14**Monetary Cooperation between Europe and America**

Imperfect Capital Mobility

	Europe	America
Initial Output	940	1060
Change in Money Supply	20	- 20
Output	1000	1000

5. Monetary and Fiscal Cooperation

1) The model. This section deals with cooperation between the European central bank, the American central bank, the European government, and the American government. As a starting point, take the output model. It can be represented by a system of two equations:

$$Y_1 = A_1 + \alpha M_1 - \beta M_2 + \gamma G_1 + \delta G_2 \quad (1)$$

$$Y_2 = A_2 + \alpha M_2 - \beta M_1 + \gamma G_2 + \delta G_1 \quad (2)$$

According to equation (1), European output is determined by European money supply, American money supply, European government purchases, and American government purchases. According to equation (2), American output is determined by American money supply, European money supply, American government purchases, and European government purchases. Here α , β , γ and δ are positive coefficients with $\alpha > \beta$ and $\gamma > \delta$. An increase in European money supply raises European output but lowers American output. An increase in European government purchases raises both European output and American output.

At the beginning there is unemployment in Europe as well as America. The targets of policy cooperation are full employment in Europe and full employment in America. The instruments of policy cooperation are European money supply, American money supply, European government purchases, and American government purchases. There are two targets and four instruments, so there are two degrees of freedom. As a result, there is an infinite number of solutions. In other words, monetary and fiscal cooperation can achieve full employment in Europe and America.

On this basis, the policy model can be characterized by a system of two equations:

$$\bar{Y}_1 = A_1 + \alpha M_1 - \beta M_2 + \gamma G_1 + \delta G_2 \quad (3)$$

$$\bar{Y}_2 = A_2 + \alpha M_2 - \beta M_1 + \gamma G_2 + \delta G_1 \quad (4)$$

Here \bar{Y}_1 denotes full-employment output in Europe, and \bar{Y}_2 denotes full-employment output in America. The endogenous variables are European money supply, American money supply, European government purchases, and American government purchases.

Of course there are many more potential targets of policy cooperation:

- balancing the budget in Europe
- balancing the budget in America
- balancing the current account in Europe and America
- high investment in Europe
- high investment in America
- preventing foreign exchange bubbles
- preventing stock market bubbles
- and so on.

To sum up, in a sense, policy instruments are abundant. And in another sense, policy instruments are scarce.

2) A numerical example. For ease of exposition, without losing generality, assume $\alpha = 2.5$, $\beta = 0.5$, $\gamma = 1.5$ and $\delta = 0.5$. On this assumption, the output model can be written as follows:

$$Y_1 = A_1 + 2.5M_1 - 0.5M_2 + 1.5G_1 + 0.5G_2 \quad (5)$$

$$Y_2 = A_2 + 2.5M_2 - 0.5M_1 + 1.5G_2 + 0.5G_1 \quad (6)$$

Evidently, an increase in European money supply of 100 causes an increase in European output of 250 and a decline in American output of 50. An increase in European government purchases of 100 causes an increase in European output of 150 and an increase in American output of 50. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

Let initial output in Europe be 940, and let initial output in America be the same. The output gap in Europe is 60, as is the output gap in America. What is needed, for instance, is an increase in European money supply of 20, an increase

in American money supply of equally 20, an increase in European government purchases of 10, and an increase in American government purchases of equally 10. The increase in European money supply of 20 raises European output by 50 and lowers American output by 10. Correspondingly, the increase in American money supply of 20 raises American output by 50 and lowers European output by 10. The increase in European government purchases of 10 raises European output by 15 and American output by 5. Correspondingly, the increase in American government purchases of 10 raises American output by 15 and European output by 5.

The total effect is an increase in European output of 60 and an increase in American output of equally 60. As a consequence, European output goes from 940 to 1000, as does American output. In Europe there is now full employment, and the same holds for America. As a result, monetary and fiscal cooperation can achieve full employment. Table 2.15 presents a synopsis.

Table 2.15
Monetary and Fiscal Cooperation
 Imperfect Capital Mobility

	Europe	America
Initial Output	940	940
Change in Money Supply	20	20
Change in Government Purchases	10	10
Output	1000	1000

Chapter 3

High Capital Mobility

1. Fiscal Competition between Europe and America

To illustrate high capital mobility, have a look at some numerical examples. For ease of exposition, without loss of generality, assume $\gamma = 1.2$ and $\delta = 0.8$. On this assumption, the static model can be written as follows:

$$Y_1 = A_1 + 1.2G_1 + 0.8G_2 \quad (1)$$

$$Y_2 = A_2 + 1.2G_2 + 0.8G_1 \quad (2)$$

Obviously, an increase in European government purchases of 100 causes an increase in European output of 120 and an increase in American output of 80. In the same way, an increase in American government purchases of 100 causes an increase in American output of 120 and an increase in European output of 80. That means, under high capital mobility, fiscal spillovers are large. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

It proves useful to study two distinct cases:

- unemployment in Europe equals unemployment in America
- unemployment in Europe equals overemployment in America.

1) Unemployment in Europe equals unemployment in America. Let initial output in Europe be 940, and let initial output in America be the same. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 1.2. So what is needed in Europe is an increase in European government purchases of 50. The output gap in America is 60. The fiscal policy multiplier in America is 1.2. So what is needed in America is an increase in American government purchases of 50.

Step 2 refers to the output lag. The increase in European government purchases of 50 causes an increase in European output of 60. As a side effect, it causes an increase in American output of 40. The increase in American government purchases of 50 causes an increase in American output of 60. As a side effect, it causes an increase in European output of 40. The total effect is an increase in European output of 100 and an increase in American output of equally 100. As a consequence, European output goes from 940 to 1040, as does American output. And so on.

Table 2.16 shows the process of fiscal competition between Europe and America. In each round, the output gap declines by 33 percent. This clearly differs from the conclusions drawn under low capital mobility. There, in each round, the output gap declined by 67 percent. As a result, under high capital mobility, fiscal competition is a relatively slow process. By contrast, under low capital mobility, fiscal competition is a relatively fast process.

Table 2.16
Fiscal Competition between Europe and America
 High Capital Mobility

	Europe	America
Initial Output	940	940
Change in Government Purchases	50	50
Output	1040	1040
Change in Government Purchases	- 33.3	- 33.3
Output	973.3	973.3
<i>and so on</i>	...	...

Taking the sum over all periods, the increase in European government purchases is 30, as is the increase in American government purchases. That is to say, the total increase in European government purchases is small, as compared

to the initial output gap in Europe of 60. And the same applies to the total increase in American government purchases, as compared to the initial output gap in America of 60. The effective multiplier in Europe is $60 / 30 = 2$, as is the effective multiplier in America. In other words, the effective multiplier in Europe is large. And the same holds for the effective multiplier in America. This confirms the conclusions drawn under low capital mobility.

2) Unemployment in Europe equals overemployment in America. Let initial output in Europe be 940, and let initial output in America be 1060. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 1.2. So what is needed in Europe is an increase in European government purchases of 50. The inflationary gap in America is 60. The fiscal policy multiplier in America is 1.2. So what is needed in America is a reduction in American government purchases of 50.

Step 2 refers to the output lag. The increase in European government purchases of 50 causes an increase in European output of 60. As a side effect, it causes an increase in American output of 40. The reduction in American government purchases of 50 causes a decline in American output of 60. As a side effect, it causes a decline in European output of 40. The net effect is an increase in European output of 20 and a decline in American output of equally 20. As a consequence, European output goes from 940 to 960, and American output goes from 1060 to 1040. And so on.

Table 2.17 shows the process of fiscal competition. In each round, in absolute values, the output gap declines by 33 percent. This clearly differs from the conclusions drawn under low capital mobility. There, in each round, the output gap declined by 67 percent. As a result, under high capital mobility, fiscal competition is a relatively slow process. By contrast, under low capital mobility, fiscal competition is a relatively fast process.

Taking the sum over all periods, the increase in European government purchases is 150, and the reduction in American government purchases is equally 150. The total increase in European government purchases is very large, as compared to the initial output gap in Europe of 60. Correspondingly, the total reduction in American government purchases is very large, as compared to the initial inflationary gap in America of 60. The effective multiplier in Europe is

$60/150 = 0.4$, and the effective multiplier in America is equally $60/150 = 0.4$. That means, the effective multiplier in Europe is very small. And the same is true of the effective multiplier in America. Again, this clearly differs from the conclusions drawn under low capital mobility. There the total increase in European government purchases was 60, and the total reduction in American government purchases was equally 60.

Table 2.17
Fiscal Competition between Europe and America
 High Capital Mobility

	Europe	America
Initial Output	940	1060
Change in Government Purchases	50	- 50
Output	960	1040
Change in Government Purchases	33.3	- 33.3
Output	973.3	1026.7
<i>and so on</i>	...	...

3) Summary. High capital mobility slows down the process of fiscal competition. And what is more, high capital mobility can increase the total change in government purchases.

2. Fiscal Cooperation between Europe and America

An increase in European government purchases of 100 causes an increase in European output of 120 and an increase in American output of 80. Likewise, an increase in American government purchases of 100 causes an increase in American output of 120 and an increase in European output of 80. It proves useful to consider two distinct cases:

- unemployment in Europe equals unemployment in America
- unemployment in Europe equals overemployment in America.

1) Unemployment in Europe equals unemployment in America. Let initial output in Europe be 940, and let initial output in America be the same. The output gap in Europe is 60, as is the output gap in America. What is needed, then, is an increase in European government purchases of 30 and an increase in American government purchases of equally 30. The increase in European government purchases of 30 raises European output by 36 and American output by 24. The increase in American government purchases of 30 raises American output by 36 and European output by 24. The total effect is an increase in European output of 60 and an increase in American output of equally 60. As a consequence, European output goes from 940 to 1000, as does American output. In Europe there is now full employment, and the same holds for America. As a result, fiscal cooperation can achieve full employment.

The required increase in European government purchases is small, as compared to the initial output gap in Europe. And the same applies to the required increase in American government purchases, as compared to the initial output gap in America. The effective multiplier in Europe is $60 / 30 = 2$, as is the effective multiplier in America. That is to say, the effective multiplier in Europe is large. And the same is true of the effective multiplier in America. Table 2.18 presents a synopsis.

Table 2.18
Fiscal Cooperation between Europe and America
 High Capital Mobility

	Europe	America
Initial Output	940	940
Change in Government Purchases	30	30
Output	1000	1000

2) Unemployment in Europe equals overemployment in America. Let initial output in Europe be 940, and let initial output in America be 1060. The output gap in Europe is 60, and the inflationary gap in America is equally 60. What is needed, then, is an increase in European government purchases of 150 and a reduction in American government purchases of equally 150. The increase in European government purchases of 150 raises European output by 180 and American output by 120. The reduction in American government purchases of 150 lowers American output by 180 and European output by 120. The net effect is an increase in European output of 60 and a decline in American output of equally 60. As a consequence, European output goes from 940 to 1000, and American output goes from 1060 to 1000. In Europe there is now full employment, and the same holds for America. As a result, fiscal cooperation can achieve full employment.

However, the required increase in European government purchases is very large, as compared to the initial output gap in Europe. Correspondingly, the required cut in American government purchases is very large, as compared to the initial inflationary gap in America. The effective multiplier in Europe is $60/150 = 0.4$. That means, the effective multiplier in Europe is very small. And the same is true of the effective multiplier in America. This clearly differs from the conclusions drawn under low capital mobility. What was needed, there, was an increase in European government purchases of 60 and a reduction in American government purchases of equally 60. As a result, under high capital mobility, the required change in government purchases is very large. By contrast,

under low capital mobility, the required change in government purchases is just large. Table 2.19 gives an overview.

Table 2.19
Fiscal Cooperation between Europe and America
High Capital Mobility

	Europe	America
Initial Output	940	1060
Change in Government Purchases	150	- 150
Output	1000	1000

Chapter 4

Gradualist Policies

1. Fiscal Competition between Europe and America

So far we have assumed that the governments follow a cold-turkey strategy. Now we assume that the governments follow a gradualist strategy. Besides we assume imperfect capital mobility between Europe and America. As a point of reference, consider the static model. It can be represented by a system of two equations:

$$Y_1 = A_1 + 1.5G_1 + 0.5G_2 \quad (1)$$

$$Y_2 = A_2 + 1.5G_2 + 0.5G_1 \quad (2)$$

Obviously, an increase in European government purchases of 100 causes an increase in European output of 150 and an increase in American output of 50. Correspondingly, an increase in American government purchases of 100 causes an increase in American output of 150 and an increase in European output of 50. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

At the beginning there is unemployment in Europe and America. The general target of the European government is full employment in Europe. We assume that the European government follows a gradualist strategy. The specific target of the European government is to close the output gap in Europe by the fraction λ_1 . The general target of the American government is full employment in America. We assume that the American government follows a gradualist strategy. The specific target of the American government is to close the output gap in America by the fraction λ_2 . We assume that the European government and the American government decide simultaneously and independently. Under a gradualist strategy, is fiscal competition a slow process or a fast one? Surprisingly, the answer depends upon initial conditions.

It proves useful to study two distinct cases:

- unemployment in Europe equals unemployment in America
- unemployment in Europe equals overemployment in America.

1) Unemployment in Europe equals unemployment in America. We assume $\lambda_1 = \lambda_2 = 0.6$. That means, the governments close the output gaps by 60 percent. Let initial output in Europe be 940, and let initial output in America be the same. Step 1 refers to the policy response. First consider fiscal policy in Europe. The output gap in Europe is 60. The specific target of the European government is to close the output gap in Europe by 60 percent, that is by 36. The fiscal policy multiplier in Europe is 1.5. So what is needed in Europe is an increase in European government purchases of 24. Second consider fiscal policy in America. The output gap in America is 60. The specific target of the American government is to close the output gap in America by 60 percent, that is by 36. The fiscal policy multiplier in America is 1.5. So what is needed in America is an increase in American government purchases of 24.

Step 2 refers to the output lag. The increase in European government purchases of 24 causes an increase in European output of 36. As a side effect, it causes an increase in American output of 12. The increase in American government purchases of 24 causes an increase in American output of 36. As a side effect, it causes an increase in European output of 12. The total effect is an increase in European output of 48 and an increase in American output of equally 48. As a consequence, European output goes from 940 to 988, as does American output.

Step 3 refers to the policy response. First consider fiscal policy in Europe. The output gap in Europe is 12. The specific target of the European government is to close the output gap in Europe by 60 percent, that is by 7.2. The fiscal policy multiplier in Europe is 1.5. So what is needed in Europe is an increase in European government purchases of 4.8. Second consider fiscal policy in America. The output gap in America is 12. The specific target of the American government is to close the output gap in America by 60 percent, that is by 7.2. The fiscal policy multiplier in America is 1.5. So what is needed in America is an increase in American government purchases of 4.8.

Step 4 refers to the output lag. The increase in European government purchases of 4.8 causes an increase in European output of 7.2. As a side effect, it causes an increase in American output of 2.4. The increase in American government purchases of 4.8 causes an increase in American output of 7.2. As a side effect, it causes an increase in European output of 2.4. The total effect is an increase in European output of 9.6 and an increase in American output of equally 9.6. As a consequence, European output goes from 988 to 997.6, as does American output. And so on. Table 2.20 presents a synopsis.

What are the dynamic characteristics of this process? In each round, the output gap declines by 80 percent. This clearly differs from the conclusions drawn under a cold-turkey strategy. There, in each round, the output gap declined by 67 percent. As a result, under a gradualist strategy, fiscal competition is a relatively fast process. By contrast, under a cold-turkey strategy, fiscal competition is a relatively slow process. At first glance this comes as a surprise. Moreover, under a gradualist strategy, there are repeated increases in output. On the other hand, under a cold-turkey strategy, there are oscillations in output. Taking the sum over all periods, the increase in European government purchases is 30, as is the increase in American government purchases. This confirms the conclusions drawn under a cold-turkey strategy.

Table 2.20
Fiscal Competition between Europe and America
 Gradualist Policies

	Europe	America
Initial Output	940	940
Change in Government Purchases	24	24
Output	988	988
Change in Government Purchases	4.8	4.8
Output	997.6	997.6
<i>and so on</i>	...	...

2) Unemployment in Europe equals overemployment in America. We assume $\lambda_1 = \lambda_2 = 0.5$. That is to say, the governments close the output gaps by 50 percent. Let initial output in Europe be 940, and let initial output in America be 1060. Step 1 refers to the policy response. First consider fiscal policy in Europe. The output gap in Europe is 60. The specific target of the European government is to close the output gap in Europe by 50 percent, that is by 30. The fiscal policy multiplier in Europe is 1.5. So what is needed in Europe is an increase in European government purchases of 20. Second consider fiscal policy in America. The inflationary gap in America is 60. The specific target of the American government is to close the inflationary gap in America by 50 percent, that is by 30. The fiscal policy multiplier in America is 1.5. So what is needed in America is a reduction in American government purchases of 20.

Step 2 refers to the output lag. The increase in European government purchases of 20 causes an increase in European output of 30. As a side effect, it causes an increase in American output of 10. The reduction in American government purchases of 20 causes a decline in American output of 30. As a side effect, it causes a decline in European output of 10. The net effect is an increase in European output of 20 and a decline in American output of equally 20. As a consequence, European output goes from 940 to 960, and American output goes from 1060 to 1040.

Step 3 refers to the policy response. First consider fiscal policy in Europe. The output gap in Europe is 40. The specific target of the European government is to close the output gap in Europe by 50 percent, that is by 20. The fiscal policy multiplier in Europe is 1.5. So what is needed in Europe is an increase in European government purchases of 13.3. Second consider fiscal policy in America. The inflationary gap in America is 40. The specific target of the American government is to close the inflationary gap in America by 50 percent, that is by 20. The fiscal policy multiplier in America is 1.5. So what is needed in America is a reduction in American government purchases of 13.3.

Step 4 refers to the output lag. The increase in European government purchases of 13.3 causes an increase in European output of 20. As a side effect, it causes an increase in American output of 6.7. The reduction in American government purchases of 13.3 causes a decline in American output of 20. As a side effect, it causes a decline in European output of 6.7. The net effect is an

increase in European output of 13.3 and a decline in American output of equally 13.3. As a consequence, European output goes from 960 to 973.3, and American output goes from 1040 to 1026.7. And so on. Table 2.21 gives an overview.

What are the dynamic characteristics? In each round, in absolute values, the output gap declines by 33 percent. This clearly differs from the conclusions reached under a cold-turkey strategy. There, in each round, the output gap declined by 67 percent. As a result, under a gradualist strategy, fiscal competition is a relatively slow process. By contrast, under a cold-turkey strategy, fiscal competition is a relatively fast process. Under a gradualist strategy, there are repeated increases in European output, and there are repeated cuts in American output. Taking the sum over all periods, the increase in European government purchases is 60, and the reduction in American government purchases is equally 60. This confirms the conclusions reached under a cold-turkey strategy.

3) Summary. A gradualist strategy can speed up or slow down the process of fiscal competition, depending upon initial conditions. And what is more, a gradualist strategy can prevent output from oscillating.

Table 2.21
Fiscal Competition between Europe and America
 Gradualist Policies

	Europe	America
Initial Output	940	1060
Change in Government Purchases	20	- 20
Output	960	1040
Change in Government Purchases	13.3	- 13.3
Output	973.3	1026.7
<i>and so on</i>	...	...

2. Monetary Competition between Europe and America

So far we have assumed that the central banks follow a cold-turkey strategy. Now we assume that the central banks follow a gradualist strategy. Besides we assume perfect capital mobility between Europe and America. As a point of departure, consider the static model. It can be represented by a system of two equations:

$$Y_1 = A_1 + 3M_1 - M_2 \quad (1)$$

$$Y_2 = A_2 + 3M_2 - M_1 \quad (2)$$

Evidently, an increase in European money supply of 100 causes an increase in European output of 300 and a decline in American output of 100. Correspondingly, an increase in American money supply of 100 causes an increase in American output of 300 and a decline in European output of 100. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

At the start there is unemployment in Europe and America. The general target of the European central bank is full employment in Europe. We assume that the European central bank follows a gradualist strategy. The specific target of the European central bank is to close the output gap in Europe by the fraction μ_1 . The general target of the American central bank is full employment in America. We assume that the American central bank follows a gradualist strategy. The specific target of the American central bank is to close the output gap in America by the fraction μ_2 . We assume that the European central bank and the American central bank decide simultaneously and independently. Under a gradualist strategy, is monetary competition a slow process or a fast one? Surprisingly, the answer depends upon initial conditions.

It proves useful to study two distinct cases:

- unemployment in Europe equals unemployment in America
- unemployment in Europe equals overemployment in America.

1) Unemployment in Europe equals unemployment in America. We assume $\mu_1 = \mu_2 = 0.5$. That means, the central banks close the output gaps by 50 percent. Let initial output in Europe be 940, and let initial output in America be the same. Step 1 refers to the policy response. First consider monetary policy in Europe. The output gap in Europe is 60. The specific target of the European central bank is to close the output gap in Europe by 50 percent, that is by 30. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 10. Second consider monetary policy in America. The output gap in America is 60. The specific target of the American central bank is to close the output gap in America by 50 percent, that is by 30. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 10.

Step 2 refers to the output lag. The increase in European money supply of 10 causes an increase in European output of 30. As a side effect, it causes a decline in American output of 10. The increase in American money supply of 10 causes an increase in American output of 30. As a side effect, it causes a decline in European output of 10. The net effect is an increase in European output of 20 and an increase in American output of equally 20. As a consequence, European output goes from 940 to 960, as does American output.

Step 3 refers to the policy response. First consider monetary policy in Europe. The output gap in Europe is 40. The specific target of the European central bank is to close the output gap in Europe by 50 percent, that is by 20. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 6.7. Second consider monetary policy in America. The output gap in America is 40. The specific target of the American central bank is to close the output gap in America by 50 percent, that is by 20. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 6.7.

Step 4 refers to the output lag. The increase in European money supply of 6.7 causes an increase in European output of 20. As a side effect, it causes a decline in American output of 6.7. The increase in American money supply of 6.7 causes an increase in American output of 20. As a side effect, it causes a decline in European output of 6.7. The net effect is an increase in European output of 13.3 and an increase in American output of equally 13.3. As a consequence, European

output goes from 960 to 973.3, as does American output. And so on. For a synopsis see Table 2.22.

What are the dynamic characteristics of this process? In each round, the output gap declines by 33 percent. This clearly differs from the conclusions drawn under a cold-turkey strategy. There, in each round, the output gap declined by 67 percent. As a result, under a gradualist strategy, monetary competition is a relatively slow process. By contrast, under a cold-turkey strategy, monetary competition is a relatively fast process. Taking the sum over all periods, the increase in European money supply is 30, as is the increase in American money supply. This confirms the conclusions drawn under a cold-turkey strategy.

Table 2.22

Monetary Competition between Europe and America

Gradualist Policies

	Europe	America
Initial Output	940	940
Change in Money Supply	10	10
Output	960	960
Change in Money Supply	6.7	6.7
Output	973.3	973.3
<i>and so on</i>	...	...

2) Unemployment in Europe equals overemployment in America. We assume $\mu_1 = \mu_2 = 0.6$. That is to say, the central banks close the output gaps by 60 percent. Let initial output in Europe be 940, and let initial output in America be 1060. Step 1 refers to the policy response. First consider monetary policy in Europe. The output gap in Europe is 60. The specific target of the European central bank is to close the output gap in Europe by 60 percent, that is by 36. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an

increase in European money supply of 12. Second consider monetary policy in America. The inflationary gap in America is 60. The specific target of the American central bank is to close the inflationary gap in America by 60 percent, that is by 36. The monetary policy multiplier in America is 3. So what is needed in America is a reduction in American money supply of 12.

Step 2 refers to the output lag. The increase in European money supply of 12 causes an increase in European output of 36. As a side effect, it causes a decline in American output of 12. The reduction in American money supply of 12 causes a decline in American output of 36. As a side effect, it causes an increase in European output of 12. The total effect is an increase in European output of 48 and a decline in American output of equally 48. As a consequence, European output goes from 940 to 988, and American output goes from 1060 to 1012.

Step 3 refers to the policy response. First consider monetary policy in Europe. The output gap in Europe is 12. The specific target of the European central bank is to close the output gap in Europe by 60 percent, that is by 7.2. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 2.4. Second consider monetary policy in America. The inflationary gap in America is 12. The specific target of the American central bank is to close the inflationary gap in America by 60 percent, that is by 7.2. The monetary policy multiplier in America is 3. So what is needed in America is a reduction in American money supply of 2.4.

Step 4 refers to the output lag. The increase in European money supply of 2.4 causes an increase in European output of 7.2. As a side effect, it causes a decline in American output of 2.4. The reduction in American money supply of 2.4 causes a decline in American output of 7.2. As a side effect, it causes an increase in European output of 2.4. The total effect is an increase in European output of 9.6 and a decline in American output of equally 9.6. As a consequence, European output goes from 988 to 997.6, and American output goes from 1012 to 1002.4. And so on. For an overview see Table 2.23.

What are the dynamic characteristics? In each round, in absolute values, the output gap declines by 80 percent. This clearly differs from the conclusions reached under a cold-turkey strategy. There, in each round, the output gap declined by 67 percent. As a result, under a gradualist strategy, monetary

competition is a relatively fast process. By contrast, under a cold-turkey strategy, monetary competition is a relatively slow process. At first glance this comes as a surprise. Moreover, under a gradualist strategy, there are repeated increases in European output, and there are repeated cuts in American output. On the other hand, under a cold-turkey strategy, there are oscillations in both European and American output. Taking the sum over all periods, the increase in European money supply is 15, and the reduction in American money supply is equally 15. This confirms the conclusions reached under a cold-turkey strategy.

3) Summary. A gradualist strategy can slow down or speed up the process of monetary competition, depending upon initial conditions. Further, a gradualist strategy can prevent output from oscillating.

Table 2.23
Monetary Competition between Europe and America
 Gradualist Policies

	Europe	America
Initial Output	940	1060
Change in Money Supply	12	- 12
Output	988	1012
Change in Money Supply	2.4	- 2.4
Output	997.6	1002.4
<i>and so on</i>	...	...

3. Monetary and Fiscal Competition

1) The static model. This section deals with competition between the European central bank, the American central bank, the European government, and the American government. We assume imperfect capital mobility between Europe and America. As a point of reference, consider the static model. It can be represented by a system of two equations:

$$Y_1 = A_1 + 2.5M_1 - 0.5M_2 + 1.5G_1 + 0.5G_2 \quad (1)$$

$$Y_2 = A_2 + 2.5M_2 - 0.5M_1 + 1.5G_2 + 0.5G_1 \quad (2)$$

Obviously, an increase in European money supply of 100 causes an increase in European output of 250 and a decline in American output of 50. An increase in European government purchases of 100 causes an increase in European output of 150 and an increase in American output of 50. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

2) The dynamic model. At the beginning there is unemployment in Europe and America. The general target of the European central bank is full employment in Europe. The specific target of the European central bank is to close the output gap in Europe by the fraction μ_1 . The general target of the American central bank is full employment in America. The specific target of the American central bank is to close the output gap in America by the fraction μ_2 . The general target of the European government is full employment in Europe. The specific target of the European government is to close the output gap in Europe by the fraction λ_1 . The general target of the American government is full employment in America. The specific target of the American government is to close the output gap in America by the fraction λ_2 . We assume that the European central bank, the American central bank, the European government, and the American government decide simultaneously and independently.

As a result, there is a stability condition. The steady state of monetary and fiscal competition is stable if the speed of adjustment in European money supply,

American money supply, European government purchases, and American government purchases is sufficiently low. Taking the sum over all periods, the increase in European money supply, American money supply, European government purchases, and American government purchases depends upon the relative speed of adjustment in European money supply, American money supply, European government purchases, and American government purchases. For the method see Carlberg (2004) p. 154.

3) A numerical example. To illustrate the dynamic model, have a look at a numerical example with $\mu_1 = 0.8$, $\mu_2 = 0.6$, $\lambda_1 = 0.2$, and $\lambda_2 = 0.4$. That means, the specific target of the European central bank is to close the output gap in Europe by 80 percent. The specific target of the American central bank is to close the output gap in America by 60 percent. The specific target of the European government is to close the output gap in Europe by 20 percent. And the specific target of the American government is to close the output gap in America by 40 percent.

Let initial output in Europe be 940, and let initial output in America be the same. Step 1 refers to the policy response. First consider monetary policy in Europe. The output gap in Europe is 60. The specific target of the European central bank is to close the output gap in Europe by 80 percent, that is by 48. The monetary policy multiplier in Europe is 2.5. So what is needed in Europe is an increase in European money supply of 19.2. Second consider monetary policy in America. The output gap in America is 60. The specific target of the American central bank is to close the output gap in America by 60 percent, that is by 36. The monetary policy multiplier in America is 2.5. So what is needed in America is an increase in American money supply of 14.4.

Third consider fiscal policy in Europe. The output gap in Europe is 60. The specific target of the European government is to close the output gap in Europe by 20 percent, that is by 12. The fiscal policy multiplier in Europe is 1.5. So what is needed in Europe is an increase in European government purchases of 8. Fourth consider fiscal policy in America. The output gap in America is 60. The specific target of the American government is to close the output gap in America by 40 percent, that is by 24. The fiscal policy multiplier in America is 1.5. So what is needed in America is an increase in American government purchases of 16.

Step 2 refers to the output lag. The increase in European money supply of 19.2 causes an increase in European output of 48. As a side effect, it causes a decline in American output of 9.6. The increase in American money supply of 14.4 causes an increase in American output of 36. As a side effect, it causes a decline in European output of 7.2. The increase in European government purchases of 8 causes an increase in European output of 12. As a side effect, it causes an increase in American output of 4. The increase in American government purchases of 16 causes an increase in American output of 24. As a side effect, it causes an increase in European output of 8. The net effect is an increase in European output of 60.8 and an increase in American output of 54.4. As a consequence, European output goes from 940 to 1000.8, and American output goes from 940 to 994.4.

Step 3 refers to the policy response. First consider monetary policy in Europe. The inflationary gap in Europe is 0.8. The specific target of the European central bank is to close the inflationary gap in Europe by 80 percent, that is by 0.64. The monetary policy multiplier in Europe is 2.5. So what is needed in Europe is a reduction in European money supply of 0.26. Second consider monetary policy in America. The output gap in America is 5.6. The specific target of the American central bank is to close the output gap in America by 60 percent, that is by 3.36. The monetary policy multiplier in America is 2.5. So what is needed in America is an increase in American money supply of 1.34.

Third consider fiscal policy in Europe. The inflationary gap in Europe is 0.8. The specific target of the European government is to close the inflationary gap in Europe by 20 percent, that is by 0.16. The fiscal policy multiplier in Europe is 1.5. So what is needed in Europe is a reduction in European government purchases of 0.11. Fourth consider fiscal policy in America. The output gap in America is 5.6. The specific target of the American government is to close the output gap in America by 40 percent, that is by 2.24. The fiscal policy multiplier in America is 1.5. So what is needed in America is an increase in American government purchases of 1.49.

Step 4 refers to the output lag. The reduction in European money supply of 0.26 causes a decline in European output of 0.64. As a side effect, it causes an increase in American output of 0.13. The increase in American money supply of

1.34 causes an increase in American output of 3.36. As a side effect, it causes a decline in European output of 0.67. The reduction in European government purchases of 0.11 causes a decline in European output of 0.16. As a side effect, it causes a decline in American output of 0.05. The increase in American government purchases of 1.49 causes an increase in American output of 2.24. As a side effect, it causes an increase in European output of 0.75. The net effect is a decline in European output of 0.72 and an increase in American output of 5.68. As a consequence, European output goes from 1000.8 to 1000.1, and American output goes from 994.4 to 1000.1. And so on. Table 2.24 presents a synopsis.

As a result, the process of monetary and fiscal competition leads to full employment in Europe and America. And what is more, monetary and fiscal competition is a fast process. Taking the sum over all periods, the increase in European money supply is 18.9, the increase in American money supply is 15.7, the increase in European government purchases in 7.9, and the increase in American government purchases is 17.5.

Table 2.24
Monetary and Fiscal Competition
 Gradualist Policies

	Europe	America
Initial Output	940	940
Change in Money Supply	19.2	19.2
Change in Government Purchases	8	8
Output	1000.8	1000.8
Change in Money Supply	- 0.3	- 0.3
Change in Government Purchases	- 0.1	- 0.1
Output	1000.1	1000.1
<i>and so on</i>	...	...

Generally speaking, the total increase in European government purchases depends on:

- the initial output gap in Europe
- the initial output gap in America
- the direct policy multipliers α and γ
- the cross policy multipliers β and δ
- the speed of adjustment in European money supply μ_1
- the speed of adjustment in American money supply μ_2
- the speed of adjustment in European government purchases λ_1
- the speed of adjustment in American government purchases λ_2 .

Part Three

The World of Two Monetary Regions

Advanced Models

Chapter 1

The Regions Differ in Policy Multipliers

1. Monetary Competition between Europe and America

1) The static model. In this section we assume that the regions differ in monetary policy multipliers. Besides we assume that the central banks follow a cold-turkey strategy. As a point of reference, consider the static model. It can be represented by a system of two equations:

$$Y_1 = A_1 + \alpha_1 M_1 - \beta_2 M_2 \quad (1)$$

$$Y_2 = A_2 + \alpha_2 M_2 - \beta_1 M_1 \quad (2)$$

According to equation (1), European output Y_1 is determined by European money supply M_1 and American money supply M_2 . According to equation (2), American output Y_2 is determined by American money supply M_2 and European money supply M_1 . Here α_1 , α_2 , β_1 and β_2 denote the monetary policy multipliers. The direct effects of monetary policy are positive $\alpha_1 > 0$ and $\alpha_2 > 0$. By contrast, the cross effects of monetary policy are negative $\beta_1 > 0$ and $\beta_2 > 0$.

An increase in European money supply raises European output but lowers American output. An increase in American money supply raises American output but lowers European output. An increase in European money supply of 1 causes an increase in European output of α_1 and a decline in American output of β_1 . An increase in American money supply of 1 causes an increase in American output of α_2 and a decline in European output of β_2 .

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European central bank is full employment in Europe. And the target of the American central bank is full employment in America. The dynamic model can be characterized by a system of two equations:

$$\bar{Y}_1 = A_1 + \alpha_1 M_1^{+1} - \beta_2 M_2 \quad (3)$$

$$\bar{Y}_2 = A_2 + \alpha_2 M_2^{+1} - \beta_1 M_1 \quad (4)$$

Here is a list of the new symbols:

\bar{Y}_1 full-employment output in Europe

\bar{Y}_2 full-employment output in America

M_1 European money supply this period

M_2 American money supply this period

M_1^{+1} European money supply next period

M_2^{+1} American money supply next period.

Here the endogenous variables are M_1^{+1} and M_2^{+1} .

According to equation (3), the European central bank raises European money supply so as to close the output gap in Europe. According to equation (4), the American central bank raises American money supply so as to close the output gap in America. We assume that the European central bank and the American central bank decide simultaneously and independently.

3) The steady state. In the steady state by definition we have:

$$M_1^{+1} = M_1 \quad (5)$$

$$M_2^{+1} = M_2 \quad (6)$$

Equation (5) has it that European money supply does not change any more. Similarly, equation (6) has it that American money supply does not change any more. Therefore the steady state of the dynamic model can be described by a system of two equations:

$$\bar{Y}_1 = A_1 + \alpha_1 M_1 - \beta_2 M_2 \quad (7)$$

$$\bar{Y}_2 = A_2 + \alpha_2 M_2 - \beta_1 M_1 \quad (8)$$

Here the endogenous variables are European money supply and American money supply.

To simplify notation, we introduce $B_1 = \bar{Y}_1 - A_1$ and $B_2 = \bar{Y}_2 - A_2$. Then we solve the model for the endogenous variables:

$$M_1 = \frac{\alpha_2 B_1 + \beta_2 B_2}{\alpha_1 \alpha_2 - \beta_1 \beta_2} \quad (9)$$

$$M_2 = \frac{\alpha_1 B_2 + \beta_1 B_1}{\alpha_1 \alpha_2 - \beta_1 \beta_2} \quad (10)$$

Equation (9) shows the steady-state level of European money supply, and equation (10) shows the steady-state level of American money supply. As a result, there is a steady state if and only if $\alpha_1 \alpha_2 \neq \beta_1 \beta_2$. That means, there is a steady state if and only if the mathematical product of the direct multipliers is unequal to the mathematical product of the cross multipliers.

As an alternative, the steady state can be represented in terms of the initial output gap and the total increase in money supply. Taking differences in equations (1) and (2), the model of the steady state can be written as follows:

$$\Delta Y_1 = \alpha_1 \Delta M_1 - \beta_2 \Delta M_2 \quad (11)$$

$$\Delta Y_2 = \alpha_2 \Delta M_2 - \beta_1 \Delta M_1 \quad (12)$$

Here ΔY_1 denotes the initial output gap in Europe, ΔY_2 is the initial output gap in America, ΔM_1 is the total increase in European money supply, and ΔM_2 is the total increase in American money supply. The endogenous variables are ΔM_1 and ΔM_2 . The solution to the system (11) and (12) is:

$$\Delta M_1 = \frac{\alpha_2 \Delta Y_1 + \beta_2 \Delta Y_2}{\alpha_1 \alpha_2 - \beta_1 \beta_2} \quad (13)$$

$$\Delta M_2 = \frac{\alpha_1 \Delta Y_2 + \beta_1 \Delta Y_1}{\alpha_1 \alpha_2 - \beta_1 \beta_2} \quad (14)$$

According to equation (13), the total increase in European money supply depends on the initial output gap in Europe, the initial output gap in America, the direct multipliers, and the cross multipliers. The larger the initial output gap in Europe,

the larger is the total increase in European money supply. Moreover, the larger the initial output gap in America, the larger is the total increase in European money supply.

4) Stability. As a point of departure, take the dynamic model. Equation (3) yields $dM_1^{+1} / dM_2 = \beta_2 / \alpha_1$, and equation (4) yields $dM_2 / dM_1^{-1} = \beta_1 / \alpha_2$. This implies:

$$\frac{dM_1^{+1}}{dM_1^{-1}} = \frac{\beta_1 \beta_2}{\alpha_1 \alpha_2} \quad (15)$$

Hence the stability condition is $\beta_1 \beta_2 / \alpha_1 \alpha_2 < 1$ or:

$$\alpha_1 \alpha_2 > \beta_1 \beta_2 \quad (16)$$

As a result, the steady state is stable if and only if the mathematical product of the direct multipliers is larger than the mathematical product of the cross multipliers. If $\alpha_1 \alpha_2 = \beta_1 \beta_2$, there is no steady state. If $\alpha_1 \alpha_2 > \beta_1 \beta_2$, there is a stable steady state. And if $\alpha_1 \alpha_2 < \beta_1 \beta_2$, there is a steady state, but it is unstable. To illustrate this, have a look at a numerical example. Let be $\alpha_1 = 1$, $\alpha_2 = 1$, $\beta_1 = 1.2$, and $\beta_2 = 0.8$. From this follows $\alpha_1 \alpha_2 > \beta_1 \beta_2$. In other words, there is a stable steady state. For simulations see Chapter 2 below.

5) Summary. The process of monetary competition is stable if and only if the product of the direct multipliers is larger than the product of the cross multipliers.

2. Fiscal Competition between Europe and America

1) The static model. In this section we assume that the regions differ in fiscal policy multipliers. Besides we assume that the governments follow a cold-turkey strategy. As a point of reference, consider the static model. It can be represented by a system of two equations:

$$Y_1 = A_1 + \gamma_1 G_1 + \delta_2 G_2 \quad (1)$$

$$Y_2 = A_2 + \gamma_2 G_2 + \delta_1 G_1 \quad (2)$$

According to equation (1), European output Y_1 is determined by European government purchases G_1 and American government purchases G_2 . According to equation (2), American output Y_2 is determined by American government purchases G_2 and European government purchases G_1 . Here $\gamma_1, \gamma_2, \delta_1$ and δ_2 denote the fiscal policy multipliers. The direct effects of fiscal policy are positive $\gamma_1 > 0$ and $\gamma_2 > 0$. The cross effects of fiscal policy are positive too $\delta_1 > 0$ and $\delta_2 > 0$.

An increase in European government purchases raises both European output and American output. An increase in American government purchases raises both American output and European output. An increase in European government purchases of 1 causes an increase in European output of γ_1 and an increase in American output of δ_1 . An increase in American government purchases of 1 causes an increase in American output of γ_2 and an increase in European output of δ_2 .

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European government is full employment in Europe. And the target of the American government is full employment in America. The dynamic model can be characterized by a system of two equations:

$$\bar{Y}_1 = A_1 + \gamma_1 G_1^{+1} + \delta_2 G_2 \quad (3)$$

$$\bar{Y}_2 = A_2 + \gamma_2 G_2^{+1} + \delta_1 G_1 \quad (4)$$

Here is a list of the new symbols:

\bar{Y}_1 full-employment output in Europe

\bar{Y}_2 full-employment output in America

G_1 European government purchases this period

G_2 American government purchases this period

G_1^{+1} European government purchases next period

G_2^{+1} American government purchases next period.

Here the endogenous variables are G_1^{+1} and G_2^{+1} .

According to equation (3), the European government raises European government purchases so as to close the output gap in Europe. According to equation (4), the American government raises American government purchases so as to close the output gap in America. We assume that the European government and the American government decide simultaneously and independently.

3) The steady state. In the steady state by definition we have:

$$G_1^{+1} = G_1 \quad (5)$$

$$G_2^{+1} = G_2 \quad (6)$$

Equation (5) has it that European government purchases do not change any more. Similarly, equation (6) has it that American government purchases do not change any more. Therefore the steady state of the dynamic model can be described by a system of two equations:

$$\bar{Y}_1 = A_1 + \gamma_1 G_1 + \delta_2 G_2 \quad (7)$$

$$\bar{Y}_2 = A_2 + \gamma_2 G_2 + \delta_1 G_1 \quad (8)$$

Here the endogenous variables are European government purchases and American government purchases.

To simplify notation we introduce $B_1 = \bar{Y}_1 - A_1$ and $B_2 = \bar{Y}_2 - A_2$. Then we solve the model for the endogenous variables:

$$G_1 = \frac{\gamma_2 B_1 - \gamma_2 B_2}{\gamma_1 \gamma_2 - \delta_1 \delta_2} \quad (9)$$

$$G_2 = \frac{\gamma_1 B_2 - \gamma_1 B_1}{\gamma_1 \gamma_2 - \delta_1 \delta_2} \quad (10)$$

Equation (9) shows the steady-state level of European government purchases, and equation (10) shows the steady-state level of American government purchases. As a result, there is a steady state if and only if $\gamma_1 \gamma_2 \neq \delta_1 \delta_2$. That means, there is a steady state if and only if the mathematical product of the direct multipliers is unequal to the mathematical product of the cross multipliers.

As an alternative, the steady state can be represented in terms of the initial output gap and the total increase in government purchases. Taking differences in equations (1) and (2), the model of the steady state can be written as follows:

$$\Delta Y_1 = \gamma_1 \Delta G_1 + \delta_2 \Delta G_2 \quad (11)$$

$$\Delta Y_2 = \gamma_2 \Delta G_2 + \delta_1 \Delta G_1 \quad (12)$$

Here ΔY_1 denotes the initial output gap in Europe, ΔY_2 is the initial output gap in America, ΔG_1 is the total increase in European government purchases, and ΔG_2 is the total increase in American government purchases. The endogenous variables are ΔG_1 and ΔG_2 . The solution to the system (11) and (12) is:

$$\Delta G_1 = \frac{\gamma_2 \Delta Y_1 - \delta_2 \Delta Y_2}{\gamma_1 \gamma_2 - \delta_1 \delta_2} \quad (13)$$

$$\Delta G_2 = \frac{\gamma_1 \Delta Y_2 - \delta_1 \Delta Y_1}{\gamma_1 \gamma_2 - \delta_1 \delta_2} \quad (14)$$

According to equation (13), the total increase in European government purchases depends on the initial output gap in Europe, the initial output gap in America, the direct multipliers, and the cross multipliers. The larger the initial output gap in Europe, the larger is the total increase in European government purchases.

Moreover, the larger the initial output gap in America, the smaller is the total increase in European government purchases.

4) Stability. As a point of departure, take the dynamic model. Equation (3) yields $dG_1^{+1} / dG_2 = -\delta_2 / \gamma_1$, and equation (4) yields $dG_2 / dG_1^{-1} = -\delta_1 / \gamma_2$. This implies:

$$\frac{dG_1^{+1}}{dG_1^{-1}} = \frac{\delta_1 \delta_2}{\gamma_1 \gamma_2} \quad (15)$$

Hence the stability condition is $\delta_1 \delta_2 / \gamma_1 \gamma_2 < 1$ or:

$$\gamma_1 \gamma_2 > \delta_1 \delta_2 \quad (16)$$

As a result, the steady state is stable if and only if the mathematical product of the direct multipliers is larger than the mathematical product of the cross multipliers. If $\gamma_1 \gamma_2 = \delta_1 \delta_2$, there is no steady state. If $\gamma_1 \gamma_2 > \delta_1 \delta_2$, there is a stable steady state. If $\gamma_1 \gamma_2 < \delta_1 \delta_2$, there is a steady state, but it is unstable. To illustrate this, have a look at a numerical example. Let be $\gamma_1 = 1$, $\gamma_2 = 1$, $\delta_1 = 1.2$ and $\delta_2 = 0.8$. From this follows $\gamma_1 \gamma_2 > \delta_1 \delta_2$. In other words, there is a stable steady state. For simulations see Chapter 2 below.

5) Summary. The process of fiscal competition is stable if and only if the product of the direct multipliers is larger than the product of the cross multipliers.

Chapter 2

The Regions Differ in Size

1. Monetary Competition between Europe and America

In this chapter we assume that the regions only differ in size. To be more specific, we assume that the European economy is half as large as the American economy. More precisely, full-employment output in Europe is half as large as full-employment output in America. There is perfect capital mobility between Europe and America. The central banks follow a cold-turkey strategy.

As a point of reference, consider the static model. It can be represented by a system of two equations:

$$Y_1 = A_1 + 3.33M_1 - 0.67M_2 \quad (1)$$

$$Y_2 = A_2 + 2.67M_2 - 1.33M_1 \quad (2)$$

According to equation (1), European output Y_1 is determined by European money supply M_1 and American money supply M_2 . According to equation (2), American output Y_2 is determined by American money supply M_2 and European money supply M_1 .

An increase in European money supply of 100 causes an increase in European output of 333 and a decline in American output of 133. So the increase in world output is 200. An increase in American money supply of 100 causes an increase in American output of 267 and a decline in European output of 67. So the increase in world output is 200 again. The monetary policy multipliers are from the world of three regions, see Part Four below. Obviously, in the small region, the monetary policy multiplier is large. And in the large region, the monetary policy multiplier is small. Further let full-employment output in Europe be 1000, and let full-employment output in America be 2000. The target of the European central bank is full employment in Europe, and the target of the American central bank is full employment in America.

At the beginning there is unemployment in both Europe and America. Let the rate of unemployment in Europe be equal to the rate of unemployment in America. For instance, let initial output in Europe be 940, and let initial output in America be 1880. Step 1 refers to the policy response. The output gap in Europe is 60. The monetary policy multiplier in Europe is 3.33. So what is needed in Europe is an increase in European money supply of 18. The output gap in America is 120. The monetary policy multiplier in America is 2.67. So what is needed in America is an increase in American money supply of 45.

Step 2 refers to the output lag. The increase in European money supply of 18 causes an increase in European output of 60. As a side effect, it causes a decline in American output of 24. The increase in American money supply of 45 causes an increase in American output of 120. As a side effect, it causes a decline in European output of 30. The net effect is an increase in European output of 30 and an increase in American output of 96. As a consequence, European output goes from 940 to 970, and American output goes from 1880 to 1976. And so on. Table 3.1 presents a synopsis.

Table 3.1
Monetary Competition between Europe and America
 The Regions Differ in Size

	Europe	America
Initial Output	940	1880
Change in Money Supply	18	45
Output	970	1976
Change in Money Supply	9	9
Output	994	1988
Change in Money Supply	1.8	4.5
Output	997	1997.6
<i>and so on</i>	...	...

As a result, the process of monetary competition leads to full employment in Europe and America. According to Chapter 1, the total increase in European money supply is 30, and the total increase in American money supply is 60. The effective monetary multiplier in Europe is 2, as is the effective monetary multiplier in America.

Next have a closer look at the output gap as a percentage of full-employment output. At the start, the output gap in Europe relative to full-employment output in Europe is 6 percent. And the output gap in America relative to full-employment output in America is equally 6 percent. In step 2, the output gap in Europe is 3 percent, and the output gap in America is 1.2 percent. In step 4, the output gap in Europe is 0.6 percent, and the output gap in America is equally 0.6 percent. In step 6, the output gap in Europe is 0.3 percent, and the output gap in America is 0.12 percent. And so on. Table 3.2 gives an overview. Evidently, the relative output gap in Europe is larger than the relative output gap in America. The underlying reason is that, in the small region, monetary competition is a relatively slow process. And in the large region, monetary competition is a relatively fast process.

Table 3.2
Monetary Competition between Europe and America
 The Regions Differ in Size

Output Gap in Europe in Percent	Output Gap in America in Percent
6	6
3	1.2
0.6	0.6
0.3	0.12
...	<i>and so on</i>
	...

2. Monetary Cooperation between Europe and America

At the beginning there is unemployment in both Europe and America. More precisely, the output gap in Europe equals the output gap in America. Let initial output in Europe be 940, and let initial output in America be 1940. The output gap in Europe is 60, as is the output gap in America. So what is needed, according to Chapter 1, is an increase in European money supply of 25 and an increase in American money supply of 35. The increase in European money supply of 25 raises European output by 83.3 and lowers American output by 33.3. The increase in American money supply of 35 raises American output by 93.3 and lowers European output by 23.3. The net effect is an increase in European output of 60 and an increase in American output of equally 60. As a consequence, European output goes from 940 to 1000, and American output goes from 1940 to 2000. As a result, monetary cooperation can achieve full employment.

It is worth pointing out here that the required increase in European money supply differs from the required increase in American money supply, even though the initial output gap in Europe equals the initial output gap in America. The reason is that Europe and America differ in size. For a synopsis see Table 3.3.

Table 3.3
Monetary Cooperation between Europe and America
 The Regions Differ in Size

	Europe	America
Initial Output	940	1940
Change in Money Supply	25	35
Output	1000	2000

3. Fiscal Competition between Europe and America

We assume perfect capital mobility between Europe and America. Besides, we assume that the governments follow a cold-turkey strategy. As a point of departure, take the static model. It can be represented by a system of two equations:

$$Y_1 = A_1 + 0.67G_1 + 0.67G_2 \quad (1)$$

$$Y_2 = A_2 + 1.33G_2 + 1.33G_1 \quad (2)$$

According to equation (1), European output Y_1 is determined by European government purchases G_1 and American government purchases G_2 . According to equation (2), American output is determined by American government purchases and European government purchases.

An increase in European government purchases of 100 causes an increase in European output of 67 and an increase in American output of 133. So the increase in world output is 200. An increase in American government purchases of 100 causes an increase in American output of 133 and an increase in European output of 67. So the increase in world output is 200 again. The fiscal policy multipliers are from the world of three regions, see Part Four below. Obviously, in the small region, the fiscal policy multiplier is small. And in the large region, the fiscal policy multiplier is large. Further let full-employment output in Europe be 1000, and let full-employment output in America be 2000. The target of the European government is full employment in Europe, and the target of the American government is full employment in America.

It proves useful to study two distinct cases:

- the rate of unemployment in Europe equals the rate of unemployment in America
- the output gap in Europe equals the output gap in America.

1) The rate of unemployment in Europe equals the rate of unemployment in America. At the beginning there is unemployment in Europe and America. Let

initial output in Europe be 940, and let initial output in America be 1880. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 0.67. So what is needed in Europe is an increase in European government purchases of 90. The output gap in America is 120. The fiscal policy multiplier in America is 1.33. So what is needed in America is an increase in American government purchases of 90.

Step 2 refers to the output lag. The increase in European government purchases of 90 causes an increase in European output of 60. As a side effect, it causes an increase in American output of 120. The increase in American government purchases of 90 causes an increase in American output of 120. As a side effect, it causes an increase in European output of 60. The total effect is an increase in European output of 120 and an increase in American output of 240. As a consequence, European output goes from 940 to 1060, and American output goes from 1880 to 2120.

In step 3, European government purchases are lowered by 90, and the same holds for American government purchases. In step 4, European output goes from 1060 to 940, and American output goes from 2120 to 1880. With this, European output and American output are back at their initial levels. That means, this process will repeat itself step by step. Table 3.4 presents a synopsis. As a result, the process of fiscal competition does not lead to full employment in Europe and America.

What are the dynamic characteristics of this process? There are uniform oscillations in European government purchases, as there are in American government purchases. There are uniform oscillations in European output, as there are in American output. The European economy oscillates between unemployment and overemployment, as does the American economy. It is worth pointing out here that the change in European government purchases equals the change in American government purchases, even though the initial output gap in Europe is half as large as the initial output gap in America. The reason is that Europe and America differ in size.

Table 3.4
Fiscal Competition between Europe and America
 The Regions Differ in Size

	Europe	America
Initial Output	940	1880
Change in Government Purchases	90	90
Output	1060	2120
Change in Government Purchases	- 90	- 90
Output	940	1880
<i>and so on</i>	...	...

2) The output gap in Europe equals the output gap in America. Let initial output in Europe be 940, and let initial output in America be 1940. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 0.67. So what is needed in Europe is an increase in European government purchases of 90. The output gap in America is 60. The fiscal policy multiplier in America is 1.33. So what is needed in America is an increase in American government purchases of 45.

Step 2 refers to the output lag. The increase in European government purchases of 90 causes an increase in European output of 60. As a side effect, it causes an increase in American output of 120. The increase in American government purchases of 45 causes an increase in American output of 60. As a side effect, it causes an increase in European output of 30. The total effect is an increase in European output of 90 and an increase in American output of 180. As a consequence, European output goes from 940 to 1030, and American output goes from 1940 to 2120.

In step 3, European government purchases are reduced by 45, and American government purchases are reduced by 90. In step 4, European output goes from 1030 to 940, and American output goes from 2120 to 1940. With this, output is

back at its initial level, hence this process will repeat itself. Table 3.5 gives an overview. As a result, fiscal competition does not lead to full employment. There is an upward trend in European government purchases. By contrast, there is a downward trend in American government purchases. There are uniform oscillations in European output, as there are in American output. Moreover, after a certain number of steps, American government purchases are down to zero.

Table 3.5
Fiscal Competition between Europe and America
 The Regions Differ in Size

	Europe	America
Initial Output	940	1940
Change in Government Purchases	90	45
Output	1030	2120
Change in Government Purchases	- 45	- 90
Output	940	1940
<i>and so on</i>	...	...

Chapter 3

Competition between the European Labour Union and the American Labour Union

1. The Dynamic Model

1) The static model. As a point of reference, consider the static model. The world consists of two monetary regions, say Europe and America. The exchange rate between Europe and America is flexible. There is international trade between Europe and America. There is perfect capital mobility between Europe and America. European goods and American goods are imperfect substitutes for each other. European output is determined by the demand for European goods. American output is determined by the demand for American goods. European money demand equals European money supply. And American money demand equals American money supply. The monetary regions are the same size and have the same behavioural functions.

As a result, an increase in European nominal wages lowers European output. On the other hand, it raises American output. Here the fall in European output exceeds the rise in American output. Correspondingly, an increase in American nominal wages lowers American output. On the other hand, it raises European output. Here the fall in American output exceeds the rise in European output. In the numerical example, a 1 percent increase in European nominal wages causes a 0.75 percent decline in European output and a 0.25 percent increase in American output. Similarly, a 1 percent increase in American nominal wages causes a 0.75 percent decline in American output and a 0.25 percent increase in European output. That is to say, the internal effect of wage policy is very large, and the external effect of wage policy is large. Now have a closer look at the process of adjustment. An increase in European nominal wages causes an increase in the price of European goods. This in turn causes an appreciation of the euro, a depreciation of the dollar, and an increase in the world interest rate. The increase in the price of European goods lowers European exports and raises American

exports. The appreciation of the euro lowers European exports. The depreciation of the dollar raises American exports. And the increase in the world interest rate lowers both European investment and American investment. The net effect is that European output goes down. However, American output goes up. This model is in the tradition of the Mundell-Fleming model, see Carlberg (2001) p. 164 and Carlberg (2002) p. 181.

The static model can be represented by a system of two equations:

$$Y_1 = A_1 - \varepsilon W_1 + \eta W_2 \quad (1)$$

$$Y_2 = A_2 - \varepsilon W_2 + \eta W_1 \quad (2)$$

According to equation (1), European output Y_1 is determined by European nominal wages W_1 , American nominal wages W_2 , and some other factors called A_1 . According to equation (2), American output Y_2 is determined by American nominal wages W_2 , European nominal wages W_1 , and some other factors called A_2 . Here ε and η denote the wage policy multipliers. The internal effect of wage policy is negative $\varepsilon > 0$. By contrast, the external effect of wage policy is positive $\eta > 0$. In absolute values, the internal effect is larger than the external effect $\varepsilon > \eta$. The endogenous variables are European output and American output.

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European labour union is full employment in Europe. The instrument of the European labour union is European nominal wages. The European labour union lowers European nominal wages so as to close the output gap in Europe:

$$W_1 - W_1^{-1} = - \frac{\bar{Y}_1 - Y_1}{\varepsilon} \quad (3)$$

Here is a list of the new symbols:

Y_1	European output this period
\bar{Y}_1	full-employment output in Europe
$\bar{Y}_1 - Y_1$	output gap in Europe this period
W_1^{-1}	European nominal wages last period

W_1 European nominal wages this period

$W_1 - W_1^{-1}$ change in European nominal wages.

Here the endogenous variable is European nominal wages this period W_1 .

The target of the American labour union is full employment in America. The instrument of the American labour union is American nominal wages. The American labour union lowers American nominal wages so as to close the output gap in America:

$$W_2 - W_2^{-1} = - \frac{\bar{Y}_2 - Y_2}{\varepsilon} \quad (4)$$

Here is a list of the new symbols:

Y_2 American output this period

\bar{Y}_2 full-employment output in America

$\bar{Y}_2 - Y_2$ output gap in America this period

W_2^{-1} American nominal wages last period

W_2 American nominal wages this period

$W_2 - W_2^{-1}$ change in American nominal wages.

Here the endogenous variable is American nominal wages this period W_2 . We assume that the European labour union and the American labour union decide simultaneously and independently.

In addition there is an output lag. European output next period is determined by European nominal wages this period as well as by American nominal wages this period:

$$Y_1^{+1} = A_1 - \varepsilon W_1 + \eta W_2 \quad (5)$$

Here Y_1^{+1} denotes European output next period. In the same way, American output next period is determined by American nominal wages this period as well as by European nominal wages this period:

$$Y_2^{+1} = A_2 - \varepsilon W_2 + \eta W_1 \quad (6)$$

Here Y_2^{+1} denotes American output next period.

On this basis, the dynamic model can be characterized by a system of four equations:

$$W_1 - W_1^{-1} = - \frac{\bar{Y}_1 - Y_1}{\varepsilon} \quad (7)$$

$$W_2 - W_2^{-1} = - \frac{\bar{Y}_2 - Y_2}{\varepsilon} \quad (8)$$

$$Y_1^{+1} = A_1 - \varepsilon W_1 + \eta W_2 \quad (9)$$

$$Y_2^{+1} = A_2 - \varepsilon W_2 + \eta W_1 \quad (10)$$

Equation (7) shows the wage response by the European labour union, equation (8) shows the wage response by the American labour union, equation (9) shows the output lag in Europe, and equation (10) shows the output lag in America. The endogenous variables are European nominal wages this period W_1 , American nominal wages this period W_2 , European output next period Y_1^{+1} , and American output next period Y_2^{+1} .

3) The steady state. In the steady state by definition we have:

$$W_1 = W_1^{-1} \quad (11)$$

$$W_2 = W_2^{-1} \quad (12)$$

Equation (11) has it that European nominal wages do not change any more. Similarly, equation (12) has it that American nominal wages do not change any more. Therefore the steady state can be captured by a system of four equations:

$$Y_1 = \bar{Y}_1 \quad (13)$$

$$Y_2 = \bar{Y}_2 \quad (14)$$

$$Y_1 = A_1 - \varepsilon W_1 + \eta W_2 \quad (15)$$

$$Y_2 = A_2 - \varepsilon W_2 + \eta W_1 \quad (16)$$

Here the endogenous variables are European output Y_1 , American output Y_2 , European nominal wages W_1 , and American nominal wages W_2 . According to equation (13) there is full employment in Europe, so European output is constant. According to equation (14) there is full employment in America, so American output is constant too. Further, equations (15) and (16) give the steady-state levels of European and American nominal wages.

The model of the steady state can be compressed to a system of two equations:

$$\bar{Y}_1 = A_1 - \varepsilon W_1 + \eta W_2 \quad (17)$$

$$\bar{Y}_2 = A_2 - \varepsilon W_2 + \eta W_1 \quad (18)$$

Here the endogenous variables are European nominal wages and American nominal wages. To simplify notation we introduce:

$$B_1 = A_1 - \bar{Y}_1 \quad (19)$$

$$B_2 = A_2 - \bar{Y}_2 \quad (20)$$

With this, the model of the steady state can be written as follows:

$$B_1 = \varepsilon W_1 - \eta W_2 \quad (21)$$

$$B_2 = \varepsilon W_2 - \eta W_1 \quad (22)$$

The endogenous variables are still W_1 and W_2 .

Next we solve the model for the endogenous variables:

$$W_1 = \frac{\varepsilon B_1 + \eta B_2}{\varepsilon^2 - \eta^2} \quad (23)$$

$$W_2 = \frac{\varepsilon B_2 + \eta B_1}{\varepsilon^2 - \eta^2} \quad (24)$$

Equation (23) shows the steady-state level of European nominal wages, and equation (24) shows the steady-state level of American nominal wages. As a result, there is a steady state if and only if $\varepsilon \neq \eta$. Owing to the assumption $\varepsilon > \eta$, this condition is fulfilled.

As an alternative, the steady state can be represented in terms of the initial output gap and the total change in nominal wages. Taking differences in equations (1) and (2), the model of the steady state can be written as follows:

$$\Delta Y_1 = -\varepsilon \Delta W_1 + \eta \Delta W_2 \quad (25)$$

$$\Delta Y_2 = -\varepsilon \Delta W_2 + \eta \Delta W_1 \quad (26)$$

Here ΔY_1 is the initial output gap in Europe, ΔY_2 is the initial output gap in America, ΔW_1 is the total change in European nominal wages, and ΔW_2 is the total change in American nominal wages. The endogenous variables are ΔW_1 and ΔW_2 . The solution to the system (25) and (26) is:

$$\Delta W_1 = -\frac{\varepsilon \Delta Y_1 + \eta \Delta Y_2}{\varepsilon^2 - \eta^2} \quad (27)$$

$$\Delta W_2 = -\frac{\varepsilon \Delta Y_2 + \eta \Delta Y_1}{\varepsilon^2 - \eta^2} \quad (28)$$

According to equation (27), the total cut in European nominal wages depends on the initial output gap in Europe, the initial output gap in America, the direct multiplier ε , and the cross multiplier η . The larger the initial output gap in Europe, the larger is the total cut in European nominal wages. Moreover, the larger the initial output gap in America, the larger is the total cut in European nominal wages. At first glance this comes as a surprise. According to equation (28), the total cut in American nominal wages depends on the initial output gap in America, the initial output gap in Europe, the direct multiplier ε , and the cross multiplier η .

4) Stability. Eliminate Y_1 in equation (7) by means of equation (9) and rearrange terms $\bar{Y}_1 = A_1 - \varepsilon W_1 + \eta W_2^{-1}$. By analogy, eliminate Y_2 in equation

(8) by means of equation (10) to arrive at $\bar{Y}_2 = A_2 - \varepsilon W_2 + \eta W_1^{-1}$. On this basis, the dynamic model can be described by a system of two equations:

$$\bar{Y}_1 = A_1 - \varepsilon W_1 + \eta W_2^{-1} \quad (29)$$

$$\bar{Y}_2 = A_2 - \varepsilon W_2 + \eta W_1^{-1} \quad (30)$$

Here the endogenous variables are European nominal wages W_1 and American nominal wages W_2 . To simplify notation we make use of equations (19) and (20). With this, the dynamic model can be written as follows:

$$B_1 = \varepsilon W_1 - \eta W_2^{-1} \quad (31)$$

$$B_2 = \varepsilon W_2 - \eta W_1^{-1} \quad (32)$$

The endogenous variables are still W_1 and W_2 .

Now substitute equation (32) into equation (31) and solve for:

$$\varepsilon W_1 = B_1 + \frac{\eta B_2}{\varepsilon} + \frac{\eta^2 W_1^{-2}}{\varepsilon} \quad (33)$$

Then differentiate equation (33) for W_1^{-2} :

$$\frac{dW_1}{dW_1^{-2}} = \frac{\eta^2}{\varepsilon^2} \quad (34)$$

Finally the stability condition is $\eta^2 / \varepsilon^2 < 1$ or:

$$\varepsilon > \eta \quad (35)$$

That means, the steady state is stable if and only if the internal effect of wage policy is larger than the external effect of wage policy. This condition is satisfied. As a result, there is a stable steady state of wage policy competition. In other words, competition between the European labour union and the American labour union leads to full employment in Europe and America.

2. A Numerical Example

To illustrate the dynamic model, have a look at a numerical example. For ease of exposition, without loss of generality, assume $\varepsilon = 3$ and $\eta = 1$. On this assumption, the static model can be written as follows:

$$Y_1 = A_1 - 3W_1 + W_2 \quad (1)$$

$$Y_2 = A_2 - 3W_2 + W_1 \quad (2)$$

The endogenous variables are European and American output. Obviously, an increase in European nominal wages of 100 causes a decline in European output of 300 and an increase in American output of 100. Strictly speaking, what matters here is the change in European output relative to the change in American output $300/100 = 3$. Compare this with the results given in the preceding section, where we had $0.75/0.25 = 3$. Further, an increase in American nominal wages of 100 causes a decline in American output of 300 and an increase in European output of 100. Let full-employment output in Europe be 1000, and let full-employment output in America be the same.

At the beginning there is unemployment in both Europe and America. More precisely, unemployment in Europe equals unemployment in America. Let initial output in Europe be 940, and let initial output in America be the same. Step 1 refers to the policy response. The output gap in Europe is 60. The wage policy multiplier in Europe is -3 . So what is needed in Europe is a reduction in European nominal wages of 20. The output gap in America is 60. The wage policy multiplier in America is -3 . So what is needed in America is a reduction in American nominal wages of 20.

Step 2 refers to the output lag. The reduction in European nominal wages of 20 causes an increase in European output of 60. As a side effect, it causes a decline in American output of 20. The reduction in American nominal wages of 20 causes an increase in American output of 60. As a side effect, it causes a decline in European output of 20. The net effect is an increase in European

output of 40 and an increase in American output of equally 40. As a consequence, European output goes from 940 to 980, as does American output.

Why does the European labour union not succeed in closing the output gap in Europe? The underlying reason is the negative external effect of the reduction in American nominal wages. And why does the American labour union not succeed in closing the output gap in America? The underlying reason is the negative external effect of the reduction in European nominal wages.

Step 3 refers to the policy response. The output gap in Europe is 20. The wage policy multiplier in Europe is -3 . So what is needed in Europe is a reduction in European nominal wages of 6.7. The output gap in America is 20. The wage policy multiplier in America is -3 . So what is needed in America is a reduction in American nominal wages of 6.7.

Step 4 refers to the output lag. The reduction in European nominal wages of 6.7 causes an increase in European output of 20. As a side effect, it causes a decline in American output of 6.7. The reduction in American nominal wages of 6.7 causes an increase in American output of 20. As a side effect, it causes a decline in European output of 6.7. The net effect is an increase in European output of 13.3 and an increase in American output of equally 13.3. As a consequence, European output goes from 980 to 993.3, as does American output. And so on. Table 3.6 gives an overview.

What are the dynamic characteristics of this process? There are repeated cuts in European nominal wages, as there are in American nominal wages. There are repeated increases in European output, as there are in American output. In each round, the output gap declines by 67 percent. As a result, competition between the European labour union and the American labour union leads to full employment in Europe and America.

Taking the sum over all periods, the reduction in European nominal wages is 30, as is the reduction in American nominal wages, see equations (27) and (28) in the previous section. That means, the total reduction in European nominal wages is large, as compared to the initial output gap in Europe of 60. And the same applies to the total reduction in American nominal wages, as compared to the initial output gap in America of 60. The effective multiplier in Europe is $60/30 =$

2, as is the effective multiplier in America. In other words, the effective multiplier in Europe is small. And the same is true of the effective multiplier in America.

Finally compare wage policy competition with monetary policy competition. Monetary policy competition leads to full employment. And the same holds for wage policy competition. Monetary policy competition is a relatively fast process. By contrast, wage policy competition is a relatively slow process. Judging from these points of view, monetary policy competition seems to be superior to wage policy competition.

Table 3.6
Competition between the European Labour Union and
the American Labour Union
 Unemployment in Europe and America

	Europe	America
Initial Output	940	940
Change in Nominal Wages	- 20	- 20
Output	980	980
Change in Nominal Wages	- 6.7	- 6.7
Output	993.3	993.3
<i>and so on</i>	...	...

Chapter 4

Cooperation between the European Labour Union and the American Labour Union

1. The Model

1) Introduction. As a starting point take the output model. It can be represented by a system of two equations:

$$Y_1 = A_1 - \varepsilon W_1 + \eta W_2 \quad (1)$$

$$Y_2 = A_2 - \varepsilon W_2 + \eta W_1 \quad (2)$$

Here Y_1 denotes European output, Y_2 is American output, W_1 is European nominal wages, and W_2 is American nominal wages. The endogenous variables are European output and American output. At the beginning there is unemployment in both Europe and America. The targets of wage policy cooperation are full employment in Europe and full employment in America. The instruments of wage policy cooperation are European nominal wages and American nominal wages. So there are two targets and two instruments.

2) The policy model. On this basis, the policy model can be characterized by a system of two equations:

$$\bar{Y}_1 = A_1 - \varepsilon W_1 + \eta W_2 \quad (3)$$

$$\bar{Y}_2 = A_2 - \varepsilon W_2 + \eta W_1 \quad (4)$$

Here \bar{Y}_1 denotes full-employment output in Europe, and \bar{Y}_2 denotes full-employment output in America. The endogenous variables are European nominal wages and American nominal wages.

To simplify notation, we introduce $B_1 = A_1 - \bar{Y}_1$ and $B_2 = A_2 - \bar{Y}_2$. Then we solve the model for the endogenous variables:

$$W_1 = \frac{\varepsilon B_1 + \eta B_2}{\varepsilon^2 - \eta^2} \quad (5)$$

$$W_2 = \frac{\varepsilon B_2 + \eta B_1}{\varepsilon^2 - \eta^2} \quad (6)$$

Equation (5) shows the required level of European nominal wages, and equation (6) shows the required level of American nominal wages. There is a solution if and only if $\varepsilon \neq \eta$. Due to the assumption $\varepsilon > \eta$, this condition is met. As a result, cooperation between the European labour union and the American labour union can achieve full employment in Europe and America. It is worth pointing out here that the solution to wage policy cooperation is identical to the steady state of wage policy competition.

3) Another version of the policy model. As an alternative, the policy model can be stated in terms of the initial output gap and the required change in nominal wages. Taking differences in equations (1) and (2), the policy model can be written as follows:

$$\Delta Y_1 = -\varepsilon \Delta W_1 + \eta \Delta W_2 \quad (7)$$

$$\Delta Y_2 = -\varepsilon \Delta W_2 + \eta \Delta W_1 \quad (8)$$

Here ΔY_1 denotes the initial output gap in Europe, ΔY_2 is the initial output gap in America, ΔW_1 is the required change in European nominal wages, and ΔY_2 is the required change in American nominal wages. The endogenous variables are ΔW_1 and ΔW_2 . The solution to the system (7) and (8) is:

$$\Delta W_1 = -\frac{\varepsilon \Delta Y_1 + \eta \Delta Y_2}{\varepsilon^2 - \eta^2} \quad (9)$$

$$\Delta W_2 = -\frac{\varepsilon \Delta Y_2 + \eta \Delta Y_1}{\varepsilon^2 - \eta^2} \quad (10)$$

According to equation (9), the required cut in European nominal wages depends on the initial output gap in Europe, the initial output gap in America, the direct multiplier ε , and the cross multiplier η . The larger the initial output gap in Europe, the larger is the required cut in European nominal wages. Moreover, the larger the initial output gap in America, the larger is the required cut in European nominal wages. At first glance this comes as a surprise. According to equation (10), the required cut in American nominal wages depends on the initial output gap in America, the initial output gap in Europe, the direct multiplier ε , and the cross multiplier η .

2. Some Numerical Examples

To illustrate the policy model, have a look at some numerical examples. For ease of exposition, without losing generality, assume $\varepsilon = 3$ and $\eta = 1$. On this assumption, the output model can be written as follows:

$$Y_1 = A_1 - 3W_1 + W_2 \quad (1)$$

$$Y_2 = A_2 - 3W_2 + W_1 \quad (2)$$

The endogenous variables are European and American output. Evidently, an increase in European nominal wages of 100 causes a decline in European output of 300 and an increase in American output of 100. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

It proves useful to consider four distinct cases:

- unemployment in Europe equals unemployment in America
- unemployment in Europe exceeds unemployment in America
- unemployment in Europe, full employment in America
- unemployment in Europe equals overemployment in America.

1) Unemployment in Europe equals unemployment in America. Let initial output in Europe be 940, and let initial output in America be the same. The output gap in Europe is 60, as is the output gap in America. So what is needed, according to equations (9) and (10) from the preceding section, is a reduction in European nominal wages of 30 and a reduction in American nominal wages of equally 30. The reduction in European nominal wages of 30 raises European output by 90 and lowers American output by 30. The reduction in American nominal wages of 30 raises American output by 90 and lowers European output by 30. The net effect is an increase in European output of 60 and an increase in American output of equally 60. As a consequence, European output goes from 940 to 1000, as does American output. In Europe there is now full employment, and the same holds for America. As a result, wage policy cooperation can achieve full employment.

However, the required cut in European nominal wages is large, as compared to the initial output gap in Europe. And the same applies to the required cut in American nominal wages, as compared to the initial output gap in America. The effective multiplier in Europe is $60/30 = 2$, as is the effective multiplier in America. That is to say, the effective multiplier in Europe is small. And the same is true of the effective multiplier in America. Table 3.7 gives an overview.

Table 3.7
Cooperation between the European Labour Union and
the American Labour Union

Unemployment in Europe and America

	Europe	America
Initial Output	940	940
Change in Nominal Wages	- 30	- 30
Output	1000	1000

2) Unemployment in Europe exceeds unemployment in America. Let initial output in Europe be 940, and let initial output in America be 970. The output gap in Europe is 60, and the output gap in America is 30. What is needed, according to equations (9) and (10) from the previous section, is a reduction in European nominal wages of 26.25 and a reduction in American nominal wages of 18.75. The reduction in European nominal wages of 26.25 raises European output by 78.75 and lowers American output by 26.25. The reduction in American nominal wages of 18.75 raises American output by 56.25 and lowers European output by 18.75. The net effect is an increase in European output of 60 and an increase in American output of 30. As a consequence, European output goes from 940 to 1000, and American output goes from 970 to 1000. In Europe there is now full employment, and the same holds for America. As a result, wage policy cooperation can achieve full employment.

However, the required cut in European nominal wages is large, as compared to the initial output gap in Europe. And the required cut in American nominal wages is even larger, as compared to the initial output gap in America. The effective multiplier in Europe is $60/26.25 = 2.3$, and the effective multiplier in America is $30/18.75 = 1.6$. That means, the effective multiplier in Europe is small, and the effective multiplier in America is even smaller.

3) Unemployment in Europe, full employment in America. Let initial output in Europe be 940, and let initial output in America be 1000. The output gap in Europe is 60, and the output gap in America is zero. What is needed, then, is a reduction in European nominal wages of 22.5 and a reduction in American nominal wages of 7.5. The reduction in European nominal wages of 22.5 raises European output by 67.5 and lowers American output by 22.5. The reduction in American nominal wages of 7.5 raises American output by 22.5 and lowers European output by 7.5. The net effect is an increase in European output of 60 and an increase in American output of zero. The effective multiplier in Europe is 2.7, and the effective multiplier in America is zero.

4) Unemployment in Europe equals overemployment in America. Let initial output in Europe be 940, and let initial output in America be 1060. The output gap in Europe is 60, and the output gap in America is -60 . What is needed, then, is a reduction in European nominal wages of 15 and an increase in American nominal wages of equally 15. The reduction in European nominal wages of 15

raises European output by 45 and lowers American output by 15. The increase in American nominal wages of 15 lowers American output by 45 and raises European output by 15. The total effect is an increase in European output of 60 and a decline in American output of equally 60. The effective multiplier in Europe is 4, as is the effective multiplier in America. That is to say, the effective multiplier in Europe is large. And the same is true of the effective multiplier in America.

5) Comparing wage policy cooperation with wage policy competition. Wage policy competition can achieve full employment. The same applies to wage policy cooperation. Wage policy competition is a slow process. By contrast, wage policy cooperation is a fast process. Judging from these points of view, wage policy cooperation seems to be superior to wage policy competition.

6) Comparing wage policy cooperation with monetary policy cooperation. Monetary policy cooperation can achieve full employment. The same holds for wage policy cooperation. Monetary policy cooperation does not require any changes in nominal wages and prices. On the other hand, wage policy cooperation can require large changes in nominal wages and prices. Judging from this perspective, monetary policy cooperation seems to be superior to wage policy cooperation.

Chapter 5

Inflation in Europe and America

1. Monetary Competition between Europe and America

1.1. The Dynamic Model

1) The model of output and inflation. To begin with, consider a stylized model of output and inflation:

$$Y_1 = A_1 + \alpha M_1 / P_1 - \beta M_2 / P_2 \quad (1)$$

$$Y_2 = A_2 + \alpha M_2 / P_2 - \beta M_1 / P_1 \quad (2)$$

$$\hat{P}_1 = \lambda(Y_1 - \bar{Y}_1) / \bar{Y}_1 \quad (3)$$

$$\hat{P}_2 = \lambda(Y_2 - \bar{Y}_2) / \bar{Y}_2 \quad (4)$$

According to equation (1), European output Y_1 is determined by European money supply M_1 , the price of European goods P_1 , American money supply M_2 , the price of American goods P_2 , and some other factors called A_1 . According to equation (2), American output Y_2 is determined by American money supply M_2 , the price of American goods P_2 , European money supply M_1 , the price of European goods P_1 , and some other factors called A_2 . The coefficients α and β are positive with $\alpha > \beta$. An increase in European money supply raises European output but lowers American output. An increase in the price of European goods lowers European output but raises American output.

In equation (3), \hat{P}_1 is the rate of growth of the price of European goods. The hat denotes the rate of growth $\hat{P}_1 = \dot{P}_1 / P_1$, and the dot denotes the time derivative $\dot{P}_1 = dP_1 / dt$. In other words, \hat{P}_1 is producer inflation in Europe. \bar{Y}_1 is full-employment output in Europe. $Y_1 - \bar{Y}_1$ is the inflationary gap in Europe. $(Y_1 - \bar{Y}_1) / \bar{Y}_1$ is the inflationary gap in Europe, expressed as a percentage of full-employment output in Europe. And λ is the speed of price adjustment. According to equation (3), producer inflation in Europe is proportional to the inflationary gap in Europe.

In equation (4), \hat{P}_2 is the rate of growth of the price of American goods. In other words, \hat{P}_2 is producer inflation in America. \bar{Y}_2 is full-employment output in America. $Y_2 - \bar{Y}_2$ is the inflationary gap in America. $(Y_2 - \bar{Y}_2)/\bar{Y}_2$ is the inflationary gap in America, expressed as a percentage of full-employment output in America. According to equation (4), producer inflation in America is proportional to the inflationary gap in America. In equations (1) to (4), the endogenous variables are European output, American output, producer inflation in Europe, and producer inflation in America. For the behavioural foundations of the model see Carlberg (2001, 2002).

2) The policy model. The target of the European central bank is price stability in Europe. The instrument of the European central bank is European money supply. The European central bank lowers European money supply so as to close the inflationary gap in Europe. The target of the American central bank is price stability in America. The instrument of the American central bank is American money supply. The American central bank lowers American money supply so as to close the inflationary gap in America. We assume that the European central bank and the American central bank decide simultaneously and independently. In the policy model, the endogenous variables are European money supply, American money supply, producer inflation in Europe, and producer inflation in America.

1.2. A Numerical Example

To illustrate the policy model, take a numerical example with $\alpha = 3$, $\beta = 1$ and $\lambda = 0.1$. Let initial prices be $P_1 = P_2 = 1$. Then an increase in European money supply of 100 causes an increase in European output of 300 and a decline in American output of 100. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same. At the beginning there is overemployment in both Europe and America. For that reason there is inflation in both Europe and America. More precisely, overemployment in Europe exceeds overemployment in America. For that reason, inflation in Europe exceeds

inflation in America. Let initial output in Europe be 1060, and let initial output in America be 1030. That means, the inflationary gap in Europe is 60, and the inflationary gap in America is 30. Then, according to equations (3) and (4), inflation in Europe is 6 percent, and inflation in America is 3 percent.

Step 1 refers to the policy response. The inflationary gap in Europe is 60. The monetary policy multiplier in Europe is 3. So what is needed in Europe is a reduction in European money supply of 20. The inflationary gap in America is 30. The monetary policy multiplier in America is 3. So what is needed in America is a reduction in American money supply of 10.

Step 2 refers to the output lag. The reduction in European money supply of 20 causes a decline in European output of 60. As a side effect, it causes an increase in American output of 20. The reduction in American money supply of 10 causes a decline in American output of 30. As a side effect, it causes an increase in European output of 10. The net effect is a decline in European output of 50 and a decline in American output of 10. As a consequence, European output goes from 1060 to 1010, and American output goes from 1030 to 1020. Now the inflationary gap in Europe is 10, and the inflationary gap in America is 20. Therefore inflation in Europe is 1 percent, and inflation in America is 2 percent.

Step 3 refers to the policy response. The inflationary gap in Europe is 10. The monetary policy multiplier in Europe is 3. So what is needed in Europe is a reduction in European money supply of 3.3. The inflationary gap in America is 20. The monetary policy multiplier in America is 3. So what is needed in America is a reduction in American money supply of 6.7.

Step 4 refers to the output lag. The reduction in European money supply of 3.3 causes a decline in European output of 10. As a side effect, it causes an increase in American output of 3.3. The reduction in American money supply of 6.7 causes a decline in American output of 20. As a side effect, it causes an increase in European output of 6.7. The net effect is a decline in European output of 3.3 and a decline in American output of 16.7. As a consequence, European output goes from 1010 to 1006.7, and American output goes from 1020 to 1003.3. Now the inflationary gap in Europe is 6.7, and the inflationary gap in America is 3.3. Therefore inflation in Europe is 0.67 percent, and inflation in America is 0.33 percent. And so on. Table 3.8 presents a synopsis.

Table 3.8
Monetary Competition between Europe and America
 Inflation in Europe and America

	Europe	America
Initial Output	1060	1030
Inflation	6	3
Change in Money Supply	- 20	- 10
Output	1010	1020
Inflation	1	2
Change in Money Supply	- 3.3	- 6.7
Output	1006.7	1003.3
Inflation	0.7	0.3
<i>and so on</i>	...	...

What are the dynamic characteristics of this process? There are repeated cuts in European money supply, as there are in American money supply. There are repeated cuts in European output, as there are in American output. There are repeated cuts in European inflation, as there are in American inflation. As a result, monetary competition between Europe and America leads to price stability in Europe and America. By the way, in the numerical example, the feedback from inflation to output has not been included. This can be defended on the grounds that monetary policy adjustment is a relatively fast process, as compared to wage and price adjustment.

2. Monetary Cooperation between Europe and America

At the start there is inflation in Europe and America. More precisely, inflation in Europe exceeds inflation in America. The targets of monetary cooperation are price stability in Europe and price stability in America. The instruments of monetary cooperation are European money supply and American money supply. So there are two targets and two instruments.

To illustrate this, consider a numerical example with $\alpha = 3$, $\beta = 1$ and $\lambda = 0.1$. Let initial prices be $P_1 = P_2 = 1$. Then an increase in European money supply of 100 causes an increase in European output of 300 and a decline in American output of 100. Let initial output in Europe be 1060, and let initial output in America be 1030. That means, the inflationary gap in Europe is 60, and the inflationary gap in America is 30. According to equations (3) and (4) from Section 1.1, inflation in Europe is 6 percent, and inflation in America is 3 percent. What is needed, then, is a reduction in European money supply of 26.25 and a reduction in American money supply of 18.75.

The reduction in European money supply of 26.25 lowers European output by 78.75 and raises American output by 26.25. The reduction in American money supply of 18.75 lowers American output by 56.25 and raises European output by 18.75. The net effect is a decline in European output of 60 and a decline in American output of 30. As a consequence, European output goes from 1060 to 1000, and American output goes from 1030 to 1000. Now the inflationary gap in Europe is zero, as is the inflationary gap in America. Therefore, inflation in Europe is zero, as is inflation in America. As a result, monetary cooperation between Europe and America can achieve price stability in Europe and America. Table 3.9 gives an overview.

Finally compare monetary cooperation with monetary competition. Monetary competition can achieve price stability. And the same holds for monetary cooperation. Monetary competition is a slow process. By contrast, monetary cooperation is a fast process. Judging from these points of view, monetary cooperation seems to be superior to monetary competition. However, if policy

spillovers are anticipated, then monetary competition is a fast process. Hence, in this case, there is no need for monetary cooperation.

Table 3.9
Monetary Cooperation between Europe and America
Inflation in Europe and America

	Europe	America
Initial Output	1060	1030
Inflation	6	3
Change in Money Supply	- 26.25	- 18.75
Output	1000	1000
Inflation	0	0

Part Four

The World of Three Monetary Regions

Chapter 1

Monetary Competition between Europe, America and Asia

1. The Dynamic Model

1) The static model. As a point of reference, consider the static model. The world consists of three monetary regions, say Europe, America and Asia. The exchange rates between Europe, America and Asia are flexible. There is international trade between Europe, America and Asia. There is perfect capital mobility between Europe, America and Asia. European goods, American goods, and Asian goods are imperfect substitutes for each other. European output is determined by the demand for European goods. American output is determined by the demand for American goods. And Asian output is determined by the demand for Asian goods. European money demand equals European money supply. American money demand equals American money supply. And Asian money demand equals Asian money supply. The monetary regions are the same size and have the same behavioural functions. Nominal wages and prices adjust slowly.

As a result, an increase in European money supply raises European output. On the other hand, it lowers both American output and Asian output. Here the rise in European output exceeds the fall in American output and Asian output taken together. Correspondingly, an increase in American money supply raises American output. On the other hand, it lowers both European output and Asian output. Here the rise in American output exceeds the fall in European output and Asian output taken together. By analogy, an increase in Asian money supply raises Asian output. On the other hand, it lowers both European output and American output. Here the rise in Asian output exceeds the fall in European output and American output taken together.

In the numerical example, a 1 percent increase in European money supply causes a 0.83 percent increase in European output, a 0.17 percent decline in American output, and a 0.17 percent decline in Asian output. Correspondingly, a

1 percent increase in American money supply causes a 0.83 percent increase in American output, 0.17 percent decline in European output, and 0.17 percent decline in Asian output. By analogy, a 1 percent increase in Asian money supply causes a 0.83 percent increase in Asian output, a 0.17 percent decline in European output, and a 0.17 percent decline in American output. That is to say, the internal effect of monetary policy is very large, and the external effect of monetary policy is large.

Now have a closer look at the process of adjustment. An increase in European money supply causes a depreciation of the euro and a decline in the world interest rate. The depreciation of the euro raises European exports but lowers American exports and Asian exports. The decline in the world interest rate raises European investment, American investment, and Asian investment. The net effect is that European output goes up. However, American output and Asian output go down. This model is in the tradition of the Mundell-Fleming model, see Carlberg (2000) p. 205.

The static model can be represented by a system of three equations:

$$Y_1 = A_1 + \alpha M_1 - \beta M_2 - \beta M_3 \quad (1)$$

$$Y_2 = A_2 + \alpha M_2 - \beta M_1 - \beta M_3 \quad (2)$$

$$Y_3 = A_3 + \alpha M_3 - \beta M_1 - \beta M_2 \quad (3)$$

According to equation (1), European output Y_1 is determined by European money supply M_1 , American money supply M_2 , Asian money supply M_3 , and some other factors called A_1 . According to equation (2), American output Y_2 is determined by American money supply M_2 , European money supply M_1 , Asian money supply M_3 , and some other factors called A_2 . According to equation (3), Asian output Y_3 is determined by Asian money supply M_3 , European money supply M_1 , American money supply M_2 , and some other factors called A_3 . Here α and β denote the monetary policy multipliers. The internal effect of monetary policy is positive $\alpha > 0$. By contrast, the external effect of monetary policy is negative $\beta > 0$. In absolute values, the internal effect is larger than the external effect $\alpha > 2\beta$. The endogenous variables are European output, American output, and Asian output.

2) The dynamic model. At the beginning there is unemployment in Europe, America and Asia. The target of the European central bank is full employment in Europe. The instrument of the European central bank is European money supply. The target of the American central bank is full employment in America. The instrument of the American central bank is American money supply. The target of the Asian central bank is full employment in Asia. The instrument of the Asian central bank is Asian money supply. We assume that the European central bank, the American central bank, and the Asian central bank decide simultaneously and independently.

The dynamic model can be characterized by a system of three equations:

$$\bar{Y}_1 = A_1 + \alpha M_1 - \beta M_2^{-1} - \beta M_3^{-1} \quad (4)$$

$$\bar{Y}_2 = A_2 + \alpha M_2 - \beta M_1^{-1} - \beta M_3^{-1} \quad (5)$$

$$\bar{Y}_3 = A_3 + \alpha M_3 - \beta M_1^{-1} - \beta M_2^{-1} \quad (6)$$

Here is a list of the new symbols:

- \bar{Y}_1 full-employment output in Europe
- \bar{Y}_2 full-employment output in America
- \bar{Y}_3 full-employment output in Asia
- M_1 European money supply this period
- M_2 American money supply this period
- M_3 Asian money supply this period
- M_1^{-1} European money supply last period
- M_2^{-1} American money supply last period
- M_3^{-1} Asian money supply last period.

According to equation (4), the European central bank sets European money supply so as to reach full employment in Europe, given American money supply last period and Asian money supply last period. According to equation (5), the American central bank sets American money supply so as to reach full employment in America, given European money supply last period and Asian money supply last period. According to equation (6), the Asian central bank sets

Asian money supply so as to reach full employment in Asia, given European money supply last period and American money supply last period.

To summarize, equation (4) shows the policy response in Europe, equation (5) shows the policy response in America, and equation (6) shows the policy response in Asia. The endogenous variables are European money supply this period M_1 , American money supply this period M_2 , and Asian money supply this period M_3 .

In addition there is an output lag. European output next period is determined by European money supply this period, American money supply this period, and Asian money supply this period. American output next period is determined by American money supply this period, European money supply this period, and Asian money supply this period. Asian output next period is determined by Asian money supply this period, European money supply this period, and American money supply this period.

3) The steady state. The steady state can be represented in terms of the initial output gap and the total increase in money supply. Taking differences in equations (1), (2) and (3), the model of the steady state can be written as follows:

$$\Delta Y_1 = \alpha \Delta M_1 - \beta \Delta M_2 - \beta \Delta M_3 \quad (7)$$

$$\Delta Y_2 = \alpha \Delta M_2 - \beta \Delta M_1 - \beta \Delta M_3 \quad (8)$$

$$\Delta Y_3 = \alpha \Delta M_3 - \beta \Delta M_1 - \beta \Delta M_2 \quad (9)$$

Here ΔY_1 is the initial output gap in Europe, ΔY_2 is the initial output gap in America, ΔY_3 is the initial output gap in Asia, ΔM_1 is the total increase in European money supply, ΔM_2 is the total increase in American money supply, and ΔM_3 is the total increase in Asian money supply. The endogenous variables are ΔM_1 , ΔM_2 and ΔM_3 .

The solution to the system (7), (8) and (9) is:

$$\Delta M_1 = \frac{(\alpha - \beta)\Delta Y_1 + \beta(\Delta Y_2 + \Delta Y_3)}{\alpha^2 - \alpha\beta - 2\beta^2} \quad (10)$$

$$\Delta M_2 = \frac{(\alpha - \beta)\Delta Y_2 + \beta(\Delta Y_1 + \Delta Y_3)}{\alpha^2 - \alpha\beta - 2\beta^2} \quad (11)$$

$$\Delta M_3 = \frac{(\alpha - \beta)\Delta Y_3 + \beta(\Delta Y_1 + \Delta Y_2)}{\alpha^2 - \alpha\beta - 2\beta^2} \quad (12)$$

There is a steady state if and only if $\alpha \neq 2\beta$. Owing to the assumption $\alpha > 2\beta$, this condition is satisfied. Moreover, the stability condition is $\alpha > 2\beta$. That means, the steady state is stable if and only if the internal effect of monetary policy is larger than the external effect of monetary policy. By assumption, this condition is fulfilled. As a result, monetary competition between Europe, America and Asia leads to full employment in each of the regions.

2. Some Numerical Examples

To illustrate the dynamic model, have a look at some numerical examples. For ease of exposition, without loss of generality, assume $\alpha = 3.33$ and $\beta = 0.67$, see Carlberg (2000) p. 209. On this assumption, the static model can be written as follows:

$$Y_1 = A_1 + 3.33M_1 - 0.67M_2 - 0.67M_3 \quad (1)$$

$$Y_2 = A_2 + 3.33M_2 - 0.67M_1 - 0.67M_3 \quad (2)$$

$$Y_3 = A_3 + 3.33M_3 - 0.67M_1 - 0.67M_2 \quad (3)$$

The endogenous variables are European, American and Asian output. Obviously, an increase in European money supply of 100 causes an increase in European output of 333. On the other hand, it causes a decline in American output of 67 and a decline in Asian output of equally 67. So the increase in world output is 200. Further let full-employment output in Europe be 1000, let full-employment

output in America be 1000, and let full-employment output in Asia be equally 1000.

It proves useful to study two distinct cases:

- the regions have the same unemployment
- the regions differ in unemployment.

1) The regions have the same unemployment. Let initial output in Europe be 940, let initial output in America be 940, and let initial output in Asia be the same. Step 1 refers to the policy response. The output gap in Europe is 60. The monetary policy multiplier in Europe is 3.33. So what is needed in Europe is an increase in European money supply of 18. The output gap in America is 60. The monetary policy multiplier in America is 3.33. So what is needed in America is an increase in American money supply of 18. The output gap in Asia is 60. The monetary policy multiplier in Asia is 3.33. So what is needed in Asia is an increase in Asian money supply of 18.

Step 2 refers to the output lag. The increase in European money supply of 18 causes an increase in European output of 60. As a side effect, it causes a decline in American output of 12 and a decline in Asian output of equally 12. The increase in American money supply of 18 causes an increase in American output of 60. As a side effect, it causes a decline in European output of 12 and a decline in Asian output of equally 12. The increase in Asian money supply of 18 causes an increase in Asian output of 60. As a side effect, it causes a decline in European output of 12 and a decline in American output of equally 12. The net effect is an increase in European output of 36, an increase in American output of 36, and an increase in Asian output of equally 36. As a consequence, European output goes from 940 to 976, American output goes from 940 to 976, and Asian output goes from 940 to 976. And so on. Table 4.1 presents a synopsis.

What are the dynamic characteristics of this process? There are repeated increases in European money supply, American money supply, and Asian money supply. Correspondingly, there are repeated increases in European output, American output, and Asian output. In each round, the output gap declines by 60 percent. Taking the sum over all periods, the increase in European money supply is 30, the increase in American money supply is 30, and the increase in Asian money supply is equally 30, see equations (10), (11) and (12) from the preceding

section. The effective multiplier in Europe is 2, the effective multiplier in America is 2, and the effective multiplier in Asia is equally 2.

Coming to an end, compare the world of three regions with the world of two regions. In the world of two regions, in each round, the output gap declines by 67 percent. By contrast, in the world of three regions, in each round, the output gap declines by 60 percent. That is to say, in the world of two regions, monetary competition is a relatively fast process. And in the world of three regions, monetary competition is a relatively slow process. The underlying reason is that, in the world of two regions, monetary spillovers are relatively small. And in the world of three regions, monetary spillovers are relatively large.

Table 4.1
Monetary Competition between Europe, America and Asia

	Europe	America	Asia
Initial Output	940	940	940
Change in Money Supply	18	18	18
Output	976	976	976
Change in Money Supply	7.2	7.2	7.2
Output	990.4	990.4	990.4
<i>and so on</i>	...	...	...

2) The regions differ in unemployment. Let initial output in Europe be 940, let initial output in America be 950, and let initial output in Asia be 970. Step 1 refers to the policy response. The output gap in Europe is 60. The monetary policy multiplier in Europe is 3.33. So what is needed in Europe is an increase in European money supply of 18. The output gap in America is 50. The monetary policy multiplier in America is 3.33. So what is needed in America is an increase in American money supply of 15. The output gap in Asia is 30. The monetary

policy multiplier in Asia is 3.33. So what is needed in Asia is an increase in Asian money supply of 9.

Step 2 refers to the output lag. The increase in European money supply of 18 causes an increase in European output of 60. As a side effect, it causes a decline in American output of 12 and a decline in Asian output of equally 12. The increase in American money supply of 15 causes an increase in American output of 50. As a side effect, it causes a decline in European output of 10 and a decline in Asian output of equally 10. The increase in Asian money supply of 9 causes an increase in Asian output of 30. As a side effect, it causes a decline in European output of 6 and a decline in American output of equally 6. The net effect is an increase in European output of 44, an increase in American output of 32, and an increase in Asian output of 8. As a consequence, European output goes from 940 to 984, American output goes from 950 to 982, and Asian output goes from 970 to 978. And so on. Table 4.2 gives an overview.

There are repeated increases in money supply. There are repeated increases in output. The total increase in European money supply is 26.7, the total increase in American money supply is 24.2, and the total increase in Asian money supply is 19.2, see equations (10), (11) and (12) from the previous section. The effective multiplier in Europe is 2.3, the effective multiplier in America is 2.1, and the effective multiplier in Asia is 1.6.

Table 4.2
Monetary Competition between Europe, America and Asia

	Europe	America	Asia
Initial Output	940	950	970
Change in Money Supply	18	15	9
Output	984	982	978
Change in Money Supply	4.8	5.4	6.6
Output	992.0	992.4	993.2
<i>and so on</i>	...	...	...

Chapter 2

Monetary Cooperation between Europe, America and Asia

1. The Model

At the beginning there is unemployment in Europe, America and Asia. The targets of monetary cooperation are full employment in Europe, full employment in America, and full employment in Asia. The instruments of monetary cooperation are European money supply, American money supply, and Asian money supply. So there are three targets and three instruments.

The policy model can be stated in terms of the initial output gap and the required increase in money supply:

$$\Delta Y_1 = \alpha \Delta M_1 - \beta \Delta M_2 - \beta \Delta M_3 \quad (1)$$

$$\Delta Y_2 = \alpha \Delta M_2 - \beta \Delta M_1 - \beta \Delta M_3 \quad (2)$$

$$\Delta Y_3 = \alpha \Delta M_3 - \beta \Delta M_1 - \beta \Delta M_2 \quad (3)$$

Here ΔY_1 denotes the initial output gap in Europe, ΔY_2 is the initial output gap in America, and ΔY_3 is the initial output gap in Asia. ΔM_1 denotes the required increase in European money supply, ΔM_2 is the required increase in American money supply, and ΔM_3 is the required increase in Asian money supply. The endogenous variables are ΔM_1 , ΔM_2 and ΔM_3 .

The solution to the system (1), (2) and (3) is:

$$\Delta M_1 = \frac{(\alpha - \beta)\Delta Y_1 + \beta(\Delta Y_2 + \Delta Y_3)}{\alpha^2 - \alpha\beta - 2\beta^2} \quad (4)$$

$$\Delta M_2 = \frac{(\alpha - \beta)\Delta Y_2 + \beta(\Delta Y_1 + \Delta Y_3)}{\alpha^2 - \alpha\beta - 2\beta^2} \quad (5)$$

$$\Delta M_3 = \frac{(\alpha - \beta)\Delta Y_3 + \beta(\Delta Y_1 + \Delta Y_2)}{\alpha^2 - \alpha\beta - 2\beta^2} \quad (6)$$

There is a solution if and only if $\alpha \neq 2\beta$. Due to the assumption $\alpha > 2\beta$, this condition is fulfilled. As a result, monetary cooperation between Europe, America and Asia can achieve full employment in each of the regions.

According to equation (4), the required increase in European money supply depends on the initial output gap in Europe, the initial output gap in America, the initial output gap in Asia, the direct multiplier α , and the cross multiplier β . The larger the initial output gap in Europe, the larger is the required increase in European money supply. Moreover, the larger the initial output gap in America or Asia, the larger is the required increase in European money supply. According to equation (5), the required increase in American money supply depends on the initial output gap in America, the initial output gap in Europe, the initial output gap in Asia, the direct multiplier, and the cross multiplier. According to equation (6), the required increase in Asian money supply depends on the initial output gap in Asia, the initial output gap in Europe, the initial output gap in America, the direct multiplier, and the cross multiplier.

2. Some Numerical Examples

To illustrate the policy model, have a look at some numerical examples. For ease of exposition, without losing generality, assume $\alpha = 3.33$ and $\beta = 0.67$. It proves useful to consider two distinct cases:

- the regions have the same unemployment
- the regions differ in unemployment.

1) The regions have the same unemployment. Let initial output in Europe be 940, let initial output in America be 940, and let initial output in Asia be the same. In other words, the output gap in Europe is 60, the output gap in America

is 60, and the output gap in Asia is the same. What is needed, according to equations (4), (5) and (6) from the preceding section, is an increase in European money supply of 30, an increase in American money supply of 30, and an increase in Asian money supply of equally 30.

The increase in European money supply of 30 raises European output by 100. On the other hand, it lowers American output and Asian output by 20 each. The increase in American money supply of 30 raises American output by 100. On the other hand, it lowers European output and Asian output by 20 each. The increase in Asian money supply of 30 raises Asian output by 100. On the other hand, it lowers European output and American output by 20 each. The net effect is an increase in European output of 60, an increase in American output of 60, and an increase in Asian output of equally 60. As a consequence, European output goes from 940 to 1000, American output goes from 940 to 1000, and Asian output goes from 940 to 1000. As a result, monetary cooperation can achieve full employment. For a synopsis see Table 4.3.

Table 4.3
Monetary Cooperation between Europe, America and Asia

	Europe	America	Asia
Initial Output	940	940	940
Change in Money Supply	30	30	30
Output	1000	1000	1000

2) The regions differ in unemployment. Let initial output in Europe be 940, let initial output in America be 950, and let initial output in Asia be 970. In other words, the output gap in Europe is 60, the output gap in America is 50, and the output gap in Asia is 30. What is needed, according to equations (4), (5) and (6) from the previous section, is an increase in European money supply of 26.7, an increase in American money supply of 24.2, and an increase in Asian money supply of 19.2.

The increase in European money supply of 26.7 raises European output by 88.9. On the other hand, it lowers American output and Asian output by 17.8 each. The increase in American money supply of 24.2 raises American output by 80.6. On the other hand, it lowers European output and Asian output by 16.1 each. The increase in Asian money supply of 19.2 raises Asian output by 63.9. On the other hand, it lowers European output and American output by 12.8 each. The net effect is an increase in European output of 60, an increase in American output of 50, and an increase in Asian output of 30. As a consequence, European output goes from 940 to 1000, American output goes from 950 to 1000, and Asian output goes from 970 to 1000. As a result, monetary cooperation can achieve full employment. For an overview see Table 4.4.

Table 4.4
Monetary Cooperation between Europe, America and Asia

	Europe	America	Asia
Initial Output	940	950	970
Change in Money Supply	26.7	24.2	19.2
Output	1000	1000	1000

Chapter 3

Fiscal Competition: Perfect Capital Mobility

1. The Dynamic Model

1) The static model. As a point of reference, consider the static model. The world consists of three monetary regions, say Europe, America and Asia. The exchange rates between Europe, America and Asia are flexible. There is international trade between Europe, America and Asia. There is perfect capital mobility between Europe, America and Asia. European goods, American goods, and Asian goods are imperfect substitutes for each other. European output is determined by the demand for European goods. American output is determined by the demand for American goods. And Asian output is determined by the demand for Asian goods. European money demand equals European money supply. American money demand equals American money supply. And Asian money demand equals Asian money supply. The monetary regions are the same size and have the same behavioural functions. Nominal wages and prices adjust slowly.

As a result, an increase in European government purchases raises European output, American output and Asian output, to the same extent respectively. Correspondingly, an increase in American government purchases raises American output, European output and Asian output, to the same extent respectively. By analogy, an increase in Asian government purchases raises Asian output, European output and American output, to the same extent respectively.

In the numerical example, an increase in European government purchases of 100 causes an increase in European output of 67, an increase in American output of 67, and an increase in Asian output of equally 67. Correspondingly, an increase in American government purchases of 100 causes an increase in American output of 67, an increase in European output of 67, and an increase in Asian output of equally 67. By analogy, an increase in Asian government purchases of 100 causes an increase in Asian output of 67, an increase in

European output of 67, and an increase in American output of equally 67. That means, the internal effect of fiscal policy is very small, whereas the external effect of fiscal policy is very large.

Now have a closer look at the process of adjustment. An increase in European government purchases causes an appreciation of the euro and an increase in the world interest rate. The appreciation of the euro lowers European exports but raises American exports and Asian exports. The increase in the world interest rate lowers European investment, American investment, and Asian investment. The net effect is that European output, American output, and Asian output go up. This model is in the tradition of the Mundell-Fleming model, see Carlberg (2000) p. 205.

The static model can be represented by a system of three equations:

$$Y_1 = A_1 + \gamma G_1 + \gamma G_2 + \gamma G_3 \quad (1)$$

$$Y_2 = A_2 + \gamma G_2 + \gamma G_1 + \gamma G_3 \quad (2)$$

$$Y_3 = A_3 + \gamma G_3 + \gamma G_1 + \gamma G_2 \quad (3)$$

According to equation (1), European output Y_1 is determined by European government purchases G_1 , American government purchases G_2 , Asian government purchases G_3 , and some other factors called A_1 . According to equation (2), American output is determined by American government purchases, European government purchases, Asian government purchases, and some other factors. According to equation (3), Asian output is determined by Asian government purchases, European government purchases, American government purchases, and some other factors. Here γ is the fiscal policy multiplier. The internal effect of fiscal policy is positive $\gamma > 0$. The external effect of fiscal policy is positive too $\gamma > 0$. In a sense, the internal effect is smaller than the external effect $\gamma < 2\gamma$. The endogenous variables are European output, American output, and Asian output.

2) The dynamic model. This section deals with fiscal competition between Europe, America and Asia. At the beginning there is unemployment in each of the regions. The target of the European government is full employment in

Europe. The instrument of the European government is European government purchases. The target of the American government is full employment in America. The instrument of the American government is American government purchases. The target of the Asian government is full employment in Asia. The instrument of the Asian government is Asian government purchases. We assume that the European government, the American government, and the Asian government decide simultaneously and independently.

The dynamic model can be characterized by a system of three equations:

$$\bar{Y}_1 = A_1 + \gamma G_1 + \gamma G_2^{-1} + \gamma G_3^{-1} \quad (4)$$

$$\bar{Y}_2 = A_2 + \gamma G_2 + \gamma G_1^{-1} + \gamma G_3^{-1} \quad (5)$$

$$\bar{Y}_3 = A_3 + \gamma G_3 + \gamma G_1^{-1} + \gamma G_2^{-1} \quad (6)$$

Here is a list of the new symbols:

- \bar{Y}_1 full-employment output in Europe
- \bar{Y}_2 full-employment output in America
- \bar{Y}_3 full-employment output in Asia
- G_1 European government purchases this period
- G_2 American government purchases this period
- G_3 Asian government purchases this period
- G_1^{-1} European government purchases last period
- G_2^{-1} American government purchases last period
- G_3^{-1} Asian government purchases last period.

According to equation (4), the European government sets European government purchases so as to reach full employment in Europe, given American government purchases last period and Asian government purchases last period. According to equation (5), the American government sets American government purchases so as to reach full employment in America, given European government purchases last period and Asian government purchases last period. According to equation (6), the Asian government sets Asian government purchases so as to reach full employment in Asia, given European government purchases last period and American government purchases last period.

To summarize, equation (4) shows the policy response in Europe, equation (5) shows the policy response in America, and equation (6) shows the policy response in Asia. The endogenous variables are European government purchases this period G_1 , American government purchases this period G_2 , and Asian government purchases this period G_3 .

In addition there is an output lag. European output next period is determined by European government purchases this period, American government purchases this period, and Asian government purchases this period. American output next period is determined by American government purchases this period, European government purchases this period, and Asian government purchases this period. Asian output next period is determined by Asian government purchases this period, European government purchases this period, and American government purchases this period.

3) The steady state. The model of the steady state can be written as follows:

$$\bar{Y}_1 = A_1 + \gamma G_1 + \gamma G_2 + \gamma G_3 \quad (7)$$

$$\bar{Y}_2 = A_2 + \gamma G_2 + \gamma G_1 + \gamma G_3 \quad (8)$$

$$\bar{Y}_3 = A_3 + \gamma G_3 + \gamma G_1 + \gamma G_2 \quad (9)$$

The endogenous variables are G_1 , G_2 and G_3 . Now take differences between equations (7), (8) and (9) to reach:

$$\bar{Y}_1 - \bar{Y}_2 = A_1 - A_2 \quad (10)$$

$$\bar{Y}_1 - \bar{Y}_3 = A_1 - A_3 \quad (11)$$

$$\bar{Y}_2 - \bar{Y}_3 = A_2 - A_3 \quad (12)$$

However, this is in direct contradiction to the assumption that \bar{Y}_1 , \bar{Y}_2 , \bar{Y}_3 , A_1 , A_2 and A_3 are given independently. As a result, there is no steady state of fiscal competition. In other words, fiscal competition between Europe, America and Asia does not lead to full employment in each of the regions. The underlying reason is the large external effect of fiscal policy.

2. A Numerical Example

To illustrate the dynamic model, have a look at a numerical example. For ease of exposition, without loss of generality, assume $\gamma = 0.67$, see Carlberg (2000) p. 207. On this assumption, the static model can be written as follows:

$$Y_1 = A_1 + 0.67G_1 + 0.67G_2 + 0.67G_3 \quad (1)$$

$$Y_2 = A_2 + 0.67G_2 + 0.67G_1 + 0.67G_3 \quad (2)$$

$$Y_3 = A_3 + 0.67G_3 + 0.67G_1 + 0.67G_2 \quad (3)$$

The endogenous variables are European, American and Asian output. Evidently, an increase in European government purchases of 100 causes an increase in European output of 67, an increase in American output of 67, and an increase in Asian output of equally 67. So the increase in world output is 200. Further let full-employment output in Europe be 1000, let full-employment output in America be 1000, and let full-employment output in Asia be equally 1000.

Let initial output in Europe be 970, let initial output in America be 970, and let initial output in Asia be the same. Step 1 refers to the policy response. The output gap in Europe is 30. The fiscal policy multiplier in Europe is 0.67. So what is needed in Europe is an increase in European government purchases of 45. The output gap in America is 30. The fiscal policy multiplier in America is 0.67. So what is needed in America is an increase in American government purchases of 45. The output gap in Asia is 30. The fiscal policy multiplier in Asia is 0.67. So what is needed in Asia is an increase in Asian government purchases of 45.

Step 2 refers to the output lag. The increase in European government purchases of 45 causes an increase in European output of 30. As a side effect, it causes an increase in American output of 30 and an increase in Asian output of equally 30. The increase in American government purchases of 45 causes an increase in American output of 30. As a side effect, it causes an increase in European output of 30 and an increase in Asian output of equally 30. The increase in Asian government purchases of 45 causes an increase in Asian output

of 30. As a side effect, it causes an increase in European output of 30 and an increase in American output of equally 30. The total effect is an increase in European output of 90, an increase in American output of 90, and an increase in Asian output of equally 90. As a consequence, European output goes from 970 to 1060, American output goes from 970 to 1060, and Asian output goes from 970 to 1060. And so on. Table 4.5 presents a synopsis.

What are the dynamic characteristics of this process? There are explosive oscillations in European government purchases, American government purchases, and Asian government purchases. Correspondingly, there are explosive oscillations in European output, American output, and Asian output. In each round, in absolute values, the output gap doubles. After a few periods, the economy will collapse.

Coming to an end, compare the world of three regions with the world of two regions. In the world of two regions, fiscal competition causes uniform oscillations in government purchases and output. By contrast, in the world of three regions, fiscal competition causes explosive oscillations in government purchases and output.

Table 4.5
Fiscal Competition between Europe, America and Asia
 Perfect Capital Mobility

	Europe	America	Asia
Initial Output	970	970	970
Change in Government Purchases	45	45	45
Output	1060	1060	1060
Change in Government Purchases	- 90	- 90	- 90
Output	880	880	880
<i>and so on</i>	...	...	...

Chapter 4

Fiscal Competition: Imperfect Capital Mobility

1. The Dynamic Model

1) The static model. In this chapter we assume imperfect capital mobility between Europe, America and Asia. Under perfect capital mobility, an increase in European government purchases raises European output, American output and Asian output, to the same extent respectively. Under zero capital mobility, an increase in European government purchases raises European output to a much larger degree. On the other hand, it has no effect on American output or Asian output. Under imperfect capital mobility, an increase in European government purchases raises European output, American output and Asian output. Here the rise in European output is relatively large, whereas the rise in American output and Asian output is relatively small.

To illustrate this, consider a numerical example. Under perfect capital mobility, an increase in European government purchases of 100 causes an increase in European output of 67, an increase in American output of 67, and an increase in Asian output of equally 67. So the increase in world output is 200. Under zero capital mobility, an increase in European government purchases of 100 causes an increase in European output of 200, an increase in American output of zero, and an increase in Asian output of equally zero. So the increase in world output is 200 again. On this basis we assume that, under imperfect capital mobility, an increase in European government purchases of 100 causes an increase in European output of 133, an increase in American output of 33, and an increase in Asian output of equally 33. So the increase in world output is still 200.

That means, under perfect capital mobility, fiscal spillovers are very large. Under zero capital mobility, fiscal spillovers are zero. And under imperfect capital mobility, fiscal spillovers are medium size. What does this imply for fiscal competition? Given imperfect capital mobility, is fiscal competition a stable process or an unstable one?

The static model can be represented by a system of three equations:

$$Y_1 = A_1 + \gamma G_1 + \delta G_2 + \delta G_3 \quad (1)$$

$$Y_2 = A_2 + \gamma G_2 + \delta G_1 + \delta G_3 \quad (2)$$

$$Y_3 = A_3 + \gamma G_3 + \delta G_1 + \delta G_2 \quad (3)$$

According to equation (1), European output is determined by European government purchases, American government purchases, and Asian government purchases. According to equation (2), American output is determined by American government purchases, European government purchases, and Asian government purchases. According to equation (3), Asian output is determined by Asian government purchases, European government purchases, and American government purchases. Here γ and δ denote the fiscal policy multipliers. The internal effect of fiscal policy is positive $\gamma > 0$. The external effect of fiscal policy is positive too $\delta > 0$. And what is more, the internal effect is larger than the external effect $\gamma > \delta$.

2) The dynamic model. This section deals with fiscal competition between Europe, America and Asia. At the beginning there is unemployment in each of the regions. The dynamic model can be characterized by a system of three equations:

$$\bar{Y}_1 = A_1 + \gamma G_1 + \delta G_2^{-1} + \delta G_3^{-1} \quad (4)$$

$$\bar{Y}_2 = A_2 + \gamma G_2 + \delta G_1^{-1} + \delta G_3^{-1} \quad (5)$$

$$\bar{Y}_3 = A_3 + \gamma G_3 + \delta G_1^{-1} + \delta G_2^{-1} \quad (6)$$

According to equation (4), the European government sets European government purchases so as to reach full employment in Europe, given American government purchases last period and Asian government purchases last period. According to equation (5), the American government sets American government purchases so as to reach full employment in America, given European government purchases last period and Asian government purchases last period. According to equation (6), the Asian government sets Asian government purchases so as to reach full

employment in Asia, given European government purchases last period and American government purchases last period.

To summarize, equation (4) shows the policy response in Europe, equation (5) shows the policy response in America, and equation (6) shows the policy response in Asia. The endogenous variables are European government purchases this period, American government purchases this period, and Asian government purchases this period.

In addition there is an output lag. European output next period is determined by European government purchases this period, American government purchases this period, and Asian government purchases this period. Correspondingly, American output next period is determined by American government purchases this period, European government purchases this period, and Asian government purchases this period. By analogy, Asian output next period is determined by Asian government purchases this period, European government purchases this period, and American government purchases this period.

3) The steady state. The steady state can be represented in terms of the initial output gap and the total increase in government purchases. Taking differences in equations (1), (2) and (3), the model of the steady state can be written as follows:

$$\Delta Y_1 = \gamma \Delta G_1 + \delta \Delta G_2 + \delta \Delta G_3 \quad (7)$$

$$\Delta Y_2 = \gamma \Delta G_2 + \delta \Delta G_1 + \delta \Delta G_3 \quad (8)$$

$$\Delta Y_3 = \gamma \Delta G_3 + \delta \Delta G_1 + \delta \Delta G_2 \quad (9)$$

Here ΔY_1 is the initial output gap in Europe, ΔY_2 is the initial output gap in America, and ΔY_3 is the initial output gap in Asia. ΔG_1 is the total increase in European government purchases, ΔG_2 is the total increase in American government purchases, and ΔG_3 is the total increase in Asian government purchases. The endogenous variables are ΔG_1 , ΔG_2 and ΔG_3 .

The solution to the system (7), (8) and (9) is:

$$\Delta G_1 = \frac{(\gamma + \delta)\Delta Y_1 - \delta(\Delta Y_2 + \Delta Y_3)}{\gamma^2 + \gamma\delta - 2\delta^2} \quad (10)$$

$$\Delta G_2 = \frac{(\gamma + \delta)\Delta Y_2 - \delta(\Delta Y_1 + \Delta Y_3)}{\gamma^2 + \gamma\delta - 2\delta^2} \quad (11)$$

$$\Delta G_3 = \frac{(\gamma + \delta)\Delta Y_3 - \delta(\Delta Y_1 + \Delta Y_2)}{\gamma^2 + \gamma\delta - 2\delta^2} \quad (12)$$

There is a steady state if and only if $\gamma \neq \delta$. Owing to the assumption $\gamma > \delta$, this condition is satisfied. Moreover, the stability condition is $\gamma > 2\delta$. In other words, the steady state is stable if and only if the internal effect of fiscal policy γ is larger than the external effect of fiscal policy 2δ . That means, under low capital mobility, fiscal competition is a stable process. However, under high capital mobility, fiscal competition is an unstable process. Put another way, under low capital mobility, fiscal competition leads to full employment. On the other hand, under high capital mobility, fiscal competition does not lead to full employment.

2. Some Numerical Examples

To illustrate the dynamic model, have a look at some numerical examples. It proves useful to study two distinct cases:

- low capital mobility
- high capital mobility.

1) Low capital mobility. Assume $\gamma = 1.33$ and $\delta = 0.33$, for the motivation see the preceding section. On this assumption the static model can be written as follows:

$$Y_1 = A_1 + 1.33G_1 + 0.33G_2 + 0.33G_3 \quad (1)$$

$$Y_2 = A_2 + 1.33G_2 + 0.33G_1 + 0.33G_3 \quad (2)$$

$$Y_3 = A_3 + 1.33G_3 + 0.33G_1 + 0.33G_2 \quad (3)$$

Obviously, an increase in European government purchases of 100 causes an increase in European output of 133, an increase in American output of 33, and an increase in Asian output of equally 33. So the increase in world output is 200. Further let full-employment output in Europe be 1000, let full-employment output in America be 1000, and let full-employment output in Asia be equally 1000.

Let initial output in Europe be 940, let initial output in America be 940, and let initial output in Asia be the same. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 1.33. So what is needed in Europe is an increase in European government purchases of 45. The output gap in America is 60. The fiscal policy multiplier in America is 1.33. So what is needed in America is an increase in American government purchases of 45. The output gap in Asia is 60. The fiscal policy multiplier in Asia is 1.33. So what is needed in Asia is an increase in Asian government purchases of 45.

Step 2 refers to the output lag. The increase in European government purchases of 45 causes an increase in European output of 60. As a side effect, it causes an increase in American output of 15 and an increase in Asian output of equally 15. The increase in American government purchases of 45 causes an increase in American output of 60. As a side effect, it causes an increase in European output of 15 and an increase in Asian output of equally 15. The increase in Asian government purchases of 45 causes an increase in Asian output of 60. As a side effect, it causes an increase in European output of 15 and an increase in American output of equally 15. The total effect is an increase in European output of 90, an increase in American output of 90, and an increase in Asian output of equally 90. As a consequence, European output goes from 940 to 1030, American output goes from 940 to 1030, and Asian output goes from 940 to 1030. And so on. Table 4.6 gives an overview.

What are the dynamic characteristics of this process? There are damped oscillations in European government purchases, American government purchases, and Asian government purchases. Correspondingly, there are damped

oscillations in European output, American output, and Asian output. In each round, in absolute values, the output gap declines by 50 percent. As a result, the process of fiscal competition leads to full employment. Taking the sum over all periods, the increase in European government purchases is 30, the increase in American government purchases is 30, and the increase in Asian government purchases is equally 30, see equations (10), (11) and (12) in the previous section. The effective multiplier in Europe is 0.5, the effective multiplier in America is 0.5, and the effective multiplier in Asia is equally 0.5.

Coming to an end, compare the world of three regions with the world of two regions. In the world of two regions, in each round, the output gap declines by 67 percent. By contrast, in the world of three regions, in each round, the output gap declines by 50 percent. That is to say, in the world of two regions, fiscal competition is a relatively fast process. And in the world of three regions, fiscal competition is a relatively slow process. The underlying reason is that, in the world of two regions, fiscal spillovers are relatively small. And in the world of three regions, fiscal spillovers are relatively large.

Table 4.6

Fiscal Competition between Europe, America and Asia

Low Capital Mobility

	Europe	America	Asia
Initial Output	940	940	940
Change in Government Purchases	45	45	45
Output	1030	1030	1030
Change in Government Purchases	- 22.5	- 22.5	- 22.5
Output	985	985	985
<i>and so on</i>	...	...	...

2) High capital mobility. Assume $\gamma = 0.8$ and $\delta = 0.6$. Evidently, an increase in European government purchases of 100 causes an increase in European output of 80, an increase in American output of 60, and an increase in Asian output of equally 60. So the increase in world output is 200.

Let initial output in Europe be 940, let initial output in America be 940, and let initial output in Asia be the same. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 0.8. So what is needed in Europe is an increase in European government purchases of 75. The output gap in America is 60. The fiscal policy multiplier in America is 0.8. So what is needed in America is an increase in American government purchases of 75. The output gap in Asia is 60. The fiscal policy multiplier in Asia is 0.8. So what is needed in Asia is an increase in Asian government purchases of 75.

Step 2 refers to the output lag. The increase in European government purchases of 75 causes an increase in European output of 60. As a side effect, it causes an increase in American output of 45 and an increase in Asian output of equally 45. The increase in American government purchases of 75 causes an increase in American output of 60. As a side effect, it causes an increase in European output of 45 and an increase in Asian output of equally 45. The increase in Asian government purchases of 75 causes an increase in Asian output of 60. As a side effect, it causes an increase in European output of 45 and an increase in American output of equally 45. The total effect is an increase in European output of 150, an increase in American output of 150, and an increase in Asian output of equally 150. As a consequence, European output goes from 940 to 1090, American output goes from 940 to 1090, and Asian output goes from 940 to 1090. And so on. For a synopsis see Table 4.7.

There are explosive oscillations in European government purchases, American government purchases, and Asian government purchases. Correspondingly, there are explosive oscillations in European output, American output, and Asian output. In each round, in absolute values, the output gap grows by 50 percent. As a result, the process of fiscal competition does not lead to full employment. After a few periods, the economy will break down.

3) Comparing high capital mobility with low capital mobility. Under low capital mobility, fiscal competition leads to full employment. However, under

high capital mobility, fiscal competition does not lead to full employment. Under low capital mobility, there are damped oscillations in government purchases and output. On the other hand, under high capital mobility, there are explosive oscillations in government purchases and output.

Table 4.7
Fiscal Competition between Europe, America and Asia
 High Capital Mobility

	Europe	America	Asia
Initial Output	940	940	940
Change in Government Purchases	75	75	75
Output	1090	1090	1090
Change in Government Purchases	- 112.5	- 112.5	- 112.5
Output	865	865	865
<i>and so on</i>	...	...	...

Chapter 5

Fiscal Competition: Gradualist Policies

So far we have assumed that the governments follow a cold-turkey strategy. Now we assume that the governments follow a gradualist strategy. Besides we assume imperfect capital mobility between Europe, America and Asia. To be more specific, we assume high capital mobility, see Chapter 4 above. As a point of reference, consider the static model. It can be represented by a system of three equations:

$$Y_1 = A_1 + 0.8G_1 + 0.6G_2 + 0.6G_3 \quad (1)$$

$$Y_2 = A_2 + 0.8G_2 + 0.6G_1 + 0.6G_3 \quad (2)$$

$$Y_3 = A_3 + 0.8G_3 + 0.6G_1 + 0.6G_2 \quad (3)$$

Obviously, an increase in European government purchases of 100 causes an increase in European output of 80, an increase in American output of 60, and an increase in Asian output of equally 60. Further let full-employment output in Europe be 1000, let full-employment output in America be 1000, and let full-employment output in Asia be the same.

At the start there is unemployment in each of the regions. The general target of the European government is full employment in Europe. We assume that the European government follows a gradualist strategy. The specific target of the European government is to close the output gap in Europe by the fraction λ_1 . The general target of the American government is full employment in America. We assume that the American government follows a gradualist strategy. The specific target of the American government is to close the output gap in America by the fraction λ_2 . The general target of the Asian government is full employment in Asia. We assume that the Asian government follows a gradualist strategy. The specific target of the Asian government is to close the output gap in Asia by the fraction λ_3 . Under a gradualist strategy, does fiscal competition lead to full employment?

We assume $\lambda_1 = \lambda_2 = \lambda_3 = 0.6$. That means, the governments close the output gaps by 60 percent. Let initial output in Europe be 940, let initial output in America be 940, and let initial output in Asia be the same. Step 1 refers to the policy response. First consider fiscal policy in Europe. The output gap in Europe is 60. The specific target of the European government is to close the output gap in Europe by 60 percent, that is by 36. The fiscal policy multiplier in Europe is 0.8. So what is needed in Europe is an increase in European government purchases of 45. Second consider fiscal policy in America. The output gap in America is 60. The specific target of the American government is to close the output gap in America by 60 percent, that is by 36. The fiscal policy multiplier in America is 0.8. So what is needed in America is an increase in American government purchases of 45. Third consider fiscal policy in Asia. The output gap in Asia is 60. The specific target of the Asian government is to close the output gap in Asia by 60 percent, that is by 36. The fiscal policy multiplier in Asia is 0.8. So what is needed in Asia is an increase in Asian government purchases of 45.

Step 2 refers to the output lag. The increase in European government purchases of 45 causes an increase in European output of 36. As a side effect, it causes an increase in American output of 27 and an increase in Asian output of equally 27. The increase in American government purchases of 45 causes an increase in American output of 36. As a side effect, it causes an increase in European output of 27 and an increase in Asian output of equally 27. The increase in Asian government purchases of 45 causes an increase in Asian output of 36. As a side effect, it causes an increase in European output of 27 and an increase in American output of equally 27. The total effect is an increase in European output of 90, an increase in American output of 90, and an increase in Asian output of equally 90. As a consequence, European output goes from 940 to 1030, American output goes from 940 to 1030, and Asian output goes from 940 to 1030.

Step 3 refers to the policy response. First consider fiscal policy in Europe. The inflationary gap in Europe is 30. The specific target of the European government is to close the inflationary gap in Europe by 60 percent, that is by 18. The fiscal policy multiplier in Europe is 0.8. So what is needed in Europe is a reduction in European government purchases of 22.5. Second consider fiscal

policy in America. The inflationary gap in America is 30. The specific target of the American government is to close the inflationary gap in America by 60 percent, that is by 18. The fiscal policy multiplier in America is 0.8. So what is needed in America is a reduction in American government purchases of 22.5. Third consider fiscal policy in Asia. The inflationary gap in Asia is 30. The specific target of the Asian government is to close the inflationary gap in Asia by 60 percent, that is by 18. The fiscal policy multiplier in Asia is 0.8. So what is needed in Asia is a reduction in Asian government purchases of 22.5.

Step 4 refers to the output lag. The reduction in European government purchases of 22.5 causes a decline in European output of 18. As a side effect, it causes a decline in American output of 13.5 and a decline in Asian output of equally 13.5. The reduction in American government purchases of 22.5 causes a decline in American output of 18. As a side effect, it causes a decline in European output of 13.5 and a decline in Asian output of equally 13.5. The reduction in Asian government purchases of 22.5 causes a decline in Asian output of 18. As a side effect, it causes a decline in European output of 13.5 and a decline in American output of equally 13.5. The total effect is a decline in European output of 45, a decline in American output of 45, and a decline in Asian output of equally 45. As a consequence, European output goes from 1030 to 985, American output goes from 1030 to 985, and Asian output goes from 1030 to 985. And so on. For an overview see Table 4.8.

What are the dynamic characteristics of this process? There are damped oscillations in government purchases. Correspondingly, there are damped oscillations in output. In each round, in absolute values, the output gap declines by 50 percent. As a result, the process of fiscal competition leads to full employment.

Coming to an end, compare the gradualist strategy with the cold-turkey strategy. Under the cold-turkey strategy, in each round, the output gap grows by 50 percent. By contrast, under the gradualist strategy, in each round, the output gap declines by 50 percent. Under the cold-turkey strategy, fiscal competition is an unstable process. However, under the gradualist strategy, fiscal competition is a stable process. That is to say, under the cold-turkey strategy, fiscal competition does not lead to full employment. On the other hand, under the gradualist strategy, fiscal competition does lead to full employment. Judging from these

points of view, the gradualist strategy seems to be superior to the cold-turkey strategy.

Table 4.8
Fiscal Competition between Europe, America and Asia
 Gradualist Policies

	Europe	America	Asia
Initial Output	940	940	940
Change in Government Purchases	45	45	45
Output	1030	1030	1030
Change in Government Purchases	- 22.5	- 22.5	- 22.5
Output	985	985	985
<i>and so on</i>	...	...	...

Chapter 6

Fiscal Cooperation: Perfect Capital Mobility

This chapter deals with fiscal cooperation between Europe, America and Asia. In this chapter we assume perfect capital mobility. At the beginning there is unemployment in each of the regions. The targets of fiscal cooperation are full employment in Europe, full employment in America, and full employment in Asia. The instruments of fiscal cooperation are European government purchases, American government purchases, and Asian government purchases. So there are three targets and three instruments.

The policy model can be represented by a system of three equations:

$$\bar{Y}_1 = A_1 + \gamma G_1 + \gamma G_2 + \gamma G_3 \quad (1)$$

$$\bar{Y}_2 = A_2 + \gamma G_2 + \gamma G_1 + \gamma G_3 \quad (2)$$

$$\bar{Y}_3 = A_3 + \gamma G_3 + \gamma G_1 + \gamma G_2 \quad (3)$$

Here \bar{Y}_1 denotes full-employment output in Europe, \bar{Y}_2 is full-employment output in America, and \bar{Y}_3 is full-employment output in Asia. G_1 denotes the required level of European government purchases, G_2 is the required level of American government purchases, and G_3 is the required level of Asian government purchases.

Now take differences between equations (1), (2) and (3) to reach:

$$\bar{Y}_1 - \bar{Y}_2 = A_1 - A_2 \quad (4)$$

$$\bar{Y}_1 - \bar{Y}_3 = A_1 - A_3 \quad (5)$$

$$\bar{Y}_2 - \bar{Y}_3 = A_2 - A_3 \quad (6)$$

However, this is in direct contradiction to the assumption that \bar{Y}_1 , \bar{Y}_2 , \bar{Y}_3 , A_1 , A_2 and A_3 are given independently. As a result, there is no solution to fiscal

cooperation. In other words, fiscal cooperation between Europe, America and Asia cannot achieve full employment in each of the regions. The underlying reason is the large external effect of fiscal policy.

Chapter 7

Fiscal Cooperation: Imperfect Capital Mobility

1. The Model

This chapter deals with fiscal cooperation between Europe, America and Asia. In this chapter we assume imperfect capital mobility. At the start there is unemployment in each of the regions. The targets of fiscal cooperation are full employment in Europe, full employment in America, and full employment in Asia. The instruments of fiscal cooperation are European government purchases, American government purchases, and Asian government purchases. So there are three targets and three instruments.

The policy model can be stated in terms of the initial output gap and the required increase in government purchases:

$$\Delta Y_1 = \gamma \Delta G_1 + \delta \Delta G_2 + \delta \Delta G_3 \quad (1)$$

$$\Delta Y_2 = \gamma \Delta G_2 + \delta \Delta G_1 + \delta \Delta G_3 \quad (2)$$

$$\Delta Y_3 = \gamma \Delta G_3 + \delta \Delta G_1 + \delta \Delta G_2 \quad (3)$$

Here ΔY_1 denotes the initial output gap in Europe, ΔY_2 is the initial output gap in America, and ΔY_3 is the initial output gap in Asia. ΔG_1 denotes the required increase in European government purchases, ΔG_2 is the required increase in American government purchases, and ΔG_3 is the required increase in Asian government purchases. The endogenous variables are ΔG_1 , ΔG_2 and ΔG_3 .

The solution to the system (1), (2) and (3) is:

$$\Delta G_1 = \frac{(\gamma + \delta)\Delta Y_1 - \delta(\Delta Y_2 + \Delta Y_3)}{\gamma^2 + \gamma\delta - 2\delta^2} \quad (4)$$

$$\Delta G_2 = \frac{(\gamma + \delta)\Delta Y_2 - \delta(\Delta Y_1 + \Delta Y_3)}{\gamma^2 + \gamma\delta - 2\delta^2} \quad (5)$$

$$\Delta G_3 = \frac{(\gamma + \delta)\Delta Y_3 - \delta(\Delta Y_1 + \Delta Y_2)}{\gamma^2 + \gamma\delta - 2\delta^2} \quad (6)$$

There is a solution if and only if $\gamma \neq \delta$. Owing to the assumption $\gamma > \delta$, this condition is fulfilled. As a result, fiscal cooperation between Europe, America and Asia can achieve full employment in each of the regions.

According to equation (4), the required increase in European government purchases depends on the initial output gap in Europe, the initial output gap in America, the initial output gap in Asia, the direct multiplier γ , and the cross multiplier δ . The larger the initial output gap in Europe, the larger is the required increase in European government purchases. Moreover, the larger the initial output gap in America or Asia, the smaller is the required increase in European government purchases. According to equation (5), the required increase in American government purchases depends on the initial output gap in America, the initial output gap in Europe, the initial output gap in Asia, the direct multiplier, and the cross multiplier. According to equation (6), the required increase in Asian government purchases depends on the initial output gap in Asia, the initial output gap in Europe, the initial output gap in America, the direct multiplier, and the cross multiplier.

Finally compare fiscal cooperation with fiscal competition. Fiscal competition can achieve full employment, provided capital mobility is sufficiently low. By contrast, fiscal cooperation can achieve full employment in any case.

2. Some Numerical Examples

To illustrate the policy model, have a look at some numerical examples. It proves useful to consider three distinct cases:

- low capital mobility: the regions have the same unemployment
- low capital mobility: the regions differ in unemployment
- high capital mobility.

1) Low capital mobility: The regions have the same unemployment. For ease of exposition, without losing generality, assume $\gamma = 1.33$ and $\delta = 0.33$. Let initial output in Europe be 940, let initial output in America be 940, and let initial output in Asia be the same. In other words, the output gap in Europe is 60, the output gap in America is 60, and the output gap in Asia is the same. What is needed, according to equations (4), (5) and (6) from the preceding section, is an increase in European government purchases of 30, an increase in American government purchases of 30, and an increase in Asian government purchases of equally 30.

The increase in European government purchases of 30 raises European output by 40. In addition, it raises American output and Asian output by 10 each. The increase in American government purchases of 30 raises American output by 40. In addition, it raises European output and Asian output by 10 each. The increase in Asian government purchases of 30 raises Asian output by 40. In addition, it raises European output and American output by 10 each. The total effect is an increase in European output of 60, an increase in American output of 60, and an increase in Asian output of equally 60. As a consequence, European output goes from 940 to 1000, American output goes from 940 to 1000, and Asian output goes from 940 to 1000. As a result, fiscal cooperation can achieve full employment. Table 4.9 presents a synopsis.

Table 4.9

Fiscal Cooperation between Europe, America and Asia

Low Capital Mobility

	Europe	America	Asia
Initial Output	940	940	940
Change in Government Purchases	30	30	30
Output	1000	1000	1000

2) Low capital mobility: The regions differ in unemployment. Let initial output in Europe be 940, let initial output in America be 950, and let initial output in Asia be 970. In other words, the output gap in Europe is 60, the output gap in America is 50, and the output gap in Asia is 30. What is needed, according to equations (4), (5) and (6) from the previous section, is an increase in European government purchases of 36.7, an increase in American government purchases of 26.7, and an increase in Asian government purchases of 6.7

The increase in European government purchases of 36.7 raises European output by 48.9. In addition, it raises American output and Asian output by 12.2 each. The increase in American government purchases of 26.7 raises American output by 35.6. In addition, it raises European output and Asian output by 8.9 each. The increase in Asian government purchases of 6.7 raises Asian output by 8.9. In addition, it raises European output and American output by 2.2 each. The total effect is an increase in European output of 60, an increase in American output of 50, and an increase in Asian output of 30. As a consequence, European output goes from 940 to 1000, American output goes from 950 to 1000, and Asian output goes from 970 to 1000.

Table 4.10
Fiscal Cooperation between Europe, America and Asia
 Low Capital Mobility

	Europe	America	Asia
Initial Output	940	950	970
Change in Government Purchases	36.7	26.7	6.7
Output	1000	1000	1000

As a result, fiscal cooperation can achieve full employment. The required increase in government purchases is small, as compared to the initial output gap. The effective multiplier in Europe is 1.6, the effective multiplier in America is 1.9, and the effective multiplier in Asia is 4.5. Table 4.10 gives an overview.

3) High capital mobility. Assume $\gamma = 0.8$ and $\delta = 0.6$. That means, the internal effect of fiscal policy γ is smaller than the external effect of fiscal policy 2δ . Let initial output in Europe be 940, let initial output in America be 950, and let initial output in Asia be 970. In other words, the output gap in Europe is 60, the output gap in America is 50, and the output gap in Asia is 30. What is needed, according to equations (4), (5) and (6) from the preceding section, is an increase in European government purchases of 90, an increase in American government purchases of 40, and a reduction in Asian government purchases of 60.

The increase in European government purchases of 90 raises European output by 72. In addition, it raises American output and Asian output by 54 each. The increase in American government purchases of 40 raises American output by 32. In addition, it raises European output and Asian output by 24 each. The reduction in Asian government purchases of 60 lowers Asian output by 48. In addition, it lowers European output and American output by 36 each. The net effect is an increase in European output of 60, an increase in American output of 50, and an increase in Asian output of 30. As a consequence, European output goes from 940 to 1000, American output goes from 950 to 1000, and Asian output goes from 970 to 1000.

As a result, fiscal cooperation can achieve full employment. The required increase in European government purchases is very large, as compared to the initial output gap in Europe. The required increase in American government purchases is large, as compared to the initial output gap in America. And the required cut in Asian government purchases has the wrong sign, as compared to the initial output gap in Asia. The effective multiplier in Europe is 0.67, the effective multiplier in America is 1.25, and the effective multiplier in Asia is -0.5 . For a synopsis see Table 4.11.

Table 4.11
Fiscal Cooperation between Europe, America and Asia
High Capital Mobility

	Europe	America	Asia
Initial Output	940	950	970
Change in Government Purchases	90	40	- 60
Output	1000	1000	1000

Part Five

The World of N Monetary Regions

Chapter 1

The World of Four Monetary Regions

1. Monetary Competition between Four Regions

The world consists of four monetary regions, say Europe, America, Asia and Africa. We assume that the monetary regions are the same size and have the same behavioural functions. Here the focus is on monetary competition between Europe, America, Asia and Africa. Besides we assume perfect capital mobility. As a point of departure, take the static model. It can be represented by a system of four equations:

$$Y_1 = A_1 + 3.5M_1 - 0.5(M_2 + M_3 + M_4) \quad (1)$$

$$Y_2 = A_2 + 3.5M_2 - 0.5(M_1 + M_3 + M_4) \quad (2)$$

$$Y_3 = A_3 + 3.5M_3 - 0.5(M_1 + M_2 + M_4) \quad (3)$$

$$Y_4 = A_4 + 3.5M_4 - 0.5(M_1 + M_2 + M_3) \quad (4)$$

Subscript 1 denotes Europe, subscript 2 denotes America, subscript 3 denotes Asia, and subscript 4 denotes Africa. According to equation (1), European output Y_1 is determined by European money supply M_1 , American money supply M_2 , Asian money supply M_3 , and African money supply M_4 . An increase in European money supply of 100 raises European output by 350. On the other hand, it lowers American output, Asian output, and African output by 50 each. Adding up, it raises world output by 200. Further let full-employment output in each of the regions be 1000. This model is in the tradition of the Mundell-Fleming model, see Carlberg (2000) p. 213.

At the beginning there is unemployment in each of the regions. The target of the European central bank is full employment in Europe. The target of the American central bank is full employment in America. The target of the Asian central bank is full employment in Asia. And the target of the African central

bank is full employment in Africa. We assume that the central banks decide simultaneously and independently.

Let initial output in each of the regions be 940. Step 1 refers to the policy response. The output gap in Europe is 60. The monetary policy multiplier in Europe is 3.5. So what is needed in Europe is an increase in European money supply of 17.1. The output gap in America is 60. The monetary policy multiplier in America is 3.5. So what is needed in America is an increase in American money supply of 17.1. And so on.

Step 2 refers to the output lag. The increase in European money supply of 17.1 causes an increase in European output of 60. As a side effect, it causes a decline in American output of 8.6, a decline in Asian output of 8.6, and a decline in African output of equally 8.6. The increase in American money supply of 17.1 causes an increase in American output of 60. As a side effect, it causes a decline in European output of 8.6, a decline in Asian output of 8.6, and a decline in African output of equally 8.6. And so on. The net effect is an increase in European output of 34.3, an increase in American output of 34.3, an increase in Asian output of 34.3, and an increase in African output of 34.3. As a consequence, European output goes from 940 to 974.3, American output goes from 940 to 974.3, Asian output goes from 940 to 974.3, and African output goes from 940 to 974.3.

Step 3 refers to the policy response. The output gap in Europe is 25.7. The monetary policy multiplier in Europe is 3.5. So what is needed in Europe is an increase in European money supply of 7.3. Step 4 refers to the output lag. The increase in European money supply of 7.3 causes an increase in European output of 25.7. As a side effect, it causes a decline in American output of 3.7, a decline in Asian output of 3.7, and a decline in African output of equally 3.7. The net effect is an increase in European output of 14.7. As a consequence, European output goes from 974.3 to 989.0. And so on. Table 5.1 presents a synopsis. There are repeated increases in money supply and output. In each round, the output gap declines by 57 percent.

Table 5.1
Monetary Competition between Four Regions

	Europe	America	Asia	Africa
Initial Output	940	940	940	940
Δ Money Supply	17.1	17.1	17.1	17.1
Output	974.3	974.3	974.3	974.3
Δ Money Supply	7.3	7.3	7.3	7.3
Output	989.0	989.0	989.0	989.0
<i>and so on</i>	...	...	...	...

2. Fiscal Competition between Four Regions: Perfect Capital Mobility

The world consists of four monetary regions, say Europe, America, Asia and Africa. We assume that the monetary regions are the same size and have the same behavioural functions. Here the focus is on fiscal competition between Europe, America, Asia and Africa. Besides we assume perfect capital mobility. As a point of departure, take the static model. It can be represented by a system of four equations:

$$Y_1 = A_1 + 0.5(G_1 + G_2 + G_3 + G_4) \quad (1)$$

$$Y_2 = A_2 + 0.5(G_1 + G_2 + G_3 + G_4) \quad (2)$$

$$Y_3 = A_3 + 0.5(G_1 + G_2 + G_3 + G_4) \quad (3)$$

$$Y_4 = A_4 + 0.5(G_1 + G_2 + G_3 + G_4) \quad (4)$$

According to equation (1), European output Y_1 is determined by European government purchases G_1 , American government purchases G_2 , Asian government purchases G_3 , and African government purchases G_4 . An increase in European government purchases of 100 raises European output, American output, Asian output, and African output by 50 each. Adding up, it raises world output by 200. Further let full-employment output in each of the regions be 1000. This model is in the tradition of the Mundell-Fleming model, see Carlberg (2000) p. 213.

At the beginning there is unemployment in each of the regions. The target of the European government is full employment in Europe. The target of the American government is full employment in America. The target of the Asian government is full employment in Asia. And the target of the African government is full employment in Africa. We assume that the governments decide simultaneously and independently.

Let initial output in each of the regions be 970. Step 1 refers to the policy response. The output gap in Europe is 30. The fiscal policy multiplier in Europe is 0.5. So what is needed in Europe is an increase in European government purchases of 60. The output gap in America is 30. The fiscal policy multiplier in America is 0.5. So what is needed in America is an increase in American government purchases of 60. And so on.

Step 2 refers to the output lag. The increase in European government purchases of 60 causes an increase in European output of 30. As a side effect, it causes an increase in American output of 30, an increase in Asian output of 30, and an increase in African output of equally 30. The increase in American government purchases of 60 causes an increase in American output of 30. As a side effect, it causes an increase in European output of 30, an increase in Asian output of 30, and an increase in African output of equally 30. And so on. The total effect is an increase in European output of 120, an increase in American output of 120, an increase in Asian output of 120, and an increase in African output of equally 120. As a consequence, European output goes from 970 to 1090, American output goes from 970 to 1090, Asian output goes from 970 to 1090, and African output goes from 970 to 1090.

Step 3 refers to the policy response. The inflationary gap in Europe is 90. The fiscal policy multiplier in Europe is 0.5. So what is needed in Europe is a reduction in European government purchases of 180. Step 4 refers to the output lag. The reduction in European government purchases of 180 causes a decline in European output of 90. As a side effect, it causes a decline in American output of 90, a decline in Asian output of 90, and a decline in African output of equally 90. The total effect is a decline in European output of 360. As a consequence, European output goes from 1090 to 730. And so on. Table 5.2 gives an overview. There are explosive oscillations in government purchases and output. In each round, in absolute values, the output gap grows by a factor of 3.

Table 5.2
Fiscal Competition between Four Regions
 Perfect Capital Mobility

	Europe	America	Asia	Africa
Initial Output	970	970	970	970
Δ Government Purchases	60	60	60	60
Output	1090	1090	1090	1090
Δ Government Purchases	- 180	- 180	- 180	- 180
Output	730	730	730	730
<i>and so on</i>	...	...	...	...

3. Fiscal Competition between Four Regions: Imperfect Capital Mobility

Under perfect capital mobility, an increase in European government purchases of 100 raises European output, American output, Asian output, and African output by 50 each. Under zero capital mobility, an increase in European government purchases of 100 raises European output by 200. On the other hand, it has no effect on American output, Asian output, and African output. On this basis we assume that, under imperfect capital mobility, an increase in European government purchases of 100 raises European output by 125. In addition, it raises American output, Asian output, and African output by 25 each.

The static model can be written in the following way:

$$Y_1 = A_1 + 1.25G_1 + 0.25(G_2 + G_3 + G_4) \quad (1)$$

$$Y_2 = A_2 + 1.25G_2 + 0.25(G_1 + G_3 + G_4) \quad (2)$$

$$Y_3 = A_3 + 1.25G_3 + 0.25(G_1 + G_2 + G_4) \quad (3)$$

$$Y_4 = A_4 + 1.25G_4 + 0.25(G_1 + G_2 + G_3) \quad (4)$$

Let initial output in each of the regions be 940. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 1.25. So what is needed in Europe is an increase in European government purchases of 48. The output gap in America is 60. The fiscal policy multiplier in America is 1.25. So what is needed in America is an increase in American government purchases of 48. And so on.

Step 2 refers to the output lag. The increase in European government purchases of 48 causes an increase in European output of 60. As a side effect, it causes an increase in American output of 12, an increase in Asian output of 12, and an increase in African output of equally 12. The increase in American government purchases of 48 causes an increase in American output of 60. As a side effect, it causes an increase in European output of 12, an increase in Asian output of 12, and an increase in African output of equally 12. And so on. The

total effect is an increase in European output of 96, an increase in American output of 96, an increase in Asian output of 96, and an increase in African output of equally 96. As a consequence, European output goes from 940 to 1036, American output goes from 940 to 1036, Asian output goes from 940 to 1036, and African output goes from 940 to 1036.

Step 3 refers to the policy response. The inflationary gap in Europe is 36. The fiscal policy multiplier in Europe is 1.25. So what is needed in Europe is a reduction in European government purchases of 28.8. Step 4 refers to the output lag. The reduction in European government purchases of 28.8 causes a decline in European output of 36. As a side effect, it causes a decline in American output of 7.2, a decline in Asian output of 7.2, and a decline in African output of equally 7.2. The total effect is a decline in European output of 57.6. As a consequence, European output goes from 1036 to 978.4. And so on. For a synopsis see Table 5.3. There are damped oscillations in government purchases and output. In each round, in absolute values, the output gap declines by 40 percent.

Table 5.3
Fiscal Competition between Four Regions
 Imperfect Capital Mobility

	Europe	America	Asia	Africa
Initial Output	940	940	940	940
Δ Government Purchases	48	48	48	48
Output	1036	1036	1036	1036
Δ Government Purchases	- 28.8	- 28.8	- 28.8	- 28.8
Output	978.4	978.4	978.4	978.4
<i>and so on</i>	...	...	...	...

Chapter 2

The World of Ten Monetary Regions

1) Monetary competition between ten regions. We assume that the regions are the same size and have the same behavioural functions. Besides we assume perfect capital mobility. Now consider one of the regions, let us say Japan. As a result, an increase in Japanese money supply of 100 causes an increase in Japanese output of 380. On the other hand, it causes a decline in rest-of-the-world output of 180. So the increase in world output is 200. For the model see Carlberg (2000) p. 217. Further let full-employment output in each of the regions be 1000.

Let initial output in each of the regions be 940. Step 1 refers to the policy response. The output gap in Japan is 60. The monetary policy multiplier in Japan is 3.8. So what is needed in Japan is an increase in Japanese money supply of 15.8. Step 2 refers to the output lag. The increase in Japanese money supply of 15.8 causes an increase in Japanese output of 60. As a side effect, it causes a decline in rest-of-the-world output of 28.4. The net effect is an increase in Japanese output of 31.6. As a consequence, Japanese output goes from 940 to 971.6. And so on. Table 5.4 presents a synopsis. In each round, the output gap declines by 53 percent.

2) Fiscal competition between ten regions: perfect capital mobility. An increase in Japanese government purchases of 100 causes an increase in Japanese output of 20. In addition, it causes an increase in rest-of-the-world output of 180. So the increase in world output is 200.

Let initial output in each of the regions be 970. Step 1 refers to the policy response. The output gap in Japan is 30. The fiscal policy multiplier in Japan is 0.2. So what is needed in Japan is an increase in Japanese government purchases of 150. Step 2 refers to the output lag. The increase in Japanese government purchases of 150 causes an increase in Japanese output of 30. As a side effect, it causes an increase in rest-of-the-world output of 270. The total effect is an increase in Japanese output of 300. As a consequence, Japanese output goes from

970 to 1270. And so on. Table 5.5 gives an overview. In each round, in absolute values, the output gap grows by a factor of 9.

Table 5.4
Monetary Competition between Ten Regions

	Region 1	Region 2
Initial Output	940	940
Change in Money Supply	15.8	15.8
Output	971.6	971.6
Change in Money Supply	7.5	7.5
Output	986.5	986.5
<i>and so on</i>	...	...

Table 5.5
Fiscal Competition between Ten Regions
Perfect Capital Mobility

	Region 1	Region 2
Initial Output	970	970
Change in Government Purchases	150	150
Output	1270	1270
Change in Government Purchases	- 1350	- 1350
Output	0	0
<i>and so on</i>	...	...

3) Fiscal competition between ten regions: imperfect capital mobility. Under perfect capital mobility, an increase in Japanese government purchases of 100 causes an increase in Japanese output of 20. In addition, it causes an increase in rest-of-the-world output of 180. Under zero capital mobility, an increase in Japanese government purchases of 100 causes an increase in Japanese output of 200. On the other hand, it has no effect on output in the rest of the world. On this basis we assume that, under imperfect capital mobility, an increase in Japanese government purchases of 100 causes an increase in Japanese output of 110. In addition, it causes an increase in rest-of-the-world output of 90.

Let initial output in each of the regions be 940. Step 1 refers to the policy response. The output gap in Japan is 60. The fiscal policy multiplier in Japan is 1.1. So what is needed in Japan is an increase in Japanese government purchases of 54.5. Step 2 refers to the output lag. The increase in Japanese government purchases of 54.5 causes an increase in Japanese output of 60. As a side effect, it causes an increase in rest-of-the-world output of 49.1. The total effect is an increase in Japanese output of 109.1. As a consequence, Japanese output goes from 940 to 1049.1. And so on. For a synopsis see Table 5.6. In each round, in absolute values, the output gap declines by 18 percent.

Table 5.6
Fiscal Competition between Ten Regions
 Imperfect Capital Mobility

	Region 1	Region 2
Initial Output	940	940
Change in Government Purchases	54.5	54.5
Output	1049.1	1049.1
Change in Government Purchases	- 44.6	- 44.6
Output	959.8	959.8
<i>and so on</i>	...	...

Chapter 3

Synopsis

1) Monetary competition. Table 5.7 gives an overview. In a world of a few large regions, monetary competition is a relatively fast process. On the other hand, in a world of many small regions, monetary competition is a relatively slow process. The reason for this is that in a world of a few large regions, monetary spillovers are relatively small. On the other hand, in a world of many small regions, monetary spillovers are relatively large. As a consequence, in a world of a few large regions, unemployment (or for that matter inflation) will be relatively low. On the other hand, in a world of many small regions, unemployment will be relatively high.

Table 5.7
Monetary Competition: A Synopsis

	In Each Round, the Gap Declines by
World of 2 Regions	67 %
World of 3 Regions	60 %
World of 4 Regions	57 %
World of 10 Regions	53 %
World of ∞ Regions	50 %

2) Fiscal competition: perfect capital mobility. Table 5.8 presents a synopsis. In a world of two large regions, fiscal competition causes uniform oscillations in output. However, in a world of many small regions, fiscal competition causes explosive oscillations in output. The reason for this is that in a world of two large regions, fiscal spillovers are very large. However, in a world of many small regions, fiscal spillovers are extremely large.

Table 5.8
Fiscal Competition: Perfect Capital Mobility

	In Each Round, the Gap Grows by a Factor of
World of 2 Regions	1
World of 3 Regions	2
World of 4 Regions	3
World of 10 Regions	9

3) Fiscal competition: imperfect capital mobility. Table 5.9 gives an overview. Under imperfect capital mobility, fiscal competition causes damped oscillations in output. In a world of a few large regions, fiscal competition is a relatively fast process. On the other hand, in a world of many small regions, fiscal competition is a relatively slow process. The reason for this is that in a world of a few large regions, fiscal spillovers are relatively small. On the other hand, in a world of many small regions, fiscal spillovers are relatively large.

Table 5.9
Fiscal Competition: Imperfect Capital Mobility

	In Each Round, the Gap Declines by
World of 2 Regions	67 %
World of 3 Regions	50 %
World of 4 Regions	40 %
World of 10 Regions	18 %

Part Six

Rational Policy Expectations

Chapter 1

Rational Policy Expectations in Europe and America

1. Monetary Competition between Europe and America

1) The static model. The world consists of two monetary regions, say Europe and America. We assume that the monetary regions are the same size and have the same behavioural functions. As a point of reference, consider the static model. It can be represented by a system of two equations:

$$Y_1 = A_1 + \alpha M_1 - \beta M_2 \quad (1)$$

$$Y_2 = A_2 + \alpha M_2 - \beta M_1 \quad (2)$$

According to equation (1), European output is determined by European money supply and American money supply. According to equation (2), American output is determined by American money supply and European money supply. α and β are positive coefficients with $\alpha > \beta$. The endogenous variables are European output and American output.

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European central bank is full employment in Europe. The instrument of the European central bank is European money supply. The target of the American central bank is full employment in America. The instrument of the American central bank is American money supply. We assume that the European central bank and the American central bank decide simultaneously and independently. The European central bank sets European money supply, forming rational expectations of American money supply. And the American central bank sets American money supply, forming rational expectations of European money supply.

On this basis, the dynamic model can be characterized by a system of four equations:

$$\bar{Y}_1 = A_1 + \alpha M_1 - \beta M_2^e \quad (3)$$

$$\bar{Y}_2 = A_2 + \alpha M_2 - \beta M_1^e \quad (4)$$

$$M_1^e = M_1 \quad (5)$$

$$M_2^e = M_2 \quad (6)$$

Here is a list of the new symbols:

- \bar{Y}_1 full-employment output in Europe
- \bar{Y}_2 full-employment output in America
- M_1^e the expectation of European money supply,
as formed by the American central bank
- M_2^e the expectation of American money supply,
as formed by the European central bank
- M_1 European money supply,
as set by the European central bank
- M_2 American money supply,
as set by the American central bank.

According to equation (3), the European central bank sets European money supply, forming an expectation of American money supply. According to equation (4), the American central bank sets American money supply, forming an expectation of European money supply. According to equation (5), the expectation of European money supply is equal to the forecast made by means of the model. According to equation (6), the expectation of American money supply is equal to the forecast made by means of the model. That is to say, the European central bank sets European money supply, predicting American money supply with the help of the model. And the American central bank sets American money supply, predicting European money supply with the help of the model. The endogenous variables are European money supply M_1 , American money supply M_2 , the expectation of European money supply M_1^e , and the expectation of American money supply M_2^e .

The dynamic model can be compressed to a system of two equations:

$$\bar{Y}_1 = A_1 + \alpha M_1 - \beta M_2 \quad (7)$$

$$\bar{Y}_2 = A_2 + \alpha M_2 - \beta M_1 \quad (8)$$

Here the endogenous variables are European money supply M_1 and American money supply M_2 . To simplify notation we introduce $B_1 = \bar{Y}_1 - A_1$ and $B_2 = \bar{Y}_2 - A_2$. Then we solve the model for the endogenous variables:

$$M_1 = \frac{\alpha B_1 + \beta B_2}{\alpha^2 - \beta^2} \quad (9)$$

$$M_2 = \frac{\alpha B_2 + \beta B_1}{\alpha^2 - \beta^2} \quad (10)$$

Equation (9) shows the equilibrium level of European money supply, and equation (10) shows the equilibrium level of American money supply. There is a solution if and only if $\alpha \neq \beta$. This condition is fulfilled. As a result, under rational expectations, there is an immediate equilibrium of monetary competition between Europe and America. In other words, under rational expectations, monetary competition between Europe and America leads to full employment immediately. It is worth pointing out here that the equilibrium under rational expectations is identical to the steady state under adaptive expectations, see Chapter 1 of Part One.

As an alternative, the dynamic model can be stated in terms of the initial output gap and the required increase in money supply:

$$\Delta Y_1 = \alpha \Delta M_1 - \beta \Delta M_2 \quad (11)$$

$$\Delta Y_2 = \alpha \Delta M_2 - \beta \Delta M_1 \quad (12)$$

Here ΔY_1 denotes the initial output gap in Europe, ΔY_2 is the initial output gap in America, ΔM_1 is the required increase in European money supply, and ΔM_2 is the required increase in American money supply. The endogenous variables are ΔM_1 and ΔM_2 . The equilibrium of the system (11) and (12) is:

$$\Delta M_1 = \frac{\alpha \Delta Y_1 + \beta \Delta Y_2}{\alpha^2 - \beta^2} \quad (13)$$

$$\Delta M_2 = \frac{\alpha \Delta Y_2 + \beta \Delta Y_1}{\alpha^2 - \beta^2} \quad (14)$$

3) A numerical example. To illustrate the dynamic model, have a look at a numerical example. For ease of exposition, without loss of generality, assume $\alpha = 3$ and $\beta = 1$. On this assumption, the static model can be written as follows:

$$Y_1 = A_1 + 3M_1 - M_2 \quad (15)$$

$$Y_2 = A_2 + 3M_2 - M_1 \quad (16)$$

The endogenous variables are European output and American output. Obviously, an increase in European money supply of 100 causes an increase in European output of 300 and a decline in American output of 100. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

Let initial output in Europe be 940, and let initial output in America be 970. That means, the output gap in Europe is 60, and the output gap in America is 30. What is needed in Europe, according to equation (13), is an increase in European money supply of 26.25. And what is needed in America, according to equation (14), is an increase in American money supply of 18.75. The increase in European money supply of 26.25 raises European output by 78.75 and lowers American output by 26.25. The increase in American money supply of 18.75 raises American output by 56.25 and lowers European output by 18.75. The net effect is an increase in European output of 60 and an increase in American output of 30. As a consequence, European output goes from 940 to 1000, and American output goes from 970 to 1000. In Europe there is now full employment, and the same holds for America. As a result, under rational expectations, monetary competition leads to full employment immediately. Table 6.1 presents a synopsis.

Table 6.1
Monetary Competition between Europe and America
 Rational Policy Expectations

	Europe	America
Initial Output	940	970
Change in Money Supply	26.25	18.75
Output	1000	1000

4) A comment. The European central bank closely observes the measures taken by the American central bank. And what is more, the European central bank can respond immediately to the measures taken by the American central bank. The other way round, the American central bank closely observes the measures taken by the European central bank. And what is more, the American central bank can respond immediately to the measures taken by the European central bank. Therefore rational policy expectations seem not to be very important.

2. Fiscal Competition: Perfect Capital Mobility

1) The static model. The world consists of two monetary regions, say Europe and America. We assume that the monetary regions are the same size and have the same behavioural functions. Besides, we assume perfect capital mobility between Europe and America. As a point of departure, consider the static model. It can be represented by a system of two equations:

$$Y_1 = A_1 + \gamma G_1 + \gamma G_2 \quad (1)$$

$$Y_2 = A_2 + \gamma G_2 + \gamma G_1 \quad (2)$$

According to equation (1), European output is determined by European government purchases and American government purchases. According to equation (2), American output is determined by American government purchases and European government purchases. γ is a positive coefficient. The endogenous variables are European output and American output.

2) The dynamic model. This section deals with fiscal competition between Europe and America. At the beginning there is unemployment in each of the regions. The target of the European government is full employment in Europe. The instrument of the European government is European government purchases. The target of the American government is full employment in America. The instrument of the American government is American government purchases. We assume that the European government and the American government decide simultaneously and independently. The European government sets European government purchases, forming rational expectations of American government purchases. And the American government sets American government purchases, forming rational expectations of European government purchases.

On this basis, the dynamic model can be characterized by a system of four equations:

$$\bar{Y}_1 = A_1 + \gamma G_1 + \gamma G_2^e \quad (3)$$

$$\bar{Y}_2 = A_2 + \gamma G_2 + \gamma G_1^e \quad (4)$$

$$G_1^e = G_1 \quad (5)$$

$$G_2^e = G_2 \quad (6)$$

Here is a list of the new symbols:

\bar{Y}_1 full-employment output in Europe

\bar{Y}_2 full-employment output in America

G_1^e the expectation of European government purchases,
as formed by the American government

G_2^e the expectation of American government purchases,
as formed by the European government

- G_1 European government purchases,
as set by the European government
- G_2 American government purchases,
as set by the American government.

According to equation (3), the European government sets European government purchases, forming an expectation of American government purchases. According to equation (4), the American government sets American government purchases, forming an expectation of European government purchases. According to equation (5), the expectation of European government purchases is equal to the forecast made by means of the model. According to equation (6), the expectation of American government purchases is equal to the forecast made by means of the model. That is to say, the European government sets European government purchases, predicting American government purchases with the help of the model. And the American government sets American government purchases, predicting European government purchases with the help of the model. The endogenous variables are European government purchases G_1 , American government purchases G_2 , the expectation of European government purchases G_1^e , and the expectation of American government purchases G_2^e .

The dynamic model can be condensed to a system of two equations:

$$\bar{Y}_1 = A_1 + \gamma G_1 + \gamma G_2 \quad (7)$$

$$\bar{Y}_2 = A_2 + \gamma G_2 + \gamma G_1 \quad (8)$$

Here the endogenous variables are European government purchases G_1 and American government purchases G_2 . Now take the difference between equations (7) and (8) to reach:

$$\bar{Y}_1 - \bar{Y}_2 = A_1 - A_2 \quad (9)$$

However, this is in direct contradiction to the assumption that \bar{Y}_1 , \bar{Y}_2 , A_1 and A_2 are given independently. As a result, under rational expectations, there is no equilibrium of fiscal competition between Europe and America. In other words, under rational expectations, fiscal competition between Europe and America

does not lead to full employment. The underlying reason is the large spillover effect of fiscal policy.

3. Fiscal Competition: Imperfect Capital Mobility

1) The static model. In this section we assume imperfect capital mobility between Europe and America. As a point of reference, consider the static model. It can be represented by a system of two equations:

$$Y_1 = A_1 + \gamma G_1 + \delta G_2 \quad (1)$$

$$Y_2 = A_2 + \gamma G_2 + \delta G_1 \quad (2)$$

According to equation (1), European output is determined by European government purchases and American government purchases. According to equation (2), American output is determined by American government purchases and European government purchases. γ and δ are positive coefficients with $\gamma > \delta$. The endogenous variables are European output and American output.

2) The dynamic model. This section deals with fiscal competition between Europe and America. At the beginning there is unemployment in each of the regions. The target of the European government is full employment in Europe. The instrument of the European government is European government purchases. The target of the American government is full employment in America. The instrument of the American government is American government purchases. We assume that the European government and the American government decide simultaneously and independently. The European government sets European government purchases, forming rational expectations of American government purchases. And the American government sets American government purchases, forming rational expectations of European government purchases.

On this basis, the dynamic model can be characterized by a system of four equations:

$$\bar{Y}_1 = A_1 + \gamma G_1 + \delta G_2^e \quad (3)$$

$$\bar{Y}_2 = A_2 + \gamma G_2 + \delta G_1^e \quad (4)$$

$$G_1^e = G_1 \quad (5)$$

$$G_2^e = G_2 \quad (6)$$

Here is a list of the new symbols:

- \bar{Y}_1 full-employment output in Europe
- \bar{Y}_2 full-employment output in America
- G_1^e the expectation of European government purchases, as formed by the American government
- G_2^e the expectation of American government purchases, as formed by the European government
- G_1 European government purchases, as set by the European government
- G_2 American government purchases, as set by the American government.

According to equation (3), the European government sets European government purchases, forming an expectation of American government purchases. According to equation (4), the American government sets American government purchases, forming an expectation of European government purchases. According to equation (5), the expectation of European government purchases is equal to the forecast made by means of the model. According to equation (6), the expectation of American government purchases is equal to the forecast made by means of the model. That is to say, the European government sets European government purchases, predicting American government purchases with the help of the model. And the American government sets American government purchases, predicting European government purchases with the help of the model. The endogenous variables are European government purchases G_1 , American government purchases G_2 , the expectation of European government purchases G_1^e , and the expectation of American government purchases G_2^e .

The dynamic model can be compressed to a system of two equations:

$$\bar{Y}_1 = A_1 + \gamma G_1 + \delta G_2 \quad (7)$$

$$\bar{Y}_2 = A_2 + \gamma G_2 + \delta G_1 \quad (8)$$

Here the endogenous variables are European government purchases G_1 and American government purchases G_2 . To simplify notation we introduce $B_1 = \bar{Y}_1 - A_1$ and $B_2 = \bar{Y}_2 - A_2$. Then we solve the model for the endogenous variables:

$$G_1 = \frac{\gamma B_1 - \delta B_2}{\gamma^2 - \delta^2} \quad (9)$$

$$G_2 = \frac{\gamma B_2 - \delta B_1}{\gamma^2 - \delta^2} \quad (10)$$

Equation (9) shows the equilibrium level of European government purchases, and equation (10) shows the equilibrium level of American government purchases. There is a solution if and only if $\gamma \neq \delta$. This condition is fulfilled. As a result, under rational expectations, there is an immediate equilibrium of fiscal competition between Europe and America. In other words, under rational expectations, fiscal competition between Europe and America leads to full employment immediately. It is worth pointing out here that the equilibrium under rational expectations is identical to the steady state under adaptive expectations, see Chapter 2 of Part Two.

As an alternative, the dynamic model can be stated in terms of the initial output gap and the required increase in government purchases:

$$\Delta Y_1 = \gamma \Delta G_1 + \delta \Delta G_2 \quad (11)$$

$$\Delta Y_2 = \gamma \Delta G_2 + \delta \Delta G_1 \quad (12)$$

Here ΔY_1 denotes the initial output gap in Europe, ΔY_2 is the initial output gap in America, ΔG_1 is the required increase in European government purchases, and

ΔG_2 is the required increase in American government purchases. The endogenous variables are ΔG_1 and ΔG_2 . The equilibrium of the system (11) and (12) is:

$$\Delta G_1 = \frac{\gamma \Delta Y_1 - \delta \Delta Y_2}{\gamma^2 - \delta^2} \quad (13)$$

$$\Delta G_2 = \frac{\gamma \Delta Y_2 - \delta \Delta Y_1}{\gamma^2 - \delta^2} \quad (14)$$

3) A numerical example. To illustrate the dynamic model, have a look at a numerical example. For ease of exposition, without losing generality, assume $\gamma = 1.5$ and $\delta = 0.5$. On this assumption, the static model can be written as follows:

$$Y_1 = A_1 + 1.5G_1 + 0.5G_2 \quad (15)$$

$$Y_2 = A_2 + 1.5G_2 + 0.5G_1 \quad (16)$$

The endogenous variables are European output and American output. Evidently, an increase in European government purchases of 100 causes an increase in European output of 150 and an increase in American output of 50. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

Let initial output in Europe be 940, and let initial output in America be 970. That means, the output gap in Europe is 60, and the output gap in America is 30. What is needed in Europe, according to equation (13), is an increase in European government purchases of 37.5. And what is needed in America, according to equation (14), is an increase in American government purchases of 7.5. The increase in European government purchases of 37.5 raises European output by 56.25 and American output by 18.75. The increase in American government purchases of 7.5 raises American output by 11.25 and European output by 3.75. The total effect is an increase in European output of 60 and an increase in American output of 30. As a consequence, European output goes from 940 to 1000, and American output goes from 970 to 1000. In Europe there is now full employment, and the same holds for America. As a result, under rational

expectations, fiscal competition leads to full employment immediately. Table 6.2 gives an overview.

4) Comparing fiscal competition with monetary competition. Fiscal competition can cause large changes in government purchases. By contrast, monetary competition cannot cause any changes in government purchases. Judging from this point of view, monetary competition seems to be superior to fiscal competition.

Table 6.2
Fiscal Competition between Europe and America
Rational Policy Expectations

	Europe	America
Initial Output	940	970
Change in Government Purchases	37.5	7.5
Output	1000	1000

4. Monetary and Fiscal Competition

1) The static model. This section deals with competition between the European central bank, the American central bank, the European government, and the American government. We assume imperfect capital mobility between Europe and America. As a point of departure, consider the static model. It can be represented by a system of two equations:

$$Y_1 = A_1 + \alpha M_1 - \beta M_2 + \gamma G_1 + \delta G_2 \quad (1)$$

$$Y_2 = A_2 + \alpha M_2 - \beta M_1 + \gamma G_2 + \delta G_1 \quad (2)$$

According to equation (1), European output is determined by European money supply, American money supply, European government purchases, and American government purchases. According to equation (2), American output is determined by American money supply, European money supply, American government purchases, and European government purchases. α , β , γ and δ are positive coefficients with $\alpha > \beta$ and $\gamma > \delta$. The endogenous variables are European output and American output.

2) The dynamic model. At the start there is unemployment in both Europe and America. The target of the European central bank is full employment in Europe. The target of the American central bank is full employment in America. The target of the European government is full employment in Europe. And the target of the American government is full employment in America. We assume that the European central bank, the American central bank, the European government, and the American government decide simultaneously and independently.

The European central bank sets European money supply, forming rational expectations of American money supply, European government purchases, and American government purchases. The American central bank sets American money supply, forming rational expectations of European money supply, American government purchases, and European government purchases. The European government sets European government purchases, forming rational expectations of American government purchases, European money supply, and American money supply. The American government sets American government purchases, forming rational expectations of European government purchases, American money supply, and European money supply. That is to say, the European central bank sets European money supply, predicting American money supply, European government purchases, and American government purchases by means of the model. The American central bank sets American money supply, predicting European money supply, American government purchases, and European government purchases by means of the model. The European government sets European government purchases, predicting American government purchases, European money supply, and American money supply by

means of the model. The American government sets American government purchases, predicting European government purchases, American money supply, and European money supply by means of the model.

On this basis, the dynamic model can be characterized by a system of two equations:

$$\bar{Y}_1 = A_1 + \alpha M_1 - \beta M_2 + \gamma G_1 + \delta G_2 \quad (3)$$

$$\bar{Y}_2 = A_2 + \alpha M_2 - \beta M_1 + \gamma G_2 + \delta G_1 \quad (4)$$

Here \bar{Y}_1 is full-employment output in Europe, and \bar{Y}_2 is full-employment output in America. The endogenous variables are European money supply, American money supply, European government purchases, and American government purchases. There are two targets and four instruments, so there are two degrees of freedom. As a result, under rational expectations, there is no unique equilibrium of monetary and fiscal competition. In other words, under rational expectations, monetary and fiscal competition does not lead to full employment.

Chapter 2

Adaptive Policy Expectations in Europe and America

1) The static model. This chapter deals with monetary competition between Europe and America. As a point of reference, consider the static model. It can be represented by a system of two equations:

$$Y_1 = A_1 + \alpha M_1 - \beta M_2 \quad (1)$$

$$Y_2 = A_2 + \alpha M_2 - \beta M_1 \quad (2)$$

According to equation (1), European output is determined by European money supply and American money supply. According to equation (2), American output is determined by American money supply and European money supply. α and β are positive coefficients with $\alpha > \beta$. The endogenous variables are European output and American output.

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European central bank is full employment in Europe. The instrument of the European central bank is European money supply. The target of the American central bank is full employment in America. The instrument of the American central bank is American money supply. We assume that the European central bank and the American central bank decide simultaneously and independently. The European central bank sets European money supply, forming adaptive expectations of American money supply. And the American central bank sets American money supply, forming adaptive expectations of European money supply.

On this basis, the dynamic model can be characterized by a system of four equations:

$$\bar{Y}_1 = A_1 + \alpha M_1 - \beta M_2^e \quad (3)$$

$$\bar{Y}_2 = A_2 + \alpha M_2 - \beta M_1^e \quad (4)$$

$$M_1^e = M_1^{-1} \quad (5)$$

$$M_2^e = M_2^{-1} \quad (6)$$

Here is a list of the new symbols:

- \bar{Y}_1 full-employment output in Europe
- \bar{Y}_2 full-employment output in America
- M_1^e the expectation of European money supply,
as formed by the American central bank
- M_2^e the expectation of American money supply,
as formed by the European central bank
- M_1 European money supply this period
- M_2 American money supply this period
- M_1^{-1} European money supply last period
- M_2^{-1} American money supply last period.

According to equation (3), the European central bank sets European money supply, forming an expectation of American money supply. According to equation (4), the American central bank sets American money supply, forming an expectation of European money supply. According to equation (5), the expectation of European money supply is equal to European money supply last period. According to equation (6), the expectation of American money supply is equal to American money supply last period. The exogenous variables are M_1^{-1} and M_2^{-1} . The endogenous variables are M_1^e , M_2^e , M_1 and M_2 .

The dynamic model can be compressed to a system of two equations:

$$\bar{Y}_1 = A_1 + \alpha M_1 - \beta M_2^{-1} \quad (7)$$

$$\bar{Y}_2 = A_2 + \alpha M_2 - \beta M_1^{-1} \quad (8)$$

According to equation (7), the European central bank sets European money supply, taking American money supply as given. According to equation (8), the American central bank sets American money supply, taking European money

supply as given. The exogenous variables are M_1^{-1} and M_2^{-1} . The endogenous variables are M_1 and M_2 .

Strictly speaking, this model is equivalent to the dynamic model developed in Chapter 1 of Part One. As a result, under adaptive expectations, there is a stable steady state of monetary competition between Europe and America. In other words, under adaptive expectations, monetary competition between Europe and America leads to full employment.

3) A numerical example. To illustrate the dynamic model, have a look at a numerical example with $\alpha = 3$ and $\beta = 1$. That is, an increase in European money supply of 100 raises European output by 300 and lowers American output by 100. Let full-employment output in Europe be 1000, and let full-employment output in America be the same.

Let initial output in Europe be 940, and let initial output in America be 970. Step 1 refers to the policy response. First consider monetary policy in Europe. The European central bank sets European money supply, taking American money supply as given. The output gap in Europe is 60. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 20. Second consider monetary policy in America. The American central bank sets American money supply, taking European money supply as given. The output gap in America is 30. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 10.

Step 2 refers to the output lag. The increase in European money supply of 20 causes an increase in European output of 60. As a side effect, it causes a decline in American output of 20. The increase in American money supply of 10 causes an increase in American output of 30. As a side effect, it causes a decline in European output of 10. The net effect is an increase in European output of 50 and an increase in American output of 10. As a consequence, European output goes from 940 to 990, and American output goes from 970 to 980.

Step 3 refers to the policy response. First consider monetary policy in Europe. The European central bank sets European money supply, taking American money supply as given. The output gap in Europe is 10. The monetary policy multiplier

in Europe is 3. So what is needed in Europe is an increase in European money supply of 3.3. Second consider monetary policy in America. The American central bank sets American money supply, taking European money supply as given. The output gap in America is 20. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 6.7.

Step 4 refers to the output lag. The increase in European money supply of 3.3 causes an increase in European output of 10. As a side effect, it causes a decline in American output of 3.3. The increase in American money supply of 6.7 causes an increase in American output of 20. As a side effect, it causes a decline in European output of 6.7. The net effect is an increase in European output of 3.3 and an increase in American output of 16.7. As a consequence, European output goes from 990 to 993.3, and American output goes from 980 to 996.7. And so on.

Chapter 3

Adaptive Policy Expectations in Europe, Rational Policy Expectations in America

1. Monetary Competition between Europe and America

1) The static model. This section deals with monetary competition between Europe and America. We assume perfect capital mobility. As a point of reference, consider the static model. It can be represented by a system of two equations:

$$Y_1 = A_1 + \alpha M_1 - \beta M_2 \quad (1)$$

$$Y_2 = A_2 + \alpha M_2 - \beta M_1 \quad (2)$$

According to equation (1), European output is determined by European money supply and American money supply. According to equation (2), American output is determined by American money supply and European money supply. α and β are positive coefficients with $\alpha > \beta$. The endogenous variables are European output and American output.

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European central bank is full employment in Europe. The instrument of the European central bank is European money supply. The target of the American central bank is full employment in America. The instrument of the American central bank is American money supply. We assume that the European central bank and the American central bank decide simultaneously and independently. The European central bank sets European money supply, forming adaptive expectations of American money supply. And the American central bank sets American money supply, forming rational expectations of European money supply.

On this basis, the dynamic model can be characterized by a system of four equations:

$$\bar{Y}_1 = A_1 + \alpha M_1 - \beta M_2^e \quad (3)$$

$$\bar{Y}_2 = A_2 + \alpha M_2 - \beta M_1^e \quad (4)$$

$$M_1^e = M_1 \quad (5)$$

$$M_2^e = M_2^{-1} \quad (6)$$

Here is a list of the new symbols:

- \bar{Y}_1 full-employment output in Europe
- \bar{Y}_2 full-employment output in America
- M_1^e the expectation of European money supply,
as formed by the American central bank
- M_2^e the expectation of American money supply,
as formed by the European central bank
- M_1 European money supply this period
- M_2 American money supply this period
- M_2^{-1} American money supply last period.

According to equation (3), the European central bank sets European money supply, forming an expectation of American money supply. According to equation (4), the American central bank sets American money supply, forming an expectation of European money supply. According to equation (5), the expectation of European money supply is equal to the forecast made by means of the model. According to equation (6), the expectation of American money supply is equal to American money supply last period. The endogenous variables are M_1 , M_2 , M_1^e and M_2^e .

The dynamic model can be compressed to a system of two equations:

$$\bar{Y}_1 = A_1 + \alpha M_1 - \beta M_2^{-1} \quad (7)$$

$$\bar{Y}_2 = A_2 + \alpha M_2 - \beta M_1 \quad (8)$$

According to equation (7), the European central bank sets European money supply, taking American money supply as given. And according to equation (8), the American central bank sets American money supply, predicting European

money supply with the help of the model. In a sense, the American central bank is a Stackelberg leader, and the European central bank is a Stackelberg follower. The endogenous variables are M_1 and M_2 .

3) The steady state. In the steady state by definition we have $M_2 = M_2^{-1}$. That is, American money supply does not change any more. Therefore the steady state can be captured by a system of two equations:

$$\bar{Y}_1 = A_1 + \alpha M_1 - \beta M_2 \quad (9)$$

$$\bar{Y}_2 = A_2 + \alpha M_2 - \beta M_1 \quad (10)$$

The endogenous variables are M_1 and M_2 .

To simplify notation we introduce:

$$B_1 = \bar{Y}_1 - A_1 \quad (11)$$

$$B_2 = \bar{Y}_2 - A_2 \quad (12)$$

Next we solve the model for the endogenous variables:

$$M_1 = \frac{\alpha B_1 + \beta B_2}{\alpha^2 - \beta^2} \quad (13)$$

$$M_2 = \frac{\alpha B_2 + \beta B_1}{\alpha^2 - \beta^2} \quad (14)$$

Equation (13) shows the steady-state level of European money supply, and equation (14) shows the steady-state level of American money supply. As a result, there is a steady state if and only if $\alpha \neq \beta$. This condition is fulfilled.

4) Stability. To simplify notation we make use of equations (11) and (12). With this, the dynamic model (7) and (8) can be written as follows:

$$B_1 = \alpha M_1 - \beta M_2^{-1} \quad (15)$$

$$B_2 = \alpha M_2 - \beta M_1 \quad (16)$$

The endogenous variables are M_1 and M_2 .

Now eliminate M_2^{-1} in equation (15) by means of equation (16) to arrive at:

$$\alpha M_1 = B_1 + \frac{\beta B_2}{\alpha} + \frac{\beta^2 M_1^{-1}}{\alpha} \quad (17)$$

Then differentiate equation (17) for M_1^{-1} :

$$\frac{dM_1}{dM_1^{-1}} = \frac{\beta^2}{\alpha^2} \quad (18)$$

Finally the stability condition is $\beta^2 / \alpha^2 < 1$ or:

$$\alpha > \beta \quad (19)$$

That means, the steady state is stable if and only if the internal effect of monetary policy is larger than the external effect of monetary policy. This condition is satisfied. As a result, under adaptive-rational expectations, there is a stable steady state of monetary competition. In other words, under adaptive-rational expectations, monetary competition leads to full employment.

5) A numerical example. To illustrate the dynamic model, have a look at a numerical example. For ease of exposition, without loss of generality, assume $\alpha = 3$ and $\beta = 1$. Obviously, an increase in European money supply of 100 raises European output by 300 and lowers American output by 100. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

Let initial output in Europe be 940, and let initial output in America be equally 940. Step 1 refers to the policy response. First consider monetary policy in Europe. The European central bank sets European money supply, taking American money supply as given. The output gap in Europe is 60. The monetary

policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 20.

Second consider monetary policy in America. The American central bank sets American money supply, forming rational expectations of European money supply. The output gap in America is 60. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 20. Moreover, the expected increase in European money supply is 20. Hence the expected decline in American output is equally 20. What is needed in America to counteract this, is another increase in American money supply of 6.7. Adding up, the total increase in American money supply is 26.7.

Step 2 refers to the output lag. The increase in European money supply of 20 causes an increase in European output of 60. As a side effect, it causes a decline in American output of 20. The increase in American money supply of 26.7 causes an increase in American output of 80. As a side effect, it causes a decline in European output of 26.7. The net effect is an increase in European output of 33.3 and an increase in American output of 60. As a consequence, European output goes from 940 to 973.3, and American output goes from 940 to 1000. In Europe unemployment comes down, but there is still a lot of unemployment left. In America there is now full employment.

Step 3 refers to the policy response. First consider monetary policy in Europe. The European central bank sets European money supply, taking American money supply as given. The output gap in Europe is 26.7. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 8.9.

Second consider monetary policy in America. The American central bank sets American money supply, forming rational expectations of European money supply. The output gap in America is zero. From this point of view, there is no need for a change in American money supply. Moreover, the expected increase in European money supply is 8.9. Hence the expected decline in American output is equally 8.9. What is needed in America to counteract this, is an increase in American money supply of 3.0. Adding up, the total increase in American money supply is 3.0.

Step 4 refers to the output lag. The increase in European money supply of 8.9 causes an increase in European output of 26.7. As a side effect, it causes a decline in American output of 8.9. The increase in American money supply of 3.0 causes an increase in American output of 8.9. As a side effect, it causes a decline in European output of 3.0. The net effect is an increase in European output of 23.7 and an increase in American output of zero. As a consequence, European output goes from 973.3 to 997.0, while American output stays at 1000. And so on. Table 6.3 presents a synopsis.

Table 6.3
Monetary Competition between Europe and America

Adaptive Policy Expectations in Europe
Rational Policy Expectations in America

	Europe	America
Initial Output	940	940
Change in Money Supply	20	26.7
Output	973.3	1000
Change in Money Supply	8.9	3
Output	997.0	1000
<i>and so on</i>	...	...

What are the dynamic characteristics of this process? There are repeated increases in European money supply and American money supply. There are repeated increases in European output. There is a one-time increase in American output. In Europe unemployment comes down step by step. In America unemployment comes down immediately. As a result, monetary competition leads to full employment. Taking the sum over the process as a whole, the increase in European money supply is 30, and the increase in American money supply is equally 30.

- 6) Comparison. Coming to an end, compare the three types of expectations:
- adaptive policy expectations in Europe and America
 - adaptive policy expectations in Europe,
rational policy expectations in America
 - rational policy expectations in Europe and America.

Under adaptive expectations, monetary competition is a slow process. Under adaptive-rational expectations, monetary competition is a process of intermediate speed. And under rational expectations, monetary competition is a fast process. That is to say, rational expectations speed up the process of monetary competition.

2. Fiscal Competition between Europe and America

1) The static model. This section deals with fiscal competition between Europe and America. We assume imperfect capital mobility. As a point of departure, consider the static model. It can be represented by a system of two equations:

$$Y_1 = A_1 + \gamma G_1 + \delta G_2 \quad (1)$$

$$Y_2 = A_2 + \gamma G_2 + \delta G_1 \quad (2)$$

According to equation (1), European output is determined by European government purchases and American government purchases. According to equation (2), American output is determined by American government purchases and European government purchases. γ and δ are positive coefficients with $\gamma > \delta$. The endogenous variables are European output and American output.

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European government is full employment in Europe. The instrument of the European government is European government purchases. The target of the American government is full employment in

America. The instrument of the American government is American government purchases. We assume that the European government and the American government decide simultaneously and independently. The European government sets European government purchases, forming adaptive expectations of American government purchases. And the American government sets American government purchases, forming rational expectations of European government purchases.

On this basis, the dynamic model can be characterized by a system of four equations:

$$\bar{Y}_1 = A_1 + \gamma G_1 + \delta G_2^e \quad (3)$$

$$\bar{Y}_2 = A_2 + \gamma G_2 + \delta G_1^e \quad (4)$$

$$G_1^e = G_1 \quad (5)$$

$$G_2^e = G_2^{-1} \quad (6)$$

Here is a list of the new symbols:

- \bar{Y}_1 full-employment output in Europe
- \bar{Y}_2 full-employment output in America
- G_1^e the expectation of European government purchases,
as formed by the American government
- G_2^e the expectation of American government purchases,
as formed by the European government
- G_1 European government purchases this period
- G_2 American government purchases this period
- G_2^{-1} American government purchases last period.

According to equation (3), the European government sets European government purchases, forming an expectation of American government purchases. According to equation (4), the American government sets American government purchases, forming an expectation of European government purchases. According to equation (5), the expectation of European government purchases is equal to the forecast made by means of the model. According to equation (6), the expectation of American government purchases is equal to

American government purchases last period. The endogenous variables are G_1 , G_2 , G_1^e and G_2^e .

The dynamic model can be condensed to a system of two equations:

$$\bar{Y}_1 = A_1 + \gamma G_1 + \delta G_2^{-1} \quad (7)$$

$$\bar{Y}_2 = A_2 + \gamma G_2 + \delta G_1 \quad (8)$$

According to equation (7), the European government sets European government purchases, taking American government purchases as given. According to equation (8), the American government sets American government purchases, predicting European government purchases with the help of the model. In a sense, the American government is a Stackelberg leader, and the European government is a Stackelberg follower. The endogenous variables are G_1 and G_2 .

3) The steady state. In the steady state by definition we have $G_2 = G_2^{-1}$. That is, American government purchases do not change any more. Therefore the steady state can be captured by a system of two equations:

$$\bar{Y}_1 = A_1 + \gamma G_1 + \delta G_2 \quad (9)$$

$$\bar{Y}_2 = A_2 + \gamma G_2 + \delta G_1 \quad (10)$$

The endogenous variables are G_1 and G_2 .

To simplify notation we introduce:

$$B_1 = \bar{Y}_1 - A_1 \quad (11)$$

$$B_2 = \bar{Y}_2 - A_2 \quad (12)$$

Next we solve the model for the endogenous variables:

$$G_1 = \frac{\gamma B_1 - \delta B_2}{\gamma^2 - \delta^2} \quad (13)$$

$$G_2 = \frac{\gamma B_2 - \delta B_1}{\gamma^2 - \delta^2} \quad (14)$$

Equation (13) shows the steady-state level of European government purchases, and equation (14) shows the steady-state level of American government purchases. As a result, there is a steady state if and only if $\gamma \neq \delta$. This condition is fulfilled.

4) Stability. To simplify notation we make use of equations (11) and (12). With this, the dynamic model (7) and (8) can be written as follows:

$$B_1 = \gamma G_1 + \delta G_2^{-1} \quad (15)$$

$$B_2 = \gamma G_2 + \delta G_1 \quad (16)$$

The endogenous variables are G_1 and G_2 .

Now eliminate G_2^{-1} in equation (15) by means of equation (16) to arrive at:

$$\gamma G_1 = B_1 - \frac{\delta B_2}{\gamma} + \frac{\delta^2 G_1^{-1}}{\gamma} \quad (17)$$

Then differentiate equation (17) for G_1^{-1} :

$$\frac{dG_1}{dG_1^{-1}} = \frac{\delta^2}{\gamma^2} \quad (18)$$

Finally the stability condition is $\delta^2 / \gamma^2 < 1$ or:

$$\gamma > \delta \quad (19)$$

That means, the steady state is stable if and only if the internal effect of fiscal policy is larger than the external effect of fiscal policy. This condition is satisfied. As a result, under adaptive-rational expectations, there is a stable steady

state of fiscal competition. In other words, under adaptive-rational expectations, fiscal competition leads to full employment.

5) A numerical example. To illustrate the dynamic model, have a look at a numerical example. For ease of exposition, without losing generality, assume $\gamma = 1.2$ and $\delta = 0.8$. Evidently, an increase in European government purchases of 100 raises European output by 120 and American output by 80. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

Let initial output in Europe be 940, and let initial output in America 1060. Step 1 refers to the policy response. First consider fiscal policy in Europe. The European government sets European government purchases, taking American government purchases as given. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 1.2. So what is needed in Europe is an increase in European government purchases of 50.

Second consider fiscal policy in America. The American government sets American government purchases, forming rational expectations of European government purchases. The inflationary gap in America is 60. The fiscal policy multiplier in America is 1.2. So what is needed in America is a reduction in American government purchases of 50. Moreover, the expected increase in European government purchases is 50. Hence the expected increase in American output is 40. What is needed in America to counteract this, is a another reduction in American government purchases of 33.3. Adding up, the total reduction in American government purchases is 83.3.

Step 2 refers to the output lag. The increase in European government purchases of 50 causes an increase in European output of 60. As a side effect, it causes an increase in American output of 40. The reduction in American government purchases of 83.3 causes a decline in American output of 100. As a side effect, it causes a decline in European output of 66.7. The net effect is a decline in European output of 6.7 and a decline in American output of 60. As a consequence, European output goes from 940 to 933.3, and American output goes from 1060 to 1000. In Europe unemployment is even worse. At first glance this comes as a surprise. In America there is now full employment.

Step 3 refers to the policy response. First consider fiscal policy in Europe. The European government sets European government purchases, taking American government purchases as given. The output gap in Europe is 66.7. The fiscal policy multiplier in Europe is 1.2. So what is needed in Europe is an increase in European government purchases of 55.6.

Second consider fiscal policy in America. The American government sets American government purchases, forming rational expectations of European government purchases. The output gap in America is zero. From this point of view, there is no need for a change in American government purchases. Moreover, the expected increase in European government purchases is 55.6. Hence the expected increase in American output is 44.4. What is needed in America to counteract this, is a reduction in American government purchases of 37.0. Adding up, the total reduction in American government purchases is 37.0.

Step 4 refers to the output lag. The increase in European government purchases of 55.6 causes an increase in European output of 66.7. As a side effect, it causes an increase in American output of 44.4. The reduction in American government purchases of 37.0 causes a decline in American output of 44.4. As a side effect, it causes a decline in European output of 29.6. The net effect is an increase in European output of 37.0 and an increase in American output of zero. As a consequence, European output goes from 933.3 to 970.3, while American output stays at 1000. In Europe unemployment comes down to a certain extent. In America there is still full employment. And so on. Table 6.4 gives an overview.

What are the dynamic characteristics of this process? There are repeated increases in European government purchases. There are repeated cuts in American government purchases. There is an initial cut in European output that is followed by repeated increases in European output. And there is a one-time cut in American output. In Europe there is unemployment. In America there is full employment. As a result, fiscal competition leads to full employment. Taking the sum over the process as a whole, the increase in European government purchases is 150, and the cut in American government purchases is equally 150.

Table 6.4**Fiscal Competition between Europe and America**

Adaptive Policy Expectations in Europe

Rational Policy Expectations in America

	Europe	America
Initial Output	940	1060
Change in Government Purchases	50	- 83.3
Output	933.3	1000
Change in Government Purchases	55.6	- 37.0
Output	970.3	1000
<i>and so on</i>	...	...

6) Comparison. Coming to an end, compare the three types of expectations:

- adaptive policy expectations in Europe and America
- adaptive policy expectations in Europe,
rational policy expectations in America
- rational policy expectations in Europe and America.

Under adaptive expectations, fiscal competition is a slow process. Under adaptive-rational expectations, fiscal competition is a process of intermediate speed. And under rational expectations, fiscal competition is a fast process. That is to say, rational expectations speed up the process of fiscal competition.

Synopsis

Table 7.1
The World of Two Monetary Regions

Monetary Competition between Europe and America	Stable
Fiscal Competition between Europe and America: Perfect Capital Mobility	Unstable
Fiscal Competition between Europe and America: Imperfect Capital Mobility	Stable
Monetary and Fiscal Competition: Gradualist Policies	Stability Condition
Monetary Cooperation between Europe and America	Solution
Fiscal Cooperation between Europe and America: Perfect Capital Mobility	No Solution
Fiscal Cooperation between Europe and America: Imperfect Capital Mobility	Solution
Monetary and Fiscal Cooperation: Imperfect Capital Mobility	Solution

Table 7.2
The World of Three Monetary Regions

Monetary Competition between Europe, America and Asia	Stable
Fiscal Competition between Europe, America and Asia: Perfect Capital Mobility	Unstable
Fiscal Competition between Europe, America and Asia: Low Capital Mobility	Stable
Fiscal Competition between Europe, America and Asia: High Capital Mobility	Unstable
Fiscal Competition between Europe, America and Asia: Gradualist Policies	Stability Condition
Monetary Cooperation between Europe, America and Asia	Solution
Fiscal Cooperation between Europe, America and Asia: Perfect Capital Mobility	No Solution
Fiscal Cooperation between Europe, America and Asia: Imperfect Capital Mobility	Solution

Table 7.3
Rational Policy Expectations

Monetary Competition between Europe and America	Unique Equilibrium
Fiscal Competition between Europe and America: Perfect Capital Mobility	No Equilibrium
Fiscal Competition between Europe and America: Imperfect Capital Mobility	Unique Equilibrium
Monetary and Fiscal Competition: Imperfect Capital Mobility	No Unique Equilibrium

Conclusion

1. Basic Models

1.1. Monetary Competition between Europe and America

1) The static model. As a point of reference, consider the static model. The world consists of two monetary regions, say Europe and America. The exchange rate between Europe and America is flexible. There is international trade between Europe and America. There is perfect capital mobility between Europe and America. European goods and American goods are imperfect substitutes for each other. European output is determined by the demand for European goods. American output is determined by the demand for American goods. European money demand equals European money supply. And American money demand equals American money supply. The monetary regions are the same size and have the same behavioural functions. Nominal wages and prices adjust slowly.

As a result, an increase in European money supply raises European output. On the other hand, it lowers American output. Here the rise in European output exceeds the fall in American output. Correspondingly, an increase in American money supply raises American output. On the other hand, it lowers European output. Here the rise in American output exceeds the fall in European output. That is to say, the internal effect of monetary policy is positive. By contrast, the external effect of monetary policy is negative. In absolute values, the internal effect is larger than the external effect.

Now have a closer look at the process of adjustment. An increase in European money supply causes a depreciation of the euro, an appreciation of the dollar, and a decline in the world interest rate. The depreciation of the euro raises European exports. The appreciation of the dollar lowers American exports. And the decline in the world interest rate raises both European investment and American investment. The net effect is that European output goes up. However, American output goes down. This model is in the tradition of the Mundell-Fleming model.

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European central bank is full employment in Europe. The instrument of the European central bank is European money supply. The European central bank raises European money supply so as to close the output gap in Europe. The target of the American central bank is full employment in America. The instrument of the American central bank is American money supply. The American central bank raises American money supply so as to close the output gap in America. We assume that the European central bank and the American central bank decide simultaneously and independently. In addition there is an output lag. As a result, there is a stable steady state of monetary competition. In other words, monetary competition leads to full employment in Europe and America.

3) Some numerical examples. An increase in European money supply of 100 causes an increase in European output of 300 and a decline in American output of 100. Similarly, an increase in American money supply of 100 causes an increase in American output of 300 and a decline in European output of 100. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same. It proves useful to study two distinct cases:

- unemployment in Europe and America
- inflation in Europe and America.

First consider unemployment in Europe and America. Let initial output in Europe be 940, and let initial output in America be 970. Step 1 refers to the policy response. The output gap in Europe is 60. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 20. The output gap in America is 30. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 10.

Step 2 refers to the output lag. The increase in European money supply of 20 causes an increase in European output of 60. As a side effect, it causes a decline in American output of 20. The increase in American money supply of 10 causes an increase in American output of 30. As a side effect, it causes a decline in European output of 10. The net effect is an increase in European output of 50 and an increase in American output of 10. As a consequence, European output goes from 940 to 990, and American output goes from 970 to 980.

Why does the European central bank not succeed in closing the output gap in Europe? The underlying reason is the negative external effect of the increase in American money supply. And why does the American central bank not succeed in closing the output gap in America? The underlying reason is the negative external effect of the increase in European money supply.

Step 3 refers to the policy response. The output gap in Europe is 10. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 3.3. The output gap in America is 20. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 6.7.

Step 4 refers to the output lag. The increase in European money supply of 3.3 causes an increase in European output of 10. As a side effect, it causes a decline in American output of 3.3. The increase in American money supply of 6.7 causes an increase in American output of 20. As a side effect, it causes a decline in European output of 6.7. The net effect is an increase in European output of 3.3 and an increase in American output of 16.7. As a consequence, European output goes from 990 to 993.3, and American output goes from 980 to 996.7. And so on. Table 8.1 presents a synopsis.

Table 8.1
Monetary Competition between Europe and America
 Unemployment in Europe and America

	Europe	America
Initial Output	940	970
Change in Money Supply	20	10
Output	990	980
Change in Money Supply	3.3	6.7
Output	993.3	996.7
<i>and so on</i>	...	...

What are the dynamic characteristics of this process? There are repeated increases in European money supply, as there are in American money supply. There are repeated increases in European output, as there are in American output. There are repeated cuts in the world interest rate. There are repeated increases in European investment, as there are in American investment. There are repeated cuts in budget deficits and public debts. As a result, monetary competition leads to full employment.

Taking the sum over all periods, the increase in European money supply is 26.25, and the increase in American money supply is 18.75. The total increase in European money supply is large, as compared to the initial output gap in Europe of 60. And the total increase in American money supply is even larger, as compared to the initial output gap in America of 30. The effective multiplier in Europe is $60/26.25 = 2.3$, and the effective multiplier in America is $30/18.75 = 1.6$. That is to say, the effective multiplier in Europe is small, and the effective multiplier in America is even smaller.

Second consider inflation in Europe and America. At the start there is overemployment in both Europe and America. For that reason there is inflation in both Europe and America. Let initial output in Europe be 1060, and let initial output in America be 1030. Step 1 refers to the policy response. The inflationary gap in Europe is 60. The target of the European central bank is price stability in Europe. The monetary policy multiplier in Europe is 3. So what is needed in Europe is a reduction in European money supply of 20. The inflationary gap in America is 30. The target of the American central bank is price stability in America. The monetary policy multiplier in America is 3. So what is needed in America is a reduction in American money supply of 10.

Step 2 refers to the output lag. The reduction in European money supply of 20 causes a decline in European output of 60. As a side effect, it causes an increase in American output of 20. The reduction in American money supply of 10 causes a decline in American output of 30. As a side effect, it causes an increase in European output of 10. The net effect is a decline in European output of 50 and a decline in American output of 10. As a consequence, European output goes from 1060 to 1010, and American output goes from 1030 to 1020.

Step 3 refers to the policy response. The inflationary gap in Europe is 10. The monetary policy multiplier in Europe is 3. So what is needed in Europe is a reduction in European money supply of 3.3. The inflationary gap in America is 20. The monetary policy multiplier in America is 3. So what is needed in America is a reduction in American money supply of 6.7.

Step 4 refers to the output lag. The reduction in European money supply of 3.3 causes a decline in European output of 10. As a side effect, it causes an increase in American output of 3.3. The reduction in American money supply of 6.7 causes a decline in American output of 20. As a side effect, it causes an increase in European output of 6.7. The net effect is a decline in European output of 3.3 and a decline in American output of 16.7. As a consequence, European output goes from 1010 to 1006.7, and American output goes from 1020 to 1003.3. And so on. Table 8.2 gives an overview.

What are the dynamic characteristics of this process? There are repeated cuts in European money supply, as there are in American money supply. There are repeated cuts in European output, as there are in American output. As a result, the process of monetary competition leads to both price stability and full employment.

Table 8.2
Monetary Competition between Europe and America
 Inflation in Europe and America

	Europe	America
Initial Output	1060	1030
Change in Money Supply	- 20	- 10
Output	1010	1020
Change in Money Supply	- 3.3	- 6.7
Output	1006.7	1003.3
<i>and so on</i>	...	...

1.2. Monetary Cooperation between Europe and America

1) The model. At the beginning there is unemployment in both Europe and America. The targets of monetary cooperation are full employment in Europe and full employment in America. The instruments of monetary cooperation are European money supply and American money supply. So there are two targets and two instruments. As a result, there is a solution to monetary cooperation. In other words, monetary cooperation can achieve full employment in Europe and America. The required increase in European money supply depends on the initial output gap in Europe, the initial output gap in America, the direct multiplier, and the cross multiplier. The larger the initial output gap in Europe, the larger is the required increase in European money supply. Moreover, the larger the initial output gap in America, the larger is the required increase in European money supply. At first glance this comes as a surprise. The required increase in American money supply depends on the initial output gap in America, the initial output gap in Europe, the direct multiplier, and the cross multiplier. It is worth pointing out here that the solution to monetary cooperation is identical to the steady state of monetary competition.

2) Some numerical examples. It proves useful to study two distinct cases. First consider unemployment in Europe and America. Let initial output in Europe be 940, and let initial output in America be 970. The output gap in Europe is 60, and the output gap in America is 30. What is needed, then, is an increase in European money supply of 26.25 and an increase in American money supply of 18.75. The increase in European money supply of 26.25 raises European output by 78.75 and lowers American output by 26.25. The increase in American money supply of 18.75 raises American output by 56.25 and lowers European output by 18.75. The net effect is an increase in European output of 60 and an increase in American output of 30. As a consequence, European output goes from 940 to 1000, and American output goes from 970 to 1000. In Europe there is now full employment, and the same holds for America. The required increase in money supply is large, as compared to the initial output gap. For a synopsis see Table 8.3.

Table 8.3**Monetary Cooperation between Europe and America**

Unemployment in Europe and America

	Europe	America
Initial Output	940	970
Change in Money Supply	26.25	18.75
Output	1000	1000

Second consider inflation in Europe and America. At the start there is overemployment in both Europe and America. For that reason there is inflation in both Europe and America. Let overemployment in Europe exceed overemployment in America. Let initial output in Europe be 1060, and let initial output in America be 1030. The inflationary gap in Europe is 60, and the inflationary gap in America is 30. The targets of monetary cooperation are price stability in Europe and price stability in America. What is needed, then, is a reduction in European money supply of 26.25 and a reduction in American money supply of 18.75. As a consequence, European output goes from 1060 to 1000, and American output goes from 1030 to 1000. There is now full employment in both Europe and America. For that reason there is now price stability in both Europe and America. As a result, monetary cooperation can achieve full employment and price stability. For an overview see Table 8.4.

3) Comparing monetary cooperation with monetary competition. Monetary competition can achieve full employment. The same applies to monetary cooperation. Monetary competition is a slow process. By contrast, monetary cooperation is a fast process. Judging from these points of view, monetary cooperation seems to be superior to monetary competition.

Table 8.4**Monetary Cooperation between Europe and America**

Inflation in Europe and America

	Europe	America
Initial Output	1060	1030
Change in Money Supply	- 26.25	- 18.75
Output	1000	1000

1.3. Fiscal Competition between Europe and America

1) The static model. An increase in European government purchases raises both European output and American output. And what is more, the rise in European output equals the rise in American output. Correspondingly, an increase in American government purchases raises both American output and European output. And what is more, the rise in American output equals the rise in European output. That is to say, the internal effect of fiscal policy is positive. The external effect of fiscal policy is positive too. And what is more, the internal effect and the external effect are the same size.

Now have a closer look at the process of adjustment. An increase in European government purchases causes an appreciation of the euro, a depreciation of the dollar, and an increase in the world interest rate. The appreciation of the euro lowers European exports. The depreciation of the dollar raises American exports. And the increase in the world interest rate lowers both European investment and American investment. The net effect is that European output and American output go up, to the same extent respectively. This model is in the tradition of the Mundell-Fleming model.

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European government is full employment in Europe. The instrument of the European government is European government purchases. The European government raises European government purchases so as to close the output gap in Europe. The target of the American government is full employment in America. The instrument of the American government is American government purchases. The American government raises American government purchases so as to close the output gap in America. We assume that the European government and the American government decide simultaneously and independently. In addition there is an output lag. As a result, there is no steady state of fiscal competition. In other words, fiscal competition does not lead to full employment in Europe and America. The underlying reason is the large external effect of fiscal policy.

3) A numerical example. An increase in European government purchases of 100 causes an increase in European output of 100 and an increase in American output of equally 100. Likewise, an increase in American government purchases of 100 causes an increase in American output of 100 and an increase in European output of equally 100. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

At the start there is unemployment in both Europe and America. Let initial output in Europe be 940, and let initial output in America be 970. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 1. So what is needed in Europe is an increase in European government purchases of 60. The output gap in America is 30. The fiscal policy multiplier in America is 1. So what is needed in America is an increase in American government purchases of 30.

Step 2 refers to the output lag. The increase in European government purchases of 60 causes an increase in European output of 60. As a side effect, it causes an increase in American output of equally 60. The increase in American government purchases of 30 causes an increase in American output of 30. As a side effect, it causes an increase in European output of equally 30. The total effect is an increase in European output of 90 and an increase in American output of equally 90. As a consequence, European output goes from 940 to 1030, and American output goes from 970 to 1060. Put another way, the output gap in

Europe of 60 turns into an inflationary gap of 30. And the output gap in America of 30 turns into an inflationary gap of 60.

Why does the European government not succeed in closing the output gap in Europe (or, for that matter, the inflationary gap in Europe)? The underlying reason is the positive external effect of the increase in American government purchases. And why does the American government not succeed in closing the output gap in America (or the inflationary gap in America)? The underlying reason is the positive external effect of the increase in European government purchases.

Step 3 refers to the policy response. The inflationary gap in Europe is 30. The fiscal policy multiplier in Europe is 1. So what is needed in Europe is a reduction in European government purchases of 30. The inflationary gap in America is 60. The fiscal policy multiplier in America is 1. So what is needed in America is a reduction in American government purchases of 60.

Step 4 refers to the output lag. The reduction in European government purchases of 30 causes a decline in European output of 30. As a side effect, it causes a decline in American output of equally 30. The reduction in American government purchases of 60 causes a decline in American output of 60. As a side effect, it causes a decline in European output of equally 60. The total effect is a decline in European output of 90 and a decline in American output of equally 90. As a consequence, European output goes from 1030 to 940, and American output goes from 1060 to 970. With this, European output and American output are back at their initial levels. That means, this process will repeat itself step by step. Table 8.5 presents a synopsis.

What are the dynamic characteristics of this process? There is an upward trend in European government purchases. By contrast, there is a downward trend in American government purchases. There are uniform oscillations in European output, as there are in American output. The European economy oscillates between unemployment and overemployment, as does the American economy. There are repeated appreciations of the euro and repeated depreciations of the dollar. Accordingly, there are repeated cuts in European exports and repeated increases in American exports. Moreover, after a certain number of steps,

American government purchases are down to zero. As a result, the process of fiscal competition does not lead to full employment.

4) Comparing fiscal competition with monetary competition. Monetary competition can achieve full employment, but fiscal competition cannot do so. Judging from this point of view, monetary competition is superior to fiscal competition.

Table 8.5

Fiscal Competition between Europe and America

Unemployment in Europe and America

	Europe	America
Initial Output	940	970
Change in Government Purchases	60	30
Output	1030	1060
Change in Government Purchases	– 30	– 60
Output	940	970
<i>and so on</i>	...	...

1.4. Fiscal Cooperation between Europe and America

1) The model. At the beginning there is unemployment in both Europe and America. More precisely, unemployment in Europe exceeds unemployment in America. The targets of fiscal cooperation are full employment in Europe and full employment in America. The instruments of fiscal cooperation are European government purchases and American government purchases. So there are two

targets and two instruments. As a result, there is no solution to fiscal cooperation. In other words, fiscal cooperation cannot achieve full employment in Europe and America. The underlying reason is the large external effect of fiscal policy.

2) A numerical example. Let initial output in Europe be 940, and let initial output in America be 970. In this case, the specific target of fiscal cooperation is full employment in America. Aiming for full employment in Europe would imply overemployment in America and, hence, inflation in America. So what is needed is an increase in American output of 30. What is needed, for instance, is an increase in European government purchases of 15 and an increase in American government purchases of equally 15. The increase in European government purchases of 15 raises European output and American output by 15 each. Similarly, the increase in American government purchases of 15 raises American output and European output by 15 each. The total effect is an increase in European output of 30 and an increase in American output of equally 30. As a consequence, European output goes from 940 to 970, and American output goes from 970 to 1000. In Europe unemployment comes down, but there is still some unemployment left. In America there is now full employment. As a result, in this case, fiscal cooperation can reduce unemployment in Europe and America to a certain extent. On the other hand, fiscal cooperation cannot achieve full employment in both Europe and America. Table 8.6 gives an overview.

Table 8.6
Fiscal Cooperation between Europe and America
 Unemployment in Europe and America

	Europe	America
Initial Output	940	970
Change in Government Purchases	15	15
Output	970	1000

3) Comparing fiscal cooperation with fiscal competition. Fiscal competition cannot achieve full employment. The same is true of fiscal cooperation. Fiscal competition cannot reduce unemployment. Fiscal cooperation can reduce unemployment to a certain extent. Under fiscal competition there is a tendency for government purchases to explode. And there is a tendency for output to oscillate uniformly. Under fiscal cooperation there are no such tendencies. Judging from these points of view, fiscal cooperation seems to be superior to fiscal competition.

4) Comparing fiscal cooperation with monetary cooperation. Monetary cooperation can achieve full employment. By contrast, fiscal cooperation cannot achieve full employment. From this perspective, monetary cooperation is superior to fiscal cooperation.

1.5. The Anticipation of Policy Spillovers

The focus here is on monetary competition between Europe and America. To illustrate this, have a look at a numerical example. An increase in European money supply of 100 causes an increase in European output of 300 and a decline in American output of 100. Similarly, an increase in American money supply of 100 causes an increase in American output of 300 and a decline in European output of 100. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

Let initial output in Europe be 940, and let initial output in America be 970. Steps 1, 2 and 3 refer to a series of policy responses. Then step 4 refers to the output lag. Let us begin with step 1. The output gap in Europe is 60. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 20. The output gap in America is 30. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 10.

In step 2, the European central bank anticipates the effect of the increase in American money supply. And the American central bank anticipates the effect of the increase in European money supply. The European central bank expects that, due to the increase in American money supply of 10, European output will only rise to 990. And the American central bank expects that, due to the increase in European money supply of 20, American output will only rise to 980. The expected output gap in Europe is 10. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 3.3. The expected output gap in America is 20. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 6.7.

We now come to step 3. The European central bank expects that, due to the increase in American money supply of 6.7, European output will only rise to 993.3. And the American central bank expects that, due to the increase in European money supply of 3.3, American output will only rise to 996.7. The expected output gap in Europe is 6.7. The monetary policy multiplier in Europe is 3. So what is needed in Europe is an increase in European money supply of 2.2. The expected output gap in America is 3.3. The monetary policy multiplier in America is 3. So what is needed in America is an increase in American money supply of 1.1.

Step 4 refers to the output lag. The accumulated increase in European money supply of 25.6 causes an increase in European output of 76.7. As a side effect, it causes a decline in American output of 25.6. The accumulated increase in American money supply of 17.8 causes an increase in American output of 53.3. As a side effect, it causes a decline in European output of 17.8. The net effect is an increase in European output of 58.9 and an increase in American output of 27.8. As a consequence, European output goes from 940 to 998.9, and American output goes from 970 to 997.8. For a synopsis see Table 8.7. As a result, the anticipation of policy spillovers speeds up the process of monetary competition.

Finally compare monetary competition and monetary cooperation, given anticipation. Monetary competition can achieve full employment. The same is true of monetary cooperation. Monetary competition is a fast process. Again, the same is true of monetary cooperation. From these points of view, there seems to be no need for monetary cooperation.

Table 8.7**Monetary Competition between Europe and America**

The Anticipation of Policy Spillovers

	Europe	America
Initial Output	940	970
Change in Money Supply	20	10
Change in Money Supply	3.3	6.7
Change in Money Supply	2.2	1.1
Output	998.9	997.8

2. Imperfect Capital Mobility**2.1. Fiscal Competition between Europe and America**

1) The static model. In this section we assume imperfect capital mobility between Europe and America. Under perfect capital mobility, an increase in European government purchases raises both European output and American output, to the same extent respectively. Under zero capital mobility, an increase in European government purchases raises European output to a much larger degree. On the other hand, it has no effect on American output. Under imperfect capital mobility, an increase in European government purchases raises both European output and American output. However, the rise in European output is relatively large, and the rise in American output is relatively small.

To illustrate this, consider a numerical example. Under perfect capital mobility, an increase in European government purchases of 100 causes an increase in European output of 100 and an increase in American output of

equally 100. Under zero capital mobility, by contrast, an increase in European government purchases of 100 causes an increase in European output of 200 and an increase in American output of zero. On this basis we assume that, under imperfect capital mobility, an increase in European government purchases of 100 causes an increase in European output of 150 and an increase in American output of 50. That means, under perfect capital mobility, fiscal spillovers are very large. Under zero capital mobility, fiscal spillovers are zero. And under imperfect capital mobility, fiscal spillovers are medium size.

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European government is full employment in Europe. The European government raises European government purchases so as to close the output gap in Europe. The target of the American government is full employment in America. The American government raises American government purchases so as to close the output gap in America. We assume that the European government and the American government decide simultaneously and independently. As a result, under imperfect capital mobility, there is a stable steady state of fiscal competition. In other words, fiscal competition leads to full employment in Europe and America.

3) A numerical example. An increase in European government purchases of 100 causes an increase in European output of 150 and an increase in American output of 50. Correspondingly, an increase in American government purchases of 100 causes an increase in American output of 150 and an increase in European output of 50. Further let full-employment output in Europe be 1000, and let full-employment output in America be the same.

Let initial output in Europe be 940, and let initial output in America be 970. Step 1 refers to the policy response. The output gap in Europe is 60. The fiscal policy multiplier in Europe is 1.5. So what is needed in Europe is an increase in European government purchases of 40. The output gap in America is 30. The fiscal policy multiplier in America is 1.5. So what is needed in America is an increase in American government purchases of 20.

Step 2 refers to the output lag. The increase in European government purchases of 40 causes an increase in European output of 60. As a side effect, it causes an increase in American output of 20. The increase in American

government purchases of 20 causes an increase in American output of 30. As a side effect, it causes an increase in European output of 10. The total effect is an increase in European output of 70 and an increase in American output of 50. As a consequence, European output goes from 940 to 1010, and American output goes from 970 to 1020.

Step 3 refers to the policy response. The inflationary gap in Europe is 10. The fiscal policy multiplier in Europe is 1.5. So what is needed in Europe is a reduction in European government purchases of 6.7. The inflationary gap in America is 20. The fiscal policy multiplier in America is 1.5. So what is needed in America is a reduction in American government purchases of 13.3.

Step 4 refers to the output lag. The reduction in European government purchases of 6.7 causes a decline in European output of 10. As a side effect, it causes a decline in American output of 3.3. The reduction in American government purchases of 13.3 causes a decline in American output of 20. As a side effect, it causes a decline in European output of 6.7. The total effect is a decline in European output of 16.7 and a decline in American output of 23.3. As a consequence, European output goes from 1010 to 993.3, and American output goes from 1020 to 996.7. And so on. Table 8.8 presents a synopsis.

Table 8.8
Fiscal Competition between Europe and America
 Imperfect Capital Mobility

	Europe	America
Initial Output	940	970
Change in Government Purchases	40	20
Output	1010	1020
Change in Government Purchases	- 6.7	- 13.3
Output	993.3	996.7
<i>and so on</i>	...	...

What are the dynamic characteristics of this process? There are damped oscillations in European government purchases, as there are in American government purchases. There are damped oscillations in European output, as there are in American output. As a result, the process of fiscal competition leads to full employment.

Taking the sum over all periods, the increase in European government purchases is 37.5, and the increase in American government purchases is 7.5. The total increase in European government purchases is small, as compared to the initial output gap in Europe of 60. And the total increase in American government purchases is even smaller, as compared to the initial output gap in America of 30. The effective multiplier in Europe is $60/37.5 = 1.6$, and the effective multiplier in America is $30/7.5 = 4$. That is to say, the effective multiplier in Europe is large, and the effective multiplier in America is even larger.

4) Comparing imperfect capital mobility with perfect capital mobility. Under perfect capital mobility, fiscal competition does not lead to full employment. Under imperfect capital mobility, by contrast, fiscal competition does lead to full employment.

2.2. Fiscal Cooperation between Europe and America

1) The model. At the start there is unemployment in both Europe and America. The targets of fiscal cooperation are full employment in Europe and full employment in America. The instruments of fiscal cooperation are European government purchases and American government purchases. So there are two targets and two instruments. As a result, under imperfect capital mobility, there is a solution to fiscal cooperation. In other words, fiscal cooperation can achieve full employment in Europe and America. The required increase in European government purchases depends on the initial output gap in Europe, the initial output gap in America, the direct multiplier, and the cross multiplier. The larger

the initial output gap in Europe, the larger is the required increase in European government purchases. Moreover, the larger the initial output gap in America, the smaller is the required increase in European government purchases. At first glance this comes as a surprise. The required increase in American government purchases depends on the initial output gap in America, the initial output gap in Europe, the direct multiplier, and the cross multiplier. It is worth pointing out here that the solution to fiscal cooperation is identical to the steady state of fiscal competition.

2) A numerical example. Let initial output in Europe be 940, and let initial output in America be 970. The output gap in Europe is 60, and the output gap in America is 30. What is needed, then, is an increase in European government purchases of 37.5 and an increase in American government purchases of 7.5. The increase in European government purchases of 37.5 raises European output by 56.25 and American output by 18.75. The increase in American government purchases of 7.5 raises American output by 11.25 and European output by 3.75. The total effect is an increase in European output of 60 and an increase in American output of 30. As a consequence, European output goes from 940 to 1000, and American output goes from 970 to 1000. In Europe there is now full employment, and the same holds for America. As a result, fiscal cooperation can achieve full employment. The required increase in government purchases is small, as compared to the initial output gap. Table 8.9 gives an overview.

Table 8.9
Fiscal Cooperation between Europe and America
 Imperfect Capital Mobility

	Europe	America
Initial Output	940	970
Change in Government Purchases	37.5	7.5
Output	1000	1000

3) Comparing imperfect capital mobility with perfect capital mobility. Under perfect capital mobility, fiscal cooperation cannot achieve full employment. Under imperfect capital mobility, by contrast, fiscal cooperation can indeed achieve full employment.

4) Comparing fiscal cooperation with fiscal competition, given imperfect capital mobility. Fiscal competition can achieve full employment. The same applies to fiscal cooperation. Fiscal competition is a slow process. On the other hand, fiscal cooperation is a fast process. Judging from these points of view, fiscal cooperation seems to be superior to fiscal competition.

2.3. Monetary Competition between Europe and America

1) The static model. To illustrate this, consider a numerical example. Under perfect capital mobility, an increase in European money supply of 100 causes an increase in European output of 300 and a decline in American output of 100. Under zero capital mobility, by contrast, an increase in European money supply of 100 causes an increase in European output of 200 and a decline in American output of zero. On this basis we assume that, under imperfect capital mobility, an increase in European money supply of 100 causes an increase in European output of 250 and a decline in American output of 50. That means, under high capital mobility, monetary spillovers are large. On the other hand, under zero capital mobility, monetary spillovers are zero. And under low capital mobility, monetary spillovers are small.

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European central bank is full employment in Europe. The European central bank raises European money supply so as to close the output gap in Europe. The target of the American central bank is full employment in America. The American central bank raises American money supply so as to close the output gap in America. We assume that the European central bank and the American central bank decide simultaneously and

independently. As a result, imperfect capital mobility speeds up the process of monetary competition.

3) Comparing monetary competition with fiscal competition. Monetary competition leads to full employment. The same is true of fiscal competition. Monetary competition is a relatively fast process. By contrast, fiscal competition is a relatively slow process. Judging from this perspective, monetary competition seems to be superior to fiscal competition.

2.4. Monetary and Fiscal Cooperation

This section deals with cooperation between the European central bank, the American central bank, the European government, and the American government. At the start there is unemployment in Europe as well as America. The targets of policy cooperation are full employment in Europe and full employment in America. The instruments of policy cooperation are European money supply, American money supply, European government purchases, and American government purchases. There are two targets and four instruments, so there are two degrees of freedom. As a result, there is an infinite number of solutions. In other words, monetary and fiscal cooperation can achieve full employment in Europe and America.

Of course there are many more potential targets of policy cooperation: balancing the budget in Europe, balancing the budget in America, balancing the current account in Europe and America, high investment in Europe, high investment in America, preventing foreign exchange bubbles, preventing stock market bubbles, and so on. To sum up, in a sense, policy instruments are abundant. And in another sense, policy instruments are scarce.

3. Gradualist Policies

1) Fiscal competition between Europe and America. So far we have assumed that the governments follow a cold-turkey strategy. Now we assume that the governments follow a gradualist strategy. Besides we assume imperfect capital mobility between Europe and America. At the beginning there is unemployment in Europe and America. The general target of the European government is full employment in Europe. We assume that the European government follows a gradualist strategy. The specific target of the European government is to close the output gap in Europe by the fraction λ_1 . The general target of the American government is full employment in America. We assume that the American government follows a gradualist strategy. The specific target of the American government is to close the output gap in America by the fraction λ_2 . We assume that the European government and the American government decide simultaneously and independently.

As a result, under a gradualist strategy, fiscal competition is a relatively fast process. By contrast, under a cold-turkey strategy, fiscal competition is a relatively slow process. At first glance this comes as a surprise. Moreover, under a gradualist strategy, there are repeated increases in output. On the other hand, under a cold-turkey strategy, there are oscillations in output.

2) Monetary competition between Europe and America. So far we have assumed that the central banks follow a cold-turkey strategy. Now we assume that the central banks follow a gradualist strategy. Besides we assume perfect capital mobility between Europe and America. At the start there is unemployment in Europe and America. The general target of the European central bank is full employment in Europe. We assume that the European central bank follows a gradualist strategy. The specific target of the European central bank is to close the output gap in Europe by the fraction μ_1 . The general target of the American central bank is full employment in America. We assume that the American central bank follows a gradualist strategy. The specific target of the American central bank is to close the output gap in America by the fraction μ_2 . We assume that the European central bank and the American central bank decide simultaneously and independently. As a result, under a gradualist strategy,

monetary competition is a relatively slow process. By contrast, under a cold-turkey strategy, monetary competition is a relatively fast process.

3) Monetary and fiscal competition. This section deals with competition between the European central bank, the American central bank, the European government, and the American government. We assume imperfect capital mobility between Europe and America. At the beginning there is unemployment in Europe and America. The specific target of the European central bank is to close the output gap in Europe by the fraction μ_1 . The specific target of the American central bank is to close the output gap in America by the fraction μ_2 . The specific target of the European government is to close the output gap in Europe by the fraction λ_1 . The specific target of the American government is to close the output gap in America by the fraction λ_2 . We assume that the European central bank, the American central bank, the European government, and the American government decide simultaneously and independently.

As a result, there is a stability condition. The steady state of monetary and fiscal competition is stable if the speed of adjustment in European money supply, American money supply, European government purchases, and American government purchases is sufficiently low. Taking the sum over all periods, the increase in European money supply, American money supply, European government purchases, and American government purchases depends upon the relative speed of adjustment in European money supply, American money supply, European government purchases, and American government purchases.

4. The World of Three Monetary Regions

1) Monetary competition between Europe, America and Asia. The world consists of three monetary regions, say Europe, America and Asia. The monetary regions are the same size and have the same behavioural functions. At the beginning there is unemployment in each of the regions. As a result, the steady state is stable if and only if the internal effect of monetary policy is larger than

the external effect of monetary policy. This condition is fulfilled. In other words, the process of monetary competition leads to full employment in each of the regions. Now compare the world of three regions with the world of two regions. In the world of two regions, monetary competition is a relatively fast process. By contrast, in the world of three regions, monetary competition is a relatively slow process.

2) Monetary cooperation between Europe, America and Asia. As a result, there is a solution to monetary cooperation. That is to say, monetary cooperation can achieve full employment in each of the regions.

3) Fiscal competition: perfect capital mobility. As a result, there is no steady state of fiscal competition. In other words, the process of fiscal competition does not lead to full employment. The underlying reason is the large external effect of fiscal policy. Moreover, compare the world of three regions with the world of two regions. In the world of two regions, fiscal competition causes uniform oscillations in government purchases and output. By contrast, in the world of three regions, fiscal competition causes explosive oscillations in government purchases and output.

4) Fiscal competition: imperfect capital mobility. As a result, under low capital mobility, fiscal competition is a stable process. However, under high capital mobility, fiscal competition is an unstable process. That means, under low capital mobility, fiscal competition leads to full employment. On the other hand, under high capital mobility, fiscal competition does not lead to full employment.

5) Fiscal competition: gradualist policies. We assume high capital mobility. As a result, fiscal competition is a stable process. In other words, fiscal competition leads to full employment. Judging from this perspective, the gradualist strategy seems to be superior to the cold-turkey strategy.

6) Fiscal cooperation: perfect capital mobility. As a result, there is no solution to fiscal cooperation. That is to say, fiscal cooperation cannot achieve full employment in each of the regions. The underlying reason is the large external effect of fiscal policy.

7) Fiscal cooperation: imperfect capital mobility. As a result, there is a solution to fiscal cooperation. In other words, fiscal cooperation can indeed achieve full employment in each of the regions. Finally compare fiscal cooperation with fiscal competition. Fiscal competition can achieve full employment, provided capital mobility is sufficiently low. By contrast, fiscal cooperation can achieve full employment in any case.

5. Rational Policy Expectations

1) Monetary competition between Europe and America. At the beginning there is unemployment in both Europe and America. The target of the European central bank is full employment in Europe. The instrument of the European central bank is European money supply. The target of the American central bank is full employment in America. The instrument of the American central bank is American money supply. We assume that the European central bank and the American central bank decide simultaneously and independently.

The European central bank sets European money supply, forming rational expectations of American money supply. And the American central bank sets American money supply, forming rational expectations of European money supply. That is to say, the European central bank sets European money supply, predicting American money supply by means of the model. And the American central bank sets American money supply, predicting European money supply by means of the model. As a result, there is an immediate equilibrium of monetary competition. In other words, monetary competition leads to full employment immediately. It is worth pointing out here that the equilibrium under rational expectations is identical to the steady state under adaptive expectations.

Here a comment is in place. The European central bank closely observes the measures taken by the American central bank. And what is more, the European central bank can respond immediately to the measures taken by the American central bank. The other way round, the American central bank closely observes

the measures taken by the European central bank. And what is more, the American central bank can respond immediately to the measures taken by the European central bank. Therefore rational policy expectations seem not to be very important.

2) Fiscal competition: perfect capital mobility. This section deals with fiscal competition between Europe and America. At the beginning there is unemployment in each of the regions. The target of the European government is full employment in Europe. The instrument of the European government is European government purchases. The target of the American government is full employment in America. The instrument of the American government is American government purchases. We assume that the European government and the American government decide simultaneously and independently.

The European government sets European government purchases, forming rational expectations of American government purchases. And the American government sets American government purchases, forming rational expectations of European government purchases. That is to say, the European government sets European government purchases, predicting American government purchases by means of the model. And the American government sets American government purchases, predicting European government purchases by means of the model. As a result, there is no equilibrium of fiscal competition. In other words, fiscal competition does not lead to full employment. The underlying reason is the large spillover effect of fiscal policy.

3) Fiscal competition: imperfect capital mobility. As a result, there is an immediate equilibrium of fiscal competition. In other words, fiscal competition leads to full employment immediately. It is worth pointing out here that the equilibrium under rational expectations is identical to the steady state under adaptive expectations. Now compare fiscal competition with monetary competition. Fiscal competition can cause large changes in government purchases. By contrast, monetary competition cannot cause any changes in government purchases. Judging from this point of view, monetary competition seems to be superior to fiscal competition.

4) Monetary and fiscal competition. This section deals with competition between the European central bank, the American central bank, the European

government, and the American government. We assume imperfect capital mobility. The target of the European central bank is full employment in Europe. The target of the American central bank is full employment in America. The target of the European government is full employment in Europe. And the target of the American government is full employment in America. We assume that the European central bank, the American central bank, the European government, and the American government decide simultaneously and independently.

The European central bank sets European money supply, forming rational expectations of American money supply, European government purchases, and American government purchases. The American central bank sets American money supply, forming rational expectations of European money supply, American government purchases, and European government purchases. The European government sets European government purchases, forming rational expectations of American government purchases, European money supply, and American money supply. The American government sets American government purchases, forming rational expectations of European government purchases, American money supply, and European money supply. As a result, there is no unique equilibrium of monetary and fiscal competition. In other words, monetary and fiscal competition does not lead to full employment.

Result

1. Monetary Competition between Europe and America

1) The static model. The world consists of two monetary regions, say Europe and America. The monetary regions are the same size and have the same behavioural functions. An increase in European money supply raises European output. On the other hand, it lowers American output. Here the rise in European output exceeds the fall in American output, as is well known. Correspondingly, an increase in American money supply raises American output. On the other hand, it lowers European output. Here the rise in American output exceeds the fall in European output. In the numerical example, an increase in European money supply of 100 causes an increase in European output of 300 and a decline in American output of 100. Similarly, an increase in American money supply of 100 causes an increase in American output of 300 and a decline in European output of 100. That is to say, the internal effect of monetary policy is very large, and the external effect of monetary policy is large.

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European central bank is full employment in Europe, and the instrument is European money supply. The European central bank raises European money supply so as to close the output gap in Europe. The target of the American central bank is full employment in America, and the instrument is American money supply. The American central bank raises American money supply so as to close the output gap in America. We assume that the European central bank and the American central bank decide simultaneously and independently. In addition there is an output lag. As a result, the process of monetary competition is stable. In other words, monetary competition leads to full employment in Europe and America.

3) A numerical example. Let full-employment output in Europe be 1000, and let full-employment output in America be the same. Let initial output in Europe be 940, and let initial output in America be 970. Step 1 refers to the policy response. What is needed in Europe is an increase in European money supply of 20. And what is needed in America is an increase in American money supply of

10. Step 2 refers to the output lag. The net effect is an increase in European output of 50 and an increase in American output of 10. As a consequence, European output goes to 990, and American output goes to 980. In step 3, European money supply is raised by 3.3, and American money supply is raised by 6.7. In step 4, European output goes to 993.3, and American output goes to 996.7. And so on. There are repeated increases in European money supply, as there are in American money supply. There are repeated increases in European output, as there are in American output.

4) Another numerical example. At the start there is overemployment and hence inflation. Let initial output in Europe be 1060, and let initial output in America be 1030. The target of the European central bank is price stability in Europe. The target of the American central bank is price stability in America. Step 1 refers to the policy response. What is needed in Europe is a reduction in European money supply of 20. And what is needed in America is a reduction in American money supply of 10. Step 2 refers to the output lag. The net effect is a decline in European output of 50 and a decline in American output of 10. As a consequence, European output goes to 1010, and American output goes to 1020. In step 3, European money supply is lowered by 3.3, and American money supply is lowered by 6.7. In step 4, European output goes to 1006.7, and American output goes to 1003.3. And so on. There are repeated cuts in European money supply, as there are in American money supply. There are repeated cuts in European output, as there are in American output. As a result, the process of monetary competition leads to full employment and price stability.

2. Monetary Cooperation between Europe and America

1) The model. At the beginning there is unemployment in both Europe and America. The targets of monetary cooperation are full employment in Europe and full employment in America. The instruments of monetary cooperation are European money supply and American money supply. So there are two targets and two instruments. As a result, there is a solution to monetary cooperation. In

other words, monetary cooperation can achieve full employment in Europe and America.

2) Some numerical examples. It proves useful to study two distinct cases. First consider unemployment in Europe and America. Let initial output in Europe be 940, and let initial output in America be 970. What is needed, then, is an increase in European money supply of 26.25 and an increase in American money supply of 18.75. The net effect is an increase in European output of 60 and an increase in American output of 30. As a consequence, European output goes to 1000, as does American output. Second consider inflation in Europe and America. Let initial output in Europe be 1060, and let initial output in America be 1030. The targets of monetary cooperation are price stability in Europe and price stability in America. What is needed, then, is a reduction in European money supply of 26.25 and a reduction in American money supply of 18.75. The net effect is a decline in European output of 60 and a decline in American output of 30. As a consequence, European output goes to 1000, as does American output. As a result, monetary cooperation can achieve full employment and price stability.

3) Comparing monetary cooperation with monetary competition. Monetary competition is a slow process. By contrast, monetary cooperation is a fast process. Judging from this perspective, monetary cooperation seems to be superior to monetary competition.

3. Fiscal Competition: Perfect Capital Mobility

1) The static model. An increase in European government purchases raises both European output and American output. And what is more, the rise in European output equals the rise in American output. Correspondingly, an increase in American government purchases raises both American output and European output. And what is more, the rise in American output equals the rise in European output. In the numerical example, an increase in European

government purchases of 100 causes an increase in European output of 100 and an increase in American output of equally 100. Likewise, an increase in American government purchases of 100 causes an increase in American output of 100 and an increase in European output of equally 100. In a sense, the internal effect of fiscal policy is rather small, whereas the external effect of fiscal policy is quite large.

2) The dynamic model. At the beginning there is unemployment in both Europe and America. The target of the European government is full employment in Europe, and the instrument is European government purchases. The European government raises European government purchases so as to close the output gap in Europe. The target of the American government is full employment in America, and the instrument is American government purchases. The American government raises American government purchases so as to close the output gap in America. We assume that the European government and the American government decide simultaneously and independently. In addition there is an output lag. As a result, the process of fiscal competition is unstable. In other words, fiscal competition does not lead to full employment in Europe and America. The underlying reason is the large external effect of fiscal policy.

3) A numerical example. Let full-employment output in Europe be 1000, and let full-employment output in America be the same. Let initial output in Europe be 940, and let initial output in America be 970. Step 1 refers to the policy response. What is needed in Europe is an increase in European government purchases of 60. And what is needed in America is an increase in American government purchases of 30. Step 2 refers to the output lag. The total effect is an increase in European output of 90 and an increase in American output of equally 90. As a consequence, European output goes to 1030, and American output goes to 1060. In step 3, European government purchases are lowered by 30, and American government purchases are lowered by 60. In step 4, European output goes to 940, and American output goes to 970. And so on.

There is an upward trend in European government purchases. By contrast, there is a downward trend in American government purchases. There are uniform oscillations in European output, as there are in American output. The European economy oscillates between unemployment and overemployment, as does the American economy. Moreover, after a certain number of steps, American

government purchases are down to zero. Finally compare fiscal competition with monetary competition. Monetary competition leads to full employment. Fiscal competition, however, does not lead to full employment. From this point of view, monetary competition is superior to fiscal competition.

4. Fiscal Cooperation: Perfect Capital Mobility

At the beginning there is unemployment in both Europe and America. The targets of fiscal cooperation are full employment in Europe and full employment in America. The instruments of fiscal cooperation are European government purchases and American government purchases. So there are two targets and two instruments. As a result, there is no solution to fiscal cooperation. In other words, fiscal cooperation cannot achieve full employment in Europe and America. The underlying reason is the large external effect of fiscal policy.

Consider a numerical example. Let initial output in Europe be 940, and let initial output in America be 970. In this case, the specific target of fiscal cooperation is full employment in America. Aiming for full employment in Europe would imply overemployment in America and, hence, inflation in America. So what is needed is an increase in American output of 30. What is needed, for instance, is an increase in European government purchases of 15 and an increase in American government purchases of equally 15. The total effect is an increase in European output of 30 and an increase in American output of equally 30. As a consequence, European output goes to 970, and American output goes to 1000. In Europe unemployment comes down, but there is still some unemployment left. In America there is now full employment.

Now compare fiscal cooperation with monetary cooperation. Monetary cooperation can achieve full employment. By contrast, fiscal cooperation cannot achieve full employment. From this perspective, monetary cooperation is superior to fiscal cooperation.

5. Fiscal Competition: Imperfect Capital Mobility

1) The static model. An increase in European government purchases raises both European output and American output. Here the rise in European output exceeds the rise in American output. Correspondingly, an increase in American government purchases raises both American output and European output. Here the rise in American output exceeds the rise in European output. In the numerical example, an increase in European government purchases of 100 causes an increase in European output of 150 and an increase in American output of 50. Similarly, an increase in American government purchases of 100 causes an increase in American output of 150 and an increase in European output of 50.

2) The dynamic model. The European government raises European government purchases so as to close the output gap in Europe. The American government raises American government purchases so as to close the output gap in America. We assume that the European government and the American government decide simultaneously and independently. As a result, the process of fiscal competition is stable. In other words, fiscal competition leads to full employment in Europe and America.

3) A numerical example. Let initial output in Europe be 940, and let initial output in America be 970. Step 1 refers to the policy response. What is needed in Europe is an increase in European government purchases of 40. And what is needed in America is an increase in American government purchases of 20. Step 2 refers to the output lag. The total effect is an increase in European output of 70 and an increase in American output of 50. As a consequence, European output goes to 1010, and American output goes to 1020. In step 3, European government purchases are lowered by 6.7, and American government purchases are lowered by 13.3. In step 4, European output goes to 993.3, and American output goes to 996.7. And so on. There are damped oscillations in European government purchases, as there are in American government purchases. There are damped oscillations in European output, as there are in American output.

6. Fiscal Cooperation: Imperfect Capital Mobility

As a result, there is a solution to fiscal cooperation. In other words, fiscal cooperation can achieve full employment in Europe and America. Consider a numerical example. Let initial output in Europe be 940, and let initial output in America be 970. What is needed, then, is an increase in European government purchases of 37.5 and an increase in American government purchases of 7.5. The total effect is an increase in European output of 60 and an increase in American output of 30. As a consequence, European output goes to 1000, as does American output. Now compare fiscal cooperation with fiscal competition. Fiscal competition is a slow process. By contrast, fiscal cooperation is a fast process.

7. The Anticipation of Policy Spillovers

The focus here is on monetary competition between Europe and America. In the numerical example, an increase in European money supply of 100 causes an increase in European output of 300 and a decline in American output of 100. Let initial output in Europe be 940, and let initial output in America be 970. Step 1 refers to the policy response. What is needed in Europe is an increase in European money supply of 20. And what is needed in America is an increase in American money supply of 10.

Step 2 refers to the anticipation of policy spillovers. The European central bank expects that, due to the increase in American money supply of 10, European output will only rise to 990. And the American central bank expects that, due to the increase in European money supply of 20, American output will only rise to 980. So what is needed in Europe is an increase in European money supply of 3.3. And what is needed in America is an increase in American money supply of 6.7.

Step 3 refers to the output lag. The accumulated increase in European money supply is 23.3, and the accumulated increase in American money supply is 16.7. The net effect is an increase in European output of 53.3 and an increase in American output of 26.7. As a consequence, European output goes to 993.3, and American output goes to 996.7. As a result, the anticipation of policy spillovers speeds up the process of monetary competition. Thus there seems to be no need for monetary cooperation.

Symbols

A_1	autonomous term for Europe
A_2	autonomous term for America
B_1	autonomous term for Europe
B_2	autonomous term for America
G_1	European government purchases (real)
G_2	American government purchases (real)
G_1^e	the expectation of European government purchases, as formed by the American government
G_2^e	the expectation of American government purchases, as formed by the European government
M_1	European money supply
M_2	American money supply
M_1^e	the expectation of European money supply, as formed by the American central bank
M_2^e	the expectation of American money supply, as formed by the European central bank
P_1	the price of European goods
P_2	the price of American goods
\hat{P}_1	producer inflation in Europe
\hat{P}_2	producer inflation in America
W_1	nominal wage rate in Europe
W_2	nominal wage rate in America
Y_1	European output, European income (real)
Y_2	American output, American income (real)
\bar{Y}_1	full-employment output in Europe
\bar{Y}_2	full-employment output in America
t	time
α	monetary policy multiplier (direct effect)
β	monetary policy multiplier (cross effect)
γ	fiscal policy multiplier (direct effect)

δ	fiscal policy multiplier (cross effect)
ε	wage policy multiplier (direct effect)
η	wage policy multiplier (cross effect)
λ	speed of price adjustment
λ_1	speed of adjustment of European government purchases
λ_2	speed of adjustment of American government purchases
μ_1	speed of adjustment of European money supply
μ_2	speed of adjustment of American money supply
Δ	difference operator

The Current Research Project

The present book is part of a larger research project on monetary union, see Carlberg (1999, 2000, 2001, 2002, 2003, 2004). Volume two (2000) deals with the scope and limits of macroeconomic policy in a monetary union. The leading protagonists are the union central bank, national governments, and national trade unions. Special emphasis is put on wage shocks and wage restraint. This book develops a series of basic, intermediate and more advanced models. A striking feature is the numerical estimation of policy multipliers. A lot of diagrams serve to illustrate the subject in hand. The monetary union is an open economy with high capital mobility. The exchange rate between the monetary union and the rest of the world is flexible. The world interest rate can be exogenous or endogenous. The union countries may differ in money demand, consumption, imports, openness, or size.

Volume three (2001) explores the new economics of monetary union. It carefully discusses the effects of shocks and policies on output and prices. Shocks and policies are country-specific or common. They occur on the demand or supply side. Countries can differ in behavioural functions. Wages can be fixed, flexible, or slow. In addition, fixed wages and flexible wages can coexist. Take for instance fixed wages in Germany and flexible wages in France. Or take fixed wages in Europe and flexible wages in America. Throughout this book makes use of the rate-of-growth method. This method, together with suitable initial conditions, proves to be very powerful. Further topics are inflation and disinflation. Take for instance inflation in Germany and price stability in France. Then what policy is needed for disinflation in the union? And what will be the dynamic effects on Germany and France?

Volume four (2002) deals with the causes and cures of inflation in a monetary union. It carefully studies the effects of money growth and output growth on inflation. The focus is on producer inflation, currency depreciation and consumer inflation. For instance, what determines the rate of consumer inflation in Europe, and what in America? Moreover, what determines the rate of consumer inflation in Germany, and what in France? Further issues are real depreciation, nominal and real interest rates, the growth of nominal wages, the

growth of producer real wages, and the growth of consumer real wages. Here productivity growth and labour growth play significant roles. Another issue is target inflation and required money growth. A prominent feature of this book is microfoundations for a monetary union.

Volume five (2003) deals with the international coordination of economic policy in a monetary union. It carefully discusses the process of policy competition and the structure of policy cooperation. As to policy competition, the focus is on competition between the union central bank, the German government, and the French government. Similarly, as to policy cooperation, the focus is on cooperation between the union central bank, the German government, and the French government. The key questions are: Does the process of policy competition lead to full employment and price stability? Can these targets be achieved through policy cooperation? And is policy cooperation superior to policy competition? Another topic is monetary competition / monetary cooperation between Europe and America.

Volume six (2004) studies the interactions between monetary and fiscal policies in the euro area. The policy makers are the union central bank, the German government, the French government, and other governments. The policy targets are price stability in the union, full employment in Germany, full employment in France, etc. The policy instruments are union money supply, German government purchases, French government purchases, etc. As a rule, the spillovers of fiscal policy are negative. The policy makers follow either cold-turkey or gradualist strategies. The policy decisions are taken sequentially or simultaneously. Policy expectations are adaptive or rational. This book carefully discusses the case for central bank independence and fiscal cooperation. Further information about these books is given on the web-page:
<http://carlberg.hsu-hh.de>

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