6

The Stochastic Equations of the ROW Model

6.1 Introduction

The stochastic equations of the ROW model are specified, estimated, and tested in this chapter. This chapter does for the ROW model what Chapter 5 did for the US model. Stochastic equations are estimated for 32 countries, with up to 15 equations estimated per country. The equations are listed in Table B.3, and they were briefly discussed in Section 3.3.5. The empirical results are presented in Tables 6.1a and 6.1b through 6.15a and 6.15b, one pair of tables per equation. The "a" part of each table presents the estimates of the "final" specification, and the "b" part presents the results of the tests.

The 2SLS technique was used for the quarterly countries and for equations 1, 2, and 3 for the annual countries. The OLS technique was used for the other equations for the annual countries. The 2SLS technique had to be used sparingly for the annual countries because of the limited number of observations. The selection criterion for the first stage regressors for each equation was the same as that used for the US model. Briefly, the main predetermined variables in each country's model were chosen to constitute a "basic" set, and other variables were added to this set for each individual equation. As noted in Chapter 5, the choice of first stage regressors for large scale models is discussed in Fair (1984), pp. 215–216.

The estimation periods were chosen based on data availability. With three exceptions, the periods were chosen to use all the available data. The three exceptions are the interest rate, exchange rate, and forward rate equations, where the estimation periods were chosen to begin after the advent of floating exchange rates. The earliest starting quarter (year) for these periods was 1972:2 (1972).

The tests are similar to those done for the US equations. To repeat from Chapter 5, the basic tests are 1) adding lagged values, 2) estimating the equation under the assumption of a fourth order autoregressive process for the error term, 3) adding a time trend, 4) adding values led one or more periods, 5) adding additional variables, and 6) testing for structural stability. For the annual countries the autoregressive process for the error term was taken to be third order rather than fourth order. Because of this, the notation "RHO+" instead of "RHO=4" is used in the tables in this chapter to denote the autoregressive test. The led values were one quarter ahead for the quarterly countries and one year ahead for the annual countries. This means that no moving average process of the error term has to be accounted for since the leads are only one period. The estimation periods used for the leads test were one period shorter than the regular periods because of the need to make room at the end of the sample for the led values.

One of the additional variables added, where appropriate, was the expected rate of inflation. As discussed in Chapter 5, this is a test of the nominal versus real interest rate specification. For the quarterly countries the expected rate of inflation was taken to be the actual rate of inflation during the past four quarters, and for the annual countries it was taken to be the inflation rate (at an annual rate) during the past two years. This measure of the expected rate of inflation will be denoted p^e. This variable was only added to the equations in which an interest rate was included as an explanatory variable in the final specification.

Specification

In Section 3.3.5 the equations of the econometric model were matched to the equations of the theoretical model of Section 2.2. This is a guide for the theory behind the model and in particular for the theory behind the linking together of the countries. Also, subject to data limitations, the specification of the ROW equations follows fairly closely the specification of the US equations, and so the theory in Section 2.1 that is behind the specification of the US model is relevant here.

The extra theorizing that is discussed at the beginning of Chapter 5 is also relevant here. For example, the searching procedure was the same as that used for the US equations. Lagged dependent variables were used extensively to try to account for expectational and lagged adjustment effects, and explanatory variables were dropped from the equations if they had coefficient estimates of the wrong expected sign. Both current and one quarter lagged values were generally tried for the price and interest rate variables for the quarterly countries, and the values that gave the best results were used. The equations were initially estimated under the assumption of a first order autoregressive error term, and the autoregressive assumption was retained if the estimate of the autoregressive coefficient was significant.

Data limitations prevented all 15 equations from being estimated for all 32 countries. Also, some equations for some countries were initially estimated and then rejected for giving what seemed to be poor results. For example, as will be seen, the rejection rate was high for the investment equation (equation 3), where many of the coefficient estimates of the output term seemed too large.

One difference between the US and ROW models to be aware of is that the asset variable A for each country in the ROW model measures only the net asset position of the country vis-à-vis the rest of the world; it does not include the domestic wealth of the country. Also, the asset variable has been divided by $PY \cdot YS$ before it was entered as an explanatory variable in the equations. (PY is the GDP deflator and YS is potential GDP.) This was done even for equations that were otherwise in log form. As discussed in Section 3.3.3, the asset variable is off by a constant amount, and so taking logs of the variable is not appropriate. Entering the variable in ratio form in the equations allows the error to be approximately[1] absorbed in the estimate of the constant term. This procedure is, of course, crude, but at least it somewhat responds to the problem caused by the level error in A.

Because much of the specification of the ROW equations is close to that of the US equations, the specification discussion in this chapter is brief. Only the differences are emphasized, and the reader is referred to Chapter 5 for more detail regarding the basic specifications.

The Tables

The construction of the tables in this chapter is as follows. All the coefficient estimates in an equation are presented in a table if there is room. If there is

[1]If the level error, say $\bar{A}$, is in A and not in $A/(PY \cdot YS)$, then including the latter variable in the equation means that it is not $\bar{A}$ but $\bar{A}/(PY \cdot YS)$ that is part of the equation, and $\bar{A}/(PY \cdot YS)$ is not constant. This is what is meant by the error being only approximately absorbed in the estimate of the constant term.

a space constraint, the estimate of the constant term is not presented. The R^2 values is also not presented if there is limited space. In a few cases other coefficient estimates are also not presented because of space limitations, and when this happens it is discussed in the text. The sample period that was used for the estimation of each equation is presented in the b tables except for equation 10, where the sample periods are presented in the a table. (There is no b table for equation 10.)

To save space, only the p-values are presented in the b tables for the χ^2 tests. As in Chapter 5, an equation will be said to pass a test if the p-value is greater than .01. For the stability test the AP value is presented along with the degrees of freedom and the value of λ. Many of the values of λ for the annual countries are 1.0, which means that only one possible break point was specified. This was done because of the short sample periods. The AP value has a * in front of it if it is significant at the one percent level, which means that the equation fails the stability test.

There are obviously a lot of estimates and test results in this chapter, and it is not feasible to discuss each estimate and test result in detail. The following discussion tries to give a general idea of the results, but the reader is left to pour over the tables in more detail if desired.

Previous Version of the ROW Model

The previous version of the ROW model is presented in Fair (1984), Chapter 4. Again, as with the US model, the present discussion of the model is self contained, and so this previous material does not have to be read. More changes have been made to the ROW model since 1984 than have been made to the US model. Some of the main changes are the following. First, the number of countries (not counting the United States) for which structural equations are estimated is now 32 rather than 42, and the trade share matrix is now 45×45 rather than 65×65. The model was cut in size to lessen problems caused by poor data. Second, OECD data were used whenever possible rather than IFS data. The OECD has better NIPA and labor data than is available from the IFS data. Third, annual data were used for countries in which only annual NIPA data existed. In the previous version, quarterly data were constructed for all the countries by interpolating the annual data. Fourth, wage, employment, and labor force equations were added to the model (equations 12–15). Fifth, estimates of the capital stock of each country were made, and the capital stock variable was used in the investment equation. Finally, as for the US model, a few more coefficient constraints were imposed.

The basic structure of the ROW model has, however, remained the same between the previous version and the current version, and some of the discussion in the following sections is similar to the discussion of the previous version in Sections 4.2.5 and 4.2.6 in Fair (1984).

6.2 Equation 1. M: Merchandise Imports

Equation 1 explains the real per capita merchandise imports of the country. The explanatory variables include price of domestic goods relative to the price of imports, the short term or long term interest rate, per capita income, the lagged value of real per capita assets, and the lagged dependent variable. The variables are in logs except for the interest rates and the asset variable. Equation 1 is similar to equation 27 in the US model. The three main differences between the equations are 1) the U.S. asset variable was not significant in equation 27 and so was dropped from the equation, 2) the import variable includes all imports in equation 27 but only merchandise imports in equation 1, and 3) the income variable is disposable personal income in equation 27 and total GDP in equation 1.

To save space, Table 6.1a does not include the estimate of the constant term. The results in Tables 6.1a and 6.1b show that reasonable import equations seem capable of being estimated for most countries. Only for Switzerland (ST) is the coefficient estimate for income of the wrong expected sign, although it is not significant. Four of the 32 equations fail the lags test (at the one percent level), 5 fail the RHO+ test, 9 fail the T test, and 14 fail the stability test. The led value of the income variable was used for the leads test, and it is significant at the one percent level in only 1 case. The expected inflation variable is relevant for 9 countries,[2] and it is only significant for 1. For the countries in which the relative price variable was used, the log of the domestic price level was added to test the relative price constraint. The constraint was rejected (i.e., log PY was significant) in 7 of the 23 cases.

6.3 Equation 2: C: Consumption

Equation 2 explains real per capita consumption. The explanatory variables include the short term or long term interest rate, per capita income, the lagged

[2] Remember that the expected inflation variable is relevant if an interest rate appears as an explanatory variable in the equation.

Table 6.1a

$$\log(M/POP) = a_1 + a_2 \log(M/POP)_{-1} + a_3 \log(PY/PM) + a_4 (RS or RB) + a_5 \log(Y/POP) + a_6 [A/(PY \cdot YS)]_{-1}$$

	a_2	a_3	a_4	a_5	a_6	ρ	SE	DW
Quarterly								
CA	.723	.205	[ab]-.0072	.485	.073	–	.0392	2.08
	(13.83)	(2.90)	(-2.39)	(5.65)	(2.29)			
JA	.830	.053	[a]-.0026	.173	–	–	.0395	1.84
	(16.51)	(2.64)	(-1.09)	(2.51)				
AU	.634	[a].195	-.0024	.651	–	-.243	.0384	1.96
	(4.56)	(2.14)	(-0.82)	(2.59)		(-1.77)		
FR	.282	–	[a]-.0054	1.941	.404	–	.0291	2.01
	(3.16)		(-4.61)	(8.07)	(4.68)			
GE	.648	.022	-.0018	.622	.035	–	.0268	1.98
	(7.98)	(0.53)	(-1.49)	(3.49)	(1.21)			
IT	.125	.199	–	1.592	.298	–	.0533	2.05
	(1.25)	(4.82)		(7.31)	(3.51)			
NE	.893	[a].055	–	.200	–	-.402	.0280	1.78
	(7.75)	(1.37)		(0.82)		(-2.86)		
ST	.867	–	–	-.283	.117	–	.0369	2.14
	(11.72)			(-1.12)	(3.24)			
UK	.565	–	–	.912	.035	–	.0346	1.86
	(7.24)			(5.52)	(1.37)			
FI	.184	[a].274	–	.831	.272	–	.0767	2.13
	(1.44)	(2.11)		(4.55)	(2.29)			
AS	.639	.306	–	.996	.100	–	.0459	1.82
	(10.93)	(5.67)		(6.34)	(2.87)			
SO	.765	.213	[a]-.0073	.638	.101	-.208	.0783	1.96
	(14.85)	(2.77)	(-4.42)	(4.69)	(4.74)	(-2.05)		
KO	.872	.066	–	.193	–	–	.1047	2.01
	(18.12)	(0.83)		(2.48)				
Annual								
BE	.126	.206	–	1.673	–	–	.0257	1.66
	(1.04)	(3.56)		(6.59)				
DE	.212	.219	-.0016	1.866	1.682	–	.0244	2.53
	(2.18)	(2.58)	(-0.57)	(8.73)	(5.82)			
NO	.229	–	[b]-.0168	.744	.401	–	.0540	2.13
	(1.22)		(-1.49)	(2.87)	(3.18)			
SW	–	.169	–	1.989	–	–	.0422	2.33
		(1.81)		(23.79)				
GR	.253	.282	–	1.274	.516	–	.0830	1.78
	(1.19)	(1.29)		(3.08)	(0.63)			
IR	.303	.180	–	1.137	.282	–	.0556	1.91
	(1.57)	(1.80)		(3.94)	(1.52)			
PO	.758	–	[b]-.0080	.655	–	–	.1115	1.24
	(5.65)		(-1.25)	(2.32)				
SP	.593	.289	–	1.004	1.166	–	.0574	1.79
	(3.74)	(3.06)		(2.18)	(2.16)			
NZ	.141	.327	–	1.911	.470	–	.0767	2.21
	(0.96)	(3.03)		(6.21)	(1.78)			
SA	.830	–	–	.688	–	–	.1002	1.20
	(23.72)			(5.68)				
VE	.324	.622	–	2.020	.744	–	.1596	1.70
	(2.41)	(2.47)		(3.94)	(2.18)			
CO	.328	.538	–	1.199	.893	–	.0767	2.21
	(2.16)	(1.83)		(4.21)	(2.68)			
JO	.735	.265	–	.273	.960	–	.1043	1.92
	(4.47)	(1.06)		(0.82)	(2.95)			
SY	.250	–	–	.465	.953	–	.2217	2.05
	(1.17)			(1.94)	(1.19)			
ID	.670	–	–	.514	.744	–	.1487	1.90
	(4.22)			(2.01)	(0.80)			
MA	.356	.441	–	1.096	.280	–	.0590	2.21
	(2.25)	(2.70)		(4.92)	(1.70)			
PA	.474	.488	–	.492	–	–	.0661	1.79
	(6.32)	(3.37)		(3.59)				
PH	.478	–	–	.961	.659	–	.1900	1.55
	(2.93)			(2.67)	(1.40)			
TH	.229	.486	–	1.381	1.116	–	.0815	.80
	(1.50)	(3.37)		(5.51)	(3.28)			

[a]Variable lagged once. [b]RB rather than RS.

Table 6.1b
Test Results for Equation 1

	Lags p-val	p^e p-val	log PY p-val	RHO+ p-val	T p-val	Leads p-val	Stability AP (df) λ	Sample
Quarterly								
CA	.094	.095	.315	.926	.289	.357	5.94 (6) 4.25	1966:1–1992:3
JA	.251	.119	.679	.276	.052	.666	5.88 (5) 3.57	1967:3–1992:3
AU	.097	.087	[a].008	.286	.113	.375	4.00 (6) 2.21	1971:1–1991:2
FR	.031	.948	–	.398	.269	.537	6.33 (5) 2.03	1971:1–1992:2
GE	.052	.184	.876	.132	.490	.022	*9.03 (6) 1.57	1969:1–1991:4
IT	.007	–	.000	.001	.001	.532	*9.70 (5) 2.00	1972:1–1991:4
NE	.060	–	[a].011	.065	.003	.004	*7.83 (5) 1.00	1978:2–1991:4
ST	.004	–	–	.009	.110	.093	*12.88 (4) 2.17	1971:1–1991:4
UK	.325	–	–	.434	.785	.026	5.54 (4) 3.92	1966:1–1992:3
FI	.017	–	[a].000	.000	.000	.531	*10.11 (5) 1.00	1976:1–1991:4
AS	.237	–	.406	.177	.545	.320	3.47 (5) 1.69	1971:1–1992:2
SO	.225	.341	.015	.422	.005	.100	*42.02 (7) 4.51	1962:1–1991:2
KO	.521	–	.387	.000	.736	.997	*10.94 (4) 2.03	1964:1–1991:4
Annual								
BE	.365	–	.508	.369	.865	.479	5.73 (4) 1.00	1969–1990
DE	.199	.699	.971	.061	.721	.309	3.06 (6) 1.00	1969–1990
NO	.153	.841	–	.189	.381	.072	3.77 (5) 1.00	1974–1990
SW	.300	–	.858	.427	.790	.391	2.42 (3) 1.00	1969–1990
GR	.884	–	.005	.681	.006	.704	4.94 (5) 1.00	1963–1990
IR	.044	–	.001	.873	.734	.994	*12.71 (5) 1.00	1969–1990
PO	.002	.000	–	.125	.001	.202	*28.35 (4) 1.00	1962–1990
SP	.049	–	.007	.379	.003	.352	*12.22 (5) 1.00	1969–1990
NZ	.588	–	.518	.362	.392	.733	2.07 (5) 1.00	1962–1990
SA	.572	–	–	.002	.230	.794	1.17 (3) 1.00	1970–1989
VE	.805	–	.000	.302	.003	.952	*9.57 (5) 1.00	1963–1991
CO	.381	–	.081	.023	.081	.070	*7.62 (5) 1.00	1972–1991
JO	.434	–	.014	.214	.068	.127	1.48 (5) 1.00	1971–1991
SY	.113	–	–	.654	.206	.066	1.73 (4) 1.00	1965–1990
ID	.363	–	–	.748	.889	.786	6.51 (4) 1.00	1962–1989
MA	.446	–	.721	.285	.653	.054	5.31 (5) 1.00	1972–1987
PA	.145	–	.099	.891	.439	.974	*13.39 (4) 1.00	1972–1991
PH	.150	–	–	.154	.020	.467	5.97 (4) 1.00	1962–1991
TH	.000	–	.806	.014	.000	.204	*18.57 (5) 1.00	1962–1990

[a] log PY_{-1} used rather than log PY.
*Significant at the one percent level.

value of real per capita assets, and the lagged dependent variable. The variables are in logs except for the interest rates and the asset variable. Equation 2 is similar to the consumption equations in the US model. The two main differences are 1) there is only one category of consumption in the ROW model compared to three in the US model and 2) the income variable is total GDP instead of disposable personal income.

As in Table 6.1a, the estimate of the constant term is not presented in Table 6.2a. The results in Tables 6.2a and 6.2b are of similar quality to the results in Tables 6.1a and 6.1b. The interest rate and asset variables appear in most of the equations in Table 6.2a, and so interest rate and wealth effects on consumption have been picked up as well as the usual income effect.

Most of the tests in Table 6.2b are passed. Eight of the 32 equations fail the lags test, 3 fail the RHO+ test, 5 fail the leads test,[3] and 9 fail the stability

[3]Multicollinearity problems prevented the leads test from being computed for the UK.

Table 6.2a

$$\log(C/POP) = a_1 + a_2 \log(C/POP)_{-1} + a_3(RS or RB)$$
$$+a_4 \log(Y/POP) + a_5[A/(PY \cdot YS)]_{-1}$$

	a_1	a_2	a_3	a_4	a_5	ρ	SE	DW
Quarterly								
CA	-.268	.836	[ab]-.0017	.189	.026	-.166	.0082	1.97
	(-4.35)	(15.82)	(-4.25)	(3.46)	(4.20)	(-1.65)		
JA	.123	.882	[b]-.0022	.093	–	-.286	.0101	2.11
	(4.90)	(19.87)	(-3.08)	(2.21)		(-2.87)		
AU	-.622	.254	–	.802	–	–	.0139	1.54
	(-6.58)	(2.76)		(7.91)				
FR	-.098	.853	[a]-.0007	.160	–	–	.0069	2.31
	(-1.19)	(9.46)	(-2.65)	(1.55)				
GE	.018	.923	-.0013	.051	.011	-.263	.0060	2.02
	(0.75)	(34.96)	(-5.98)	(1.64)	(3.16)	(-2.54)		
IT	-.340	.821	-.0011	.213	–	.557	.0036	1.85
	(-2.80)	(15.32)	(-4.81)	(3.31)		(5.96)		
NE	-.088	.899	–	.120	–	–	.0085	2.27
	(-2.14)	(12.57)		(2.00)				
ST	.079	.732	-.0029	.164	.017	.404	.0062	1.73
	(0.70)	(8.43)	(-2.98)	(1.85)	(1.85)	(2.89)		
UK	-.359	.895	[a]-.0017	.151	.021	–	.0112	2.60
	(-3.36)	(22.17)	(-3.68)	(2.99)	(2.52)			
FI	-.127	.689	-.0029	.309	–	–	.0093	2.07
	(-1.43)	(13.75)	(-4.48)	(6.25)				
AS	-.529	.905	-.0010	.157	.013	–	.0078	2.05
	(-2.59)	(21.53)	(-2.36)	(3.27)	(2.21)			
SO	-.518	.975	[b]-.0019	.102	.016	-.253	.0142	1.92
	(-3.35)	(23.22)	(-2.47)	(2.04)	(4.00)	(-2.68)		
KO	.166	.861	-.0012	.106	.032	–	.0555	2.04
	(1.63)	(18.29)	(-0.94)	(2.61)	(1.91)			
Annual								
BE	-.059	.698	[b]-.0051	.302	–	–	.0123	2.12
	(-0.34)	(4.39)	(-2.26)	(1.81)				
DE	-.937	.451	[b]-.0024	.720	.617	–	.0179	1.49
	(-1.64)	(3.37)	(-1.78)	(4.93)	(3.01)			
NO	.593	.243	–	.519	.052	–	.0254	1.34
	(2.62)	(1.05)		(2.63)	(0.92)			
SW	-.113	.467	–	.495	.398	–	.0129	1.50
	(-0.67)	(4.73)		(5.35)	(3.97)			
GR	.013	.540	–	.427	–	–	.0135	1.48
	(0.13)	(5.39)		(3.99)				
IR	.910	.422	–	.449	.231	–	.0244	1.51
	(1.51)	(2.57)		(4.03)	(2.91)			
PO	-.436	.537	[b]-.0044	.524	.050	–	.0357	2.22
	(-1.86)	(6.21)	(-1.08)	(5.78)	(1.09)			
SP	-.023	.468	–	.506	.272	–	.0110	1.29
	(-0.19)	(5.68)		(6.12)	(2.43)			
NZ	-.396	.357	[b]-.0048	.666	.136	–	.0176	1.68
	(-0.69)	(3.07)	(-2.21)	(5.99)	(1.74)			
SA	-.481	.842	–	.196	.190	.396	.1439	1.88
	(-0.42)	(5.42)		(0.59)	(0.70)	(0.92)		
VE	-.198	.965	-.0009	.087	.186	-.227	.0588	1.96
	(-0.48)	(20.57)	(-0.89)	(0.73)	(1.64)	(-1.10)		
CO	–	.464	–	.499	–	–	.0272	1.83
		(2.73)		(3.18)				
JO	-1.233	.568	–	.625	.455	-.337	.0504	2.36
	(-4.70)	(5.70)		(5.11)	(3.44)	(-1.50)		
SY	.980	.634	–	.246	.962	–	.1059	1.87
	(1.24)	(4.36)		(1.78)	(2.45)			
ID	.022	.383	-.0091	.497	.268	-.520	.0266	2.23
	(0.69)	(3.04)	(-3.85)	(5.41)	(2.38)	(-2.77)		
MA	-.910	.354	–	.709	.338	–	.0342	1.75
	(-1.61)	(1.99)		(3.72)	(3.94)			
PA	.100	.842	–	.079	–	-.183	.0319	1.88
	(1.48)	(6.53)		(0.60)		(-2.49)		
PH	.509	.477	–	.257	.159	–	.0313	1.65
	(2.45)	(3.20)		(2.96)	(2.05)			
TH	-.027	.530	–	.454	.297	–	.0248	2.22
	(-0.37)	(5.24)		(5.21)	(3.30)			

[a]Variable lagged once. [b]RB rather than RS.

Table 6.2b
Test Results for Equation 2

	Lags p-val	p^e p-val	RHO+ p-val	T p-val	Leads p-val	Stability AP (df) λ	Sample
Quarterly							
CA	.006	.940	.383	.299	.003	*19.08 (6) 4.248	1966:1–1992.3
JA	.002	.513	.172	.783	.241	4.56 (5) 3.57	1967:3–1992:3
AU	.000	–	.000	.390	.306	3.03 (3) 2.21	1971:1–1991:2
FR	.001	.695	.067	.022	.003	6.61 (4) 2.03	1971:1–1992:2
GE	.085	.773	.047	.941	.015	7.46 (6) 2.66	1969:1–1991:4
IT	.118	.106	.024	.585	.008	3.06 (5) 2.01	1972:1–1991:4
NE	.892	–	.178	.621	.000	3.24 (3) 1.00	1978:2–1991:4
ST	.020	.007	.003	.001	.836	7.03 (6) 2.17	1971:1–1991:4
UK	.021	–	.047	.361	–	*11.39 (6) 3.92	1966:1–1992:3
FI	.048	.317	.139	.708	.909	5.09 (4) 1.00	1976:1–1991:4
AS	.905	.893	.258	.000	.188	*9.99 (5) 1.69	1971:1–1992:2
SO	.001	.007	.507	.002	.003	*13.41 (6) 3.28	1962:1–1991:2
KO	.104	.828	.085	.125	.818	*8.99 (5) 2.03	1964:1–1991:4
Annual							
BE	.288	.968	.892	.150	.241	2.63 (4) 1.00	1969–1990
DE	.077	.357	.398	.590	.048	0.98 (5) 1.00	1969–1990
NO	.005	–	.150	.003	.616	2.59 (4) 1.00	1974–1990
SW	.547	–	.747	.114	.980	1.71 (4) 1.00	1969–1990
GR	.048	–	.698	.000	.331	2.48 (3) 1.00	1963–1990
IR	.839	–	.270	.905	.298	4.18 (4) 1.00	1969–1990
PO	.779	.519	.288	.160	.244	6.28 (5) 1.00	1962–1990
SP	.108	–	.110	.000	.755	*13.26 (4) 1.00	1969–1990
NZ	.292	.304	.218	.659	.033	5.44 (5) 1.00	1962–1990
SA	.205	–	.392	.921	.083	*9.07 (5) 1.00	1970–1989
VE	.106	.030	.872	.006	.578	6.20 (6) 1.00	1963–1991
CO	.786	–	.281	.017	.471	0.98 (2) 1.00	1972–1991
JO	.099	–	.076	.968	.114	3.87 (5) 1.00	1971–1991
SY	.001	–	.000	.000	.886	2.27 (4) 1.00	1965–1990
ID	.119	.070	.193	.755	.189	5.85 (6) 1.00	1962–1989
MA	.448	–	.102	.016	.506	0.75 (4) 1.00	1972–1987
PA	.000	–	.155	.510	.531	*6.35 (3) 1.00	1973–1991
PH	.101	–	.236	.444	.613	2.19 (4) 1.00	1962–1991
TH	.191	–	.292	.209	.324	*13.57 (4) 1.00	1962–1990

*Significant at the one percent level.

test. The led value of the income variable was used for the leads test, and it is significant in only 5 cases. The expected inflation variable is relevant for 16 countries,[4] and it is only significant for 2.

6.4 Equation 3: *I*: Fixed Investment

Equation 3 explains real fixed investment. It includes as explanatory variables the lagged value of investment, the lagged value of the capital stock, the current

[4] Multicollinearity problems also prevented the χ^2 test from being performed for the UK for the p^e case.

Table 6.3a

$I = a_1 + a_2 I_{-1} + a_3 K_{-1} + a_4 Y + a_5 (RS or RB)$

	a_2	a_3	a_4	a_5	SE	DW	β	α_1
Quarterly								
CA	.928	-.0019	.042	[ab]-38.10	464.3035	1.38	.041	14.04
	(20.02)	(-1.90)	(4.17)	(-0.75)				
JA	.946	-.0044	.071	[ab]-122.69	343.8421	1.82	.095	13.61
	(34.50)	(-2.13)	(2.17)	(-4.04)				
FR	.799	-.0139	.178	-.23	1.7454	1.87	.084	10.50
	(21.77)	(-5.32)	(5.53)	(-2.52)				
GE	.858	-.0094	.121	-.22	1.3839	1.93	.081	10.50
	(17.66)	(-5.08)	(4.91)	(-3.00)				
IT	.798	-.0089	.117	[b]-85.92	538.3504	1.63	.059	9.84
	(22.18)	(-4.73)	(5.66)	(-4.86)				
UK	.788	-.0086	.115	[a]-50.06	379.5534	2.25	.055	9.77
	(20.66)	(-4.46)	(5.77)	(-2.97)				
SO	.887	-.0032	.096	[ab]-54.80	263.6513	2.57	.043	19.64
	(27.25)	(-1.59)	(3.57)	(-2.21)				
Annual								
BE	.745	-.1083	.329	[b]-8.62	29.1172	2.27	.485	2.66
	(7.52)	(-3.41)	(4.06)	(-1.59)				
DE	.607	-.1122	.271	–	6.8804	1.62	.346	1.99
	(5.39)	(-4.51)	(4.44)					
SW	.786	-.1195	.339	–	4.8812	2.26	.619	2.56
	(7.86)	(-4.30)	(4.72)					
GR	.468	-.1724	.525	–	41.3807	1.96	.384	2.57
	(5.47)	(-5.55)	(5.69)					
IR	.799	-.0976	.267	–	216.9135	2.54	.545	2.44
	(7.46)	(-3.60)	(3.98)					
SA	.688	-.0238	.152	–	9.6964	1.45	.136	3.59
	(4.18)	(-1.56)	(2.54)					
PH	.677	-.0392	.220	-1.83	8.9770	1.52	.182	3.75
	(7.70)	(-2.93)	(4.97)	(-2.95)				

[a]Variable lagged once. [b]RB rather than RS.

value of output, and the short term or long term interest rate. Equation 3 differs from the investment equation 12 for the US model. The use of equations 5.23–5.25 in Chapter 5, which lead to the estimated equation 5.26, did not produce sensible results for most countries. Typically, the coefficient estimate of the current change in output term seemed much too large. Equation 3 instead is based on the following simpler set of equations:

$$K^{**} = \alpha_0 + \alpha_1 Y + \alpha_2 RB \tag{6.1}$$

$$K^* - K_{-1} = \beta(K^{**} - K_{-1}) \tag{6.2}$$

$$I^* = K^* - K_{-1} + \delta K_{-1} \tag{6.3}$$

$$I - I_{-1} = \lambda(I^* - I_{-1}) \tag{6.4}$$

Table 6.3b
Test Results for Equation 3

	Lags p-val	p^e p-val	RHO+ p-val	T p-val	Leads p-val	Stability AP (df) λ	Sample
Quarterly							
CA	.016	.630	.059	.430	.008	*11.59 (6) 4.25	1966:1–1992:3
JA	.000	.026	.368	.155	.005	*32.40 (5) 3.46	1967:3–1992:3
FR	.004	.251	.603	.755	.001	2.74 (5) 2.03	1971:1–1992:2
GE	.000	.842	.014	.012	.005	*8.72 (5) 2.66	1969:1–1991:4
IT	.003	.757	.186	.079	.002	*8.00 (5) 1.98	1972:1–1991:4
UK	.021	.975	.577	.255	.490	4.13 (5) 3.92	1966:1–1992:3
SO	.054	.222	.570	.003	.046	5.63 (5) 3.28	1962:1–1991:2
Annual							
BE	.113	.197	.655	.947	.948	*26.98 (5) 1.00	1969–1990
DE	.000	–	.008	.000	.693	*14.68 (4) 1.00	1969–1990
SW	.328	–	.453	.967	.812	2.69 (4) 1.00	1969–1990
GR	.671	–	.919	.293	.259	6.42 (4) 1.00	1963–1990
IR	.129	–	.948	.883	.320	3.99 (4) 1.00	1969–1990
SA	.205	–	.018	.359	.566	0.60 (4) 1.00	1970–1989
PH	.003	.066	.001	.000	.000	*9.47 (5) 1.00	1962–1991

*Significant at the one percent level.

K^{**} in equation 6.1 is the capital stock that would be desired if there were no adjustment costs of any kind. It is taken to be a function of output and the interest rate. As was the case for the stock of durable goods and the stock of housing in the US model in Chapter 5, two types of partial adjustment are postulated. The first, equation 6.2, is an adjustment of the capital stock, where K^* is the capital stock that would be desired if there were no costs of adjusting gross investment. Given K^*, "desired" gross investment, I^*, is determined by equation 6.3, where δ is the depreciation rate. (As discussed in Chapter 3, δ is .015 for the quarterly countries and .06 for the annual countries.) By definition, $I = K - K_{-1} + \delta K_{-1}$, and equation 6.3 is the same equation for the desired values. The second type of adjustment is an adjustment of gross investment to its desired value, which is equation 6.4.

Combining equations 6.1–6.4 yields:

$$I = (1-\lambda)I_{-1} + \lambda(\delta - \beta)K_{-1} + \beta\lambda\alpha_0 + \beta\lambda\alpha_1 Y + \beta\lambda\alpha_2 RB \tag{6.5}$$

Gross investment is thus a function of its lagged value, the lagged value of the capital stock, current output, and the interest rate. As was the case for durable consumption and housing investment in Chapter 5, the two partial adjustment equations are a way of adding both the lagged dependent variable and the lagged stock to the equation.

Table 6.4a

$Y = a_1 + a_2 Y_{-1} + a_3 X + a_4 V_{-1}$

	a_2	a_3	a_4	ρ	SE	DW	α	β
Quarterly								
CA	.305	.724	-.0622	.705	562.66	2.16	.090	.466
	(4.29)	(9.32)	(-1.58)	(7.71)				
JA	.326	.717	-.0645	.198	252.62	1.96	.096	.666
	(5.68)	(12.38)	(-5.78)	(1.78)				
AU	.594	.446	-.0229	–	2.67	1.97	.056	1.750
	(7.39)	(4.96)	(-0.78)					
FR	.667	.442	-.0901	–	3.00	1.85	.271	1.209
	(10.53)	(6.67)	(-5.98)					
GE	.245	.801	-.0822	.731	1.96	2.07	.109	.556
	(3.64)	(11.08)	(-1.91)	(7.50)				
IT	.624	.495	-.0593	.531	1194.83	2.03	.158	2.006
	(5.09)	(3.37)	(-1.60)	(4.50)				
NE	.315	.856	-.3792	.632	.70	2.21	.553	.452
	(7.47)	(12.76)	(-2.16)	(2.89)				
UK	.171	.874	-.0984	.645	544.22	2.01	.119	.461
	(3.95)	(17.15)	(-1.91)	(6.24)				
FI	.628	.410	-.0186	-.002	1148.10	1.95	.050	2.025
	(4.36)	(2.61)	(-1.13)	(-0.01)				
AS	.380	.665	-.0765	.408	417.28	2.06	.123	.585
	(3.99)	(6.47)	(-1.88)	(3.07)				
KO	.284	.725	-.0219	–	390.20	2.03	.031	.408
	(5.88)	(15.17)	(-1.48)					
Annual								
BE	–	1.019	-.2461	–	24.91	1.91	.246	.075
		(59.33)	(-2.50)					
DE	–	1.009	-.2416	–	3.09	1.57	.242	.039
		(50.71)	(-1.60)					
SW	.469	.509	-.1849	–	6.78	1.81	.348	-.118
	(4.20)	(4.80)	(-3.19)					
GR	.428	.722	-.1728	–	53.60	1.71	.302	.871
	(4.39)	(6.78)	(-3.69)					
IR	.261	.871	-.5022	.351	177.33	1.92	.680	.264
	(2.09)	(7.88)	(-1.57)	(0.95)				
SP	.189	.933	-.3838	–	100.34	1.99	.474	.318
	(3.26)	(19.81)	(-6.44)					
SA	.212	.762	-.3826	–	6.57	1.87	.485	-.068
	(3.32)	(10.80)	(-2.28)					
VE	.177	.882	-.1578	.289	13.30	2.05	.192	.373
	(0.82)	(5.04)	(-0.64)	(1.11)				
CO	.319	.765	-.1330	–	36.03	1.76	.195	.636
	(3.08)	(7.80)	(-1.33)					
JO	.083	.966	-.1030	–	17.20	1.84	.112	.480
	(1.74)	(21.89)	(-1.94)					
PA	.126	.955	-.2232	.420	1.38	2.04	.255	.363
	(2.22)	(17.41)	(-1.55)	(1.47)				
PH	–	1.027	-.1560	.888	6.32	1.62	.156	.173
		(13.85)	(-0.12)	(0.72)				
TH	.063	.965	-.0940	–	7.66	1.99	.100	.298
	(0.58)	(10.94)	(-1.01)					

Table 6.4b
Test Results for Equation 4

	Lags p-val	RHO+ p-val	T p-val	Leads p-val	Stability AP (df) λ	Sample
Quarterly						
CA	.016	.141	.217	.001	*21.58 (5) 4.25	1966:1–1992:3
JA	.021	.049	.058	.584	*9.97 (5) 3.57	1967:3–1992:3
AU	.815	.113	.452	.076	4.66 (4) 2.21	1971:1–1991:2
FR	.686	.059	.014	.862	*10.89 (4) 2.03	1971:1–1992:2
GE	.003	.000	.141	.012	5.73 (5) 2.66	1969:1–1991:4
IT	.009	.356	.001	.002	*23.74 (5) 2.00	1972:1–1991:4
NE	.018	.026	.015	.068	4.35 (5) 1.00	1978:2–1991:4
UK	.718	.962	.962	.108	*10.68 (5) 3.92	1966:1–1992:3
FI	.174	.071	.238	.851	*11.56 (5) 1.00	1976:1–1991:4
AS	.500	.303	.026	.751	*11.15 (5) 1.69	1971:1–1992:2
KO	.008	.000	.667	.297	3.47 (4) 2.03	1964:1–1991:4
Annual						
BE	.796	.945	.008	.452	2.53 (3) 1.00	1969–1990
DE	.286	.639	.810	.353	1.39 (3) 1.00	1969–1990
SW	.113	.005	.834	.025	*9.31 (4) 1.00	1969–1990
GR	.340	.639	.121	.686	5.13 (4) 1.00	1963–1990
IR	.492	.929	.540	.023	2.94 (5) 1.00	1969–1990
SP	.027	.566	.331	.748	1.55 (4) 1.00	1969–1990
SA	.004	.063	.481	.082	2.63 (4) 1.00	1970–1989
VE	.149	.130	.806	.024	*8.89 (5) 1.00	1963–1991
CO	.579	.495	.001	.024	0.54 (4) 1.00	1972–1991
JO	.826	.227	.412	.220	*9.15 (4) 1.00	1971–1991
PA	.148	.778	.191	.160	6.42 (5) 1.00	1972–1991
PH	.437	.406	.890	.001	4.87 (4) 1.00	1962–1991
TH	.736	.987	.056	.061	5.04 (4) 1.00	1962–1990

*Significant at the one percent level.

The estimate of the constant term is not presented in Table 6.3a. The estimate of λ is one minus a_2 in the table. Also presented in the table are the implied values of β and α_1. For the quarterly countries λ (i.e., $1 - a_2$) ranges from .054 for JA to .212 for UK and β ranges from .041 for CA to .095 for JA. For the annual countries λ ranges from .201 to .532 and β ranges from .136 to .619.

In Table 6.3b the equation fails the lags test in 6 of the 14 cases, the RHO+ test in 2 cases, the T test in 3 cases, and the leads test in 6 cases. The led value of output was used for the leads test. Equation 3 fails the stability test in 7 of the 14 cases. In none of the 9 relevant cases is the price expectations variable significant. If 4 of the 9 countries for which interest rates were significant, the short term interest rate, RS, gave better results than did the long term rate, and so it was used. In the case of CA both rates gave about the same results and

Table 6.5a

$\log PY = a_1 + a_2 \log PY_{-1} + a_3 \log PM + a_4 \log W + a_5 ZZ + a_6 JJS$

	a_2	a_3	a_4	a_5	a_6	ρ	SE	DW
Quarterly								
CA	.762	[a] .027	.165	–	.259	.591	.0055	2.25
	(14.70)	(2.06)	(4.36)		(3.96)	(6.56)		
JA	.668	.019	.186	–	–	–	.0085	.83
	(13.48)	(5.16)	(6.30)					
AU	.948	[a] .023	.019	-.115	–	-.449	.0115	2.03
	(25.81)	(1.82)	(.68)	(-1.97)		(-4.34)		
FR	.829	.024	.101	[a] -.121	–	.300	.0053	1.92
	(23.01)	(2.24)	(3.26)	(-1.54)		(2.68)		
GE	.877	[a] .010	.071	[a] -.093	–	–	.0033	1.83
	(33.79)	(2.67)	(4.06)	(-4.67)				
IT	.934	.033	.022	-.184	–	–	.0075	1.24
	(33.54)	(3.90)	(0.73)	(-4.23)				
NE	.490	.082	.374	–	–	–	.0090	1.72
	(4.41)	(4.34)	(4.19)					
ST	.985	[a] .006	–	[a] -.101	[a] .088	–	.0062	1.89
	(219.73)	(0.69)		(-2.25)	(1.61)			
UK	.821	.076	.088	[a] -.060	–	.531	.0097	2.26
	(16.78)	(4.98)	(2.32)	(-0.89)		(5.26)		
FI	.847	[a] .015	.107	–	.140	–	.0066	1.91
	(15.64)	(1.75)	(2.52)		(2.97)			
AS	.962	.025	–	–	.194	–	.0108	1.78
	(74.79)	(2.24)			(2.54)			
SO	.978	.028	–	–	–	–	.0195	2.02
	(48.78)	(1.58)						
KO	.602	.179	.166	[a] -.266	–	–	.0439	2.20
	(6.81)	(4.89)	(3.53)	(-2.65)				
Annual								
BE	.613	.090	.199	–	.379	.689	.0119	1.97
	(6.19)	(1.55)	(2.33)		(1.36)	(2.12)		
DE	.604	.063	.258	–	–	–	.0086	1.70
	(15.84)	(3.67)	(7.73)					
NO	.501	.583	.029	–	–	–	.0202	1.63
	(4.05)	(4.62)	(0.42)					
SW	.546	.090	.359	–	–	-.339	.0115	2.17
	(12.78)	(5.24)	(8.34)			(-1.42)		
GR	.706	.220	.070	-.296	–	–	.0239	1.87
	(15.99)	(4.38)	(1.58)	(-1.45)				
IR	.493	.086	.327	–	–	–	.0266	1.64
	(5.02)	(1.43)	(2.88)					
PO	.782	.270	–	-.337	–	.455	.0271	2.29
	(18.13)	(5.92)		(-1.79)		(2.39)		
SP	.582	.012	.308	-.125	–	–	.0110	2.30
	(25.16)	(0.52)	(14.27)	(-1.38)				
NZ	.682	.079	.246	–	–	–	.0319	1.67
	(12.54)	(1.59)	(3.42)					
CO	.842	.172	–	–	–	–	.0257	2.10
	(13.32)	(2.73)						
JO	.799	.204	–	–	–	–	.0408	1.79
	(16.39)	(3.62)						
SY	.926	.132	–	–	–	.378	.0761	1.84
	(11.01)	(1.62)				(1.67)		
MA	.905	.061	–	-.856	–	–	.0556	2.01
	(4.29)	(0.34)		(-1.20)				
PA	.699	.217	–	-.066	–	-.390	.0147	2.13
	(28.87)	(10.80)		(-0.36)		(-1.89)		
PH	.802	.181	–	–	–	–	.0629	1.87
	(14.52)	(4.03)						
TH	.638	.251	–	–	–	–	.0428	.90
	(5.40)	(3.17)						

[a] Variable lagged once.

Table 6.5b
Test Results for Equation 5

	Level p-val	Lags p-val	RHO+ p-val	T p-val	Leads p-val	Chg. p-val	Stability χ^2 (df) λ	Sample
Quarterly								
CA	.470	.074	.117	.836	.398	.000	*16.75 (6) 4.25	1966:1–1992:3
JA	.000	.000	.000	.006	.000	.000	*10.49 (4) 3.57	1967:3–1992:3
AU	.634	.573	.013	.134	.035	.001	5.04 (6) 2.21	1971:1–1991:2
FR	.089	.107	.050	.001	.000	.003	*8.93 (6) 2.03	1971:1–1992:2
GE	.891	.442	.039	.286	.254	.000	6.30 (5) 2.66	1969:1–1991:4
IT	.000	.001	.005	.000	.000	.000	*27.95 (5) 1.98	1972:1–1991:4
NE	.764	.194	.281	.263	.136	.000	2.15 (4) 1.00	1978:2–1991:4
ST	.052	.083	.138	.238	–	.000	4.92 (5) 2.17	1971:1–1991:4
UK	.398	.126	.128	.004	.114	.000	*20.27 (6) 3.92	1966:1–1992:3
FI	.981	.606	.486	.284	.460	.000	*8.50 (5) 1.00	1976:1–1991:4
AS	.423	.747	.263	.214	–	.000	2.98 (4) 1.69	1971:1–1992:2
SO	.088	.236	.028	.000	–	.000	*12.09 (3) 4.51	1962:1–1991:2
KO	.000	.000	.000	.000	.971	.001	*20.66 (5) 2.03	1964:1–1991:4
Annual								
BE	.082	.035	.786	.195	.128	.022	*9.39 (6) 1.00	1969–1990
DE	.787	.870	.091	.562	.116	.000	1.91 (4) 1.00	1969–1990
NO	.146	.023	.918	.587	.036	.000	5.27 (4) 1.00	1974–1990
SW	.076	.206	.078	.394	.290	.000	1.32 (5) 1.00	1969–1990
GR	.150	.001	.088	.322	.292	.000	*18.41 (5) 1.00	1963–1990
IR	.098	.098	.339	.023	.171	.041	*6.98 (4) 1.00	1969–1990
PO	.949	.007	.279	.000	–	.002	*8.93 (5) 1.00	1962–1990
SP	.298	.603	.172	.858	.538	.000	2.90 (5) 1.00	1969–1990
NZ	.001	.002	.627	.992	.173	.000	5.78 (4) 1.00	1962–1990
CO	.256	.534	.219	.006	–	.000	3.23 (3) 1.00	1972–1991
JO	.100	.203	.891	.164	–	.042	0.45 (3) 1.00	1971–1991
SY	.003	.015	.408	.004	–	.046	*7.74 (4) 1.00	1965–1990
MA	.600	.070	.002	.053	–	.935	2.13 (4) 1.00	1972–1987
PA	.036	.057	.382	.276	–	.000	2.42 (5) 1.00	1972–1991
PH	.489	.793	.409	.627	–	.001	*8.34 (3) 1.00	1962–1991
TH	.000	.000	.027	.000	–	.002	1.99 (3) 1.00	1962–1990

*Significant at the one percent level.

both were used.[5]

The reason that equation 3 was estimated for only 14 countries is that the results for the other countries were not good. The main problem, which seemed to exist for any specification tried, is that the coefficient estimate of the current output term is too large. Even though the 2SLS technique is used, there still seems to be a substantial amount of simultaneity bias. The overall results for equation 3 are thus weak in that the results for over half of the countries did not appear sensible. This is an important area for future work.

[5]The coefficient estimate for RB is presented in Table 6.3a for CA. The coefficient estimate for RS was -38.03, with a t-statistic of -1.03.

The specification of equation 3 that was finally chosen does not use excess capital as an explanatory variable, and so with hindsight the construction of the excess capital variable for each country that was described in Chapter 3 was not needed.

6.5 Equation 4: Y: Production

Equation 4 explains the level of production. It is the same as equation 11 for the US model, which is equation 5.22 in Chapter 5. It includes as explanatory variables the lagged level of production, the current level of sales, and the lagged stock of inventories.

The estimate of the constant term is not presented in Table 6.4a. The estimate of λ is one minus a_2 in the table. Also presented in the table are the implied values of α and β. The parameters λ, α, and β are presented in equations 5.19–5.21. α and λ are adjustment parameters. For the quarterly countries λ (i.e., $1 - a_2$) ranges from .333 to .829 and α ranges from .050 to .553. For the annual countries λ ranges from .531 to .937 and α ranges from .100 to .680. For the United States λ was .707 and α was .473.

Equation 4 does well in the tests in Table 6.4b except for the stability test. Four of the 24 equations fail the lags test, 3 fail the RHO+ test, 3 fail the T test, and 3 fail the leads test. The led value of sales was used for the leads test. The equation fails the stability test in 10 of the 24 cases.

As was the case for equation 11 in the US model, the coefficient estimates of equation 4 are consistent with the view that firms smooth production relative to sales, and so these results add support to the production smoothing hypothesis.

6.6 Equation 5: PY: Price Deflator

Equation 5 explains the GDP price deflator. It is the same as equation 10 for the US model. It includes as explanatory variables the lagged price level, the price of imports, the wage rate, and a demand pressure variable. Data permitting, two demand pressure variables were tried per country. One, denoted ZZ, is the percentage gap between potential and actual output ($(YS - Y)/YS$), and the other, denoted JJS, is the ratio of jobs per capita to its peak to peak interpolation (JJ/JJP). The same tests were performed for equation 5 as were performed for equation 10 in the US model. In particular, the level specification was tested against the more general specification and the change specification was tested against the more general specification.

The estimate of the constant term is not presented in Table 6.5a. The results in the table show that the price of imports is significant in most of the equations. Import prices thus appear to have important effects on domestic prices for most countries. The demand pressure variables were not included in 13 of the 29 cases because they did not have the expected sign. (When a demand pressure variable had the wrong sign, it was almost always insignificant.) The results for the demand pressure variables are thus not as strong as the results for import prices.

Equation 5 does fairly well in the tests in Table 6.5b except for the stability test and possibly the T test. The level specification is rejected over the more general specification in only 6 of the 29 cases. The change specification, on the other hand, is rejected in 24 of the 29 cases, usually with very large χ^2 values. As was the case for the US results, the change specification is strongly rejected by the data.

Seven of the 29 equations fail the lags test, 4 fail the RHO+ test, 10 fail the T test, and 14 fail the stability test. The led value of the wage rate was used for the leads test. The wage rate appears in 18 equations, and of these 18 equations, only 3 fail the leads test.

6.7 Equation 6: $M1$: Money[6]

Equation 6 explains the per capita demand for money. It is the same as equation 9 for the US model. The same nominal versus real adjustment specifications were tested here as were tested for US equation 9 (and for the US equations 17 and 26). Equation 6 includes as explanatory variables one of the two lagged money variables, depending on which adjustment specification won, the short term interest rate, and income.

The estimates in Table 6.6a show that the nominal adjustment specification won in 13 of the 19 cases, and so this hypothesis continues its winning ways. Table 6.6b shows that the equation does well in the tests. Only 1 of the 19 equations fails the lags test, none fail the RHO+ test, 4 fail the T test, and 8 fail the stability test. The nominal versus real (NvsR) test results in the table simply show that adding the lagged money variable that was not chosen for

[6]Money demand equations are estimated in Fair (1987) for 27 countries, and the results in this section are essentially an update of these earlier results.

Table 6.6a

$\log[M1/(POP \cdot PY)] = a_1 + a_2 \log[M1/(POP \cdot PY)]_{-1}$
$+ a_3 \log[M1_{-1}/(POP_{-1} \cdot PY)] + a_4 RS + a_5 \log(Y/POP)$

	a_1	a_2	a_3	a_4	a_5	ρ	SE	DW
Quarterly								
CA	-.804	–	.917	-.0055	.112	–	.0238	1.98
	(-4.80)		(53.49)	(-4.70)	(5.10)			
JA	-.211	.930	–	-.0045	.034	-.209	.0220	1.92
	(-1.21)	(37.55)		(-5.05)	(1.35)	(-2.05)		
AU	.344	–	.885	-.0023	.011	.225	.0218	2.08
	(2.65)		(14.80)	(-1.35)	(0.32)	(1.75)		
FR	.915	–	.669	[a]-.0021	–	–	.0155	1.98
	(4.69)		(9.53)	(-1.89)				
GE	-.161	.845	–	-.0049	.223	.183	.0097	1.98
	(-2.80)	(19.84)		(-8.20)	(3.55)	(1.53)		
IT	-.087	.740	–	[a]-.0043	.069	.297	.0146	2.08
	(-0.65)	(12.87)		(-6.06)	(3.44)	(2.34)		
NE	-.627	–	.762	-.0067	.559	–	.0168	2.06
	(-2.90)		(10.75)	(-3.74)	(3.20)			
UK	-.379	–	.914	-.0041	.151	-.275	.0262	1.92
	(-3.12)		(55.37)	(-3.69)	(5.47)	(-2.86)		
FI	-1.106	–	.632	[a]-.0046	.445	-.213	.0314	2.25
	(-2.87)		(6.18)	(-2.65)	(3.62)	(-1.49)		
AS	-.879	–	.900	-.0065	.210	–	.0241	1.77
	(-2.68)		(30.16)	(-4.92)	(4.35)			
SO	-.317	–	.916	–	.129	.265	.0342	2.05
	(-0.84)		(24.48)		(2.57)	(2.67)		
Annual								
BE	.806	.748	–	-.0112	.074	–	.0300	1.27
	(1.06)	(5.66)		(-3.83)	(1.43)			
DE	-1.576	–	.645	-.0118	.620	-.290	.0471	2.23
	(-3.61)		(7.27)	(-3.13)	(4.19)	(-1.28)		
SW	.221	–	.495	-.0049	.399	–	.0357	1.68
	(0.40)		(2.24)	(-1.33)	(1.60)			
PO	.545	.654	–	-.0117	.223	–	.0631	1.95
	(1.53)	(7.89)		(-3.93)	(2.86)			
VE	.074	–	.851	–	.382	–	.1027	1.16
	(0.09)		(12.46)		(1.42)			
ID	-.881	.593	–	-.0010	.573	–	.0472	1.38
	(-3.17)	(4.42)		(-0.22)	(3.17)			
PA	6.069	–	.060	-.0572	.731	–	.0636	1.12
	(9.22)		(0.47)	(-5.74)	(3.75)			
PH	1.840	–	.690	-.0065	.191	–	.0756	2.16
	(2.06)		(5.32)	(-1.68)	(1.95)			

[a]Variable lagged once.

the final specification does not produce a significant increase in explanatory power.

Table 6.6b
Test Results for Equation 6

	NvsR p-val	Lags p-val	RHO+ p-val	T p-val	Stability AP (df) λ	Sample
Quarterly						
CA	.266	.217	.018	.424	5.44 (4) 3.36	1968:1–1992:3
JA	.154	.001	.017	.000	*17.31 (5) 3.57	1967:3–1992:3
AU	.207	.253	.354	.390	*10.40 (5) 2.21	1971:1–1991:2
FR	.706	.839	.212	.893	2.16 (3) 2.03	1979:1–1992:2
GE	.500	.710	.052	.172	3.76 (5) 2.41	1969:1–1990:4
IT	.066	.199	.093	.139	*11.69 (5) 2.01	1972:1–1991:4
NE	.191	.955	.314	.215	*7.47 (4) 1.00	1978:2–1991:4
UK	.641	.918	.258	.210	5.37 (5) 3.92	1966:1–1992:3
FI	.032	.036	.063	.675	3.52 (5) 1.00	1976:1–1990:4
AS	.080	.874	.281	.055	2.88 (4) 1.69	1971:1–1992:2
SO	.811	.580	.112	.262	*25.99 (4) 4.51	1962:1–1991:2
Annual						
BE	.299	.427	.225	.000	*11.22 (4) 1.00	1969–1990
DE	.295	.212	.041	.048	6.20 (5) 1.00	1969–1990
SW	.189	.011	.079	.302	4.34 (4) 1.00	1971–1990
PO	.970	.664	.379	.002	4.09 (4) 1.00	1962–1990
VE	.013	.376	.059	.001	*7.45 (3) 1.00	1963–1991
ID	.096	.060	.100	.333	*7.48 (4) 1.00	1962–1989
PA	.075	.058	.242	.119	2.87 (4) 1.00	1972–1991
PH	.748	.111	.696	.996	2.17 (4) 1.00	1962–1991

*Significant at the one percent level.

6.8 Equation 7: RS: Short Term Interest Rate

Equation 7 explains the short term (three month) interest rate. It is interpreted as the interest rate reaction function of each country's monetary authority, and it is similar to equation 30 in the US model. The explanatory variables that were tried (as possibly influencing the monetary authority's interest rate decision) are 1) the rate of inflation, 2) the two demand pressure variables, 3) the lagged percentage growth of the money supply, 4) the first two lagged values of the asset variable for the quarterly countries and the current and one year lagged value of the asset variable for the annual countries, and 5) the U.S. short term interest rate. The change in the asset variable is highly correlated with the balance of payments on current account, and so putting in the two asset variables is similar to putting in the balance of payments. The U.S. interest rate was included on the view that some monetary authorities' decisions may be influenced by the Fed's decisions. Similarly, the two asset variables were included on the view that monetary authorities may be influenced in their policy by the status of their balance of payments.

Table 6.7a

$$RS = a_1 + a_2 RS_{-1} + a_3 PCPY + a_4 (ZZ or JJS) + a_5 PCM1_{-1}$$
$$+ a_6[A/(PY \cdot YS)]_{-1} + a_7[A/(PY \cdot YS)]_{-2} + a_8 RSUS$$

	a_2	a_3	a_4	a_6	a_7	a_8	SE	DW
Quarterly								
CA	.262	–	[a]18.58	-8.74	5.09	.857	.7384	2.19
	(3.60)		(1.46)	(-0.68)	(0.38)	(7.51)		
JA	.737	.077	–	-25.52	26.18	.119	.6879	1.99
	(10.55)	(3.13)		(-2.65)	(2.73)	(2.19)		
AU	.748	–	-23.97	-21.43	19.69	.028	.7352	2.05
	(13.15)		(-3.89)	(-4.07)	(3.88)	(0.43)		
FR	.564	.061	–	-31.44	28.61	.345	.8879	1.78
	(3.89)	(1.10)		(-1.92)	(1.85)	(2.62)		
GE	.781	–	-34.00	-8.81	7.79	.154	.7804	2.19
	(17.40)		(-5.92)	(-1.70)	(1.47)	(3.28)		
IT	.534	.143	–	-32.00	24.97	.346	1.0927	2.18
	(5.03)	(2.70)		(-2.96)	(2.39)	(2.92)		
NE	.590	–	-23.76	-12.34	13.67	.406	1.0748	2.13
	(6.59)		(-2.75)	(-1.42)	(1.50)	(3.44)		
ST	.849	–	-13.33	–	–	–	.7961	1.81
	(17.04)		(-3.49)					
UK	.706	–	-13.26	-7.49	6.74	.248	1.2022	1.87
	(9.35)		(-1.95)	(-0.65)	(0.59)	(3.26)		
FI	.836	–	–	-18.94	19.49	.072	.9740	1.68
	(13.93)			(-3.09)	(2.94)	(1.23)		
AS	.786	–	-28.69	-21.68	21.50	.143	1.1976	1.95
	(11.94)		(-3.66)	(-2.18)	(2.16)	(2.20)		
SO	.901	.012	–	–	–	.195	.9518	1.99
	(11.62)	(1.18)				(1.67)		
KO	.951	.024	-8.57	–	–	–	1.1642	2.13
	(25.87)	(3.43)	(-2.56)					
Annual								
BE	.169	.099	–	–	–	.759	1.4647	2.71
	(1.13)	(0.81)				(4.71)		
DE	.171	–	–	-37.83	42.94	.700	2.5174	2.17
	(.72)			(-1.03)	(1.17)	(2.16)		
NO	.774	–	[a]16.62	–	–	.137	1.2926	2.34
	(6.05)		(1.26)			(1.04)		
SW	.756	.035	-30.53	–	–	.494	2.0225	2.71
	(4.67)	(0.86)	(-0.94)			(2.27)		
IR	–	.123	–	-20.81	16.62	.491	2.0081	2.84
	(.00)	(1.35)		(-0.92)	(0.89)	(1.42)		
PO	.713	.292	–	–	–	.332	2.0078	1.89
	(8.76)	(2.98)				(1.53)		
NZ	.555	.266	–	-26.48	5.17	.130	2.8364	1.47
	(2.70)	(1.70)		(-1.31)	(0.22)	(0.47)		
VE	.764	.333	–	-25.43	11.41	.195	5.8892	2.52
	(5.91)	(4.35)		(-1.42)	(0.58)	(0.32)		
PA	.590	.154	–	-17.04	11.21	.120	.8082	1.91
	(4.13)	(3.30)		(-1.51)	(1.01)	(1.28)		
PH	.782	.111	–	–	–	.426	3.1857	1.43
	(4.84)	(1.34)				(1.33)		

[a] JJS rather than ZZ.

$PCPY = 100[(PY/PY_{-1})^4 - 1]$, $PCM1 = 100[(M1/M1_{-1})^4 - 1]$.

Table 6.7b
Test Results for Equation 7

	Lags p-val	RHO+ p-val	T p-val	Stability AP (df) λ	Sample
Quarterly					
CA	.079	.116	.112	*11.90 (7) 1.81	1972:2–1992:3
JA	.019	.373	.851	8.15 (7) 1.81	1972:2–1992:3
AU	.027	.461	.007	*11.34 (6) 1.78	1972:2–1991:2
FR	.040	.046	.999	6.15 (7) 1.65	1972:2–1992:2
GE	.202	.004	.306	2.29 (6) 1.58	1972:2–1991:4
IT	.631	.193	.083	6.51 (8) 1.58	1972:2–1991:4
NE	.110	.010	.331	3.47 (6) 1.00	1978:2–1991:4
ST	.392	.398	.301	1.19 (3) 1.75	1972:2–1991:4
UK	.074	.863	.549	1.96 (6) 1.64	1972:2–1992:3
FI	.550	.060	.567	4.63 (5) 1.00	1976:1–1991:4
AS	.968	.491	.132	4.55 (6) 1.35	1972:2–1992:2
SO	.171	.199	.051	5.56 (5) 1.05	1972:2–1991:2
KO	.309	.023	.767	1.42 (4) 1.00	1972:2–1991:4
Annual					
BE	.100	.011	.151	1.11 (4) 1.00	1972–1990
DE	.957	.998	.571	2.49 (5) 1.00	1972–1990
NO	.561	.122	.075	*8.91 (4) 1.00	1974–1990
SW	.022	.020	.002	3.63 (5) 1.00	1972–1990
IR	.050	.007	.229	3.89 (5) 1.00	1972–1990
PO	.815	.183	.267	2.85 (4) 1.00	1972–1990
NZ	.000	.005	.007	*19.06 (6) 1.00	1972–1990
VE	.697	.173	.612	1.90 (7) 1.00	1972–1991
PA	.000	.049	.396	5.02 (7) 1.00	1972–1991
PH	.043	.771	.067	3.90 (5) 1.00	1972–1991

*Significant at the one percent level.

The estimates of the constant term, the coefficient of the lagged money growth variable, and the serial correlation coefficient are not included in Table 6.7a because of space constraints.[7] The results in Table 6.7a show that the inflation rate is included in 13 of the 23 cases, a demand pressure variable in 10 cases, the asset variables in 15 cases, and the U.S. rate in 21 cases. There is thus evidence that monetary authorities are influenced by inflation, demand pressure, and the balance of payments. The lagged money growth variable, on the other hand, is not significant in any of the 4 cases it is included (see footnote 7), and so there is little evidence in favor of this variable. The monetary authorities of other countries do not appear to be influenced in their setting of interest rates by the lagged growth of the money supply. The signs of the coefficient estimates of the asset variables (negative for the first and

[7] Five equations were estimated under the assumption of a first order autoregressive error. The estimates and t-statistics are: CA: .707 (7.07); JA: .339 (2.51); FR: .408 (2.16); IT: .438 (2.66); SO: .644 (4.66). Four equations included the lagged money growth variable. The estimates and t-statistics are: IT: .031 (1.61); VE: .155 (1.33); PA: .056 (1.81); PH: .120 (1.26).

Table 6.8a

$$RB - RS_{-2} = a_1 + a_2(RB_{-1} - RS_{-2}) + a_3(RS - RS_{-2}) + a_4(RS_{-1} - RS_{-2})$$

	a_1	a_2	a_3	a_4	ρ	SE	R^2	DW
Quarterly								
CA	.108	.898	.470	-.429	–	.4621	0.934	2.17
	(2.10)	(29.42)	(7.75)	(-5.14)				
JA	.009	.901	.535	-.636	-.168	.4322	0.926	2.00
	(.25)	(25.29)	(4.27)	(-3.07)	(-1.33)			
AU	.143	.916	.232	-.090	.340	.2338	0.972	2.01
	(2.21)	(31.32)	(5.48)	(-1.99)	(2.96)			
FR	.101	.840	.332	-.164	.295	.3988	0.934	2.05
	(1.37)	(12.83)	(4.01)	(-1.75)	(2.35)			
GE	.116	.929	.195	-.111	.163	.4154	0.944	1.94
	(1.53)	(25.34)	(2.91)	(-1.49)	(1.28)			
IT	-.108	.813	.287	-.185	.573	.5894	0.947	2.00
	(-.66)	(10.38)	(5.00)	(-2.78)	(4.66)			
NE	.153	.864	.208	-.054	–	.4177	0.918	1.95
	(1.91)	(16.69)	(3.74)	(-0.86)				
ST	.106	.932	.142	-.074	.336	.2500	0.972	2.03
	(1.76)	(32.14)	(2.65)	(-1.36)	(2.84)			
UK	.052	.962	.405	-.376	–	.5498	0.953	1.79
	(.87)	(38.50)	(5.30)	(-4.14)				
AS	.065	.945	.311	-.252	.151	.4599	0.954	1.97
	(.99)	(24.86)	(5.20)	(-3.91)	(1.25)			
SO	.161	.957	.472	-.702	–	.4579	0.971	1.95
	(2.73)	(50.75)	(5.35)	(-4.96)				
Annual[a]								
BE	1.435	.405	.496	–	–	.6368	0.865	1.51
	(4.13)	(2.88)	(7.01)					
DE	.905	.549	.514	–	–	1.3445	0.738	1.51
	(1.98)	(3.11)	(4.72)					
NO	-.344	.204	.646	–	–	.5561	0.781	1.46
	(-1.76)	(0.90)	(5.82)					
SW	.325	.894	.299	–	–	.8289	0.849	2.53
	(1.44)	(6.64)	(3.08)					
IR	.844	.432	.484	–	–	1.3845	0.740	1.32
	(2.29)	(2.71)	(5.18)					
PO	.112	.955	.706	–	–	.6569	0.946	2.67
	(.87)	(14.48)	(11.97)					
NZ	.078	.919	.332	–	–	1.0446	0.843	2.92
	(.29)	(6.91)	(3.55)					
PA	.144	.722	-.085	–	-.410	.7544	0.803	2.25
	(1.20)	(9.91)	(-0.63)		(-1.65)			

[a] For annual countries a_4 is zero and RS_{-1} rather than RS_{-2} is subtracted from the other variables.

positive for the second) suggest that an increase (decrease) in the balance of payments has a negative (positive) effect on the interest rate target of the monetary authority.

Table 6.8b
Test Results for Equation 8

	Restr[a] p-val	Lags p-val	RHO+ p-val	T p-val	Leads p-val	Stability AP (df) λ	Sample
Quarterly							
CA	.028	.048	.474	.042	.093	3.54 (4) 4.25	1966:1–1992:3
JA	.316	.575	.667	.854	.483	2.98 (5) 3.57	1967:3–1992:3
AU	.382	.038	.718	.054	.291	2.49 (5) 2.21	1971:1–1991:2
FR	.303	.066	.070	.144	.987	3.88 (5) 2.03	1971:1–1992:2
GE	.005	.006	.221	.581	.135	6.12 (5) 2.66	1969:1–1991:4
IT	.315	.727	.270	.076	.703	*9.75 (5) 2.03	1972:1–1991:4
NE	.281	.439	.065	.700	.893	0.85 (4) 1.00	1978:2–1991:4
ST	.007	.044	.626	.567	.333	6.15 (5) 2.17	1971:1–1991:4
UK	.396	.247	.805	.007	.391	5.59 (4) 3.92	1966:1–1992:3
AS	.078	.218	.448	.020	.068	3.26 (5) 1.69	1971:1–1992:2
SO	.447	.734	.256	.845	.552	1.78 (4) 2.83	1962:1–1991:2
Annual							
BE	.236	.082	.253	.210	.177	*8.87 (3) 1.00	1969–1990
DE	.714	.364	.761	.011	.924	3.46 (3) 1.00	1969–1990
NO	.693	.970	.341	.732	.033	2.16 (3) 1.00	1974–1990
SW	.079	.551	.018	.429	.427	1.60 (3) 1.00	1969–1990
IR	.774	.386	.093	.000	.705	4.98 (3) 1.00	1969–1990
PO	.015	.061	.264	.638	.013	.84 (3) 1.00	1962–1990
NZ	.308	.000	.000	.853	.656	.19 (3) 1.00	1962–1990
PA	.834	.041	.335	.490	.294	.66 (4) 1.00	1972–1991

[a] RS_{-2} added for quarterly countries, RS_{-1} added for annual countries.
*Significant at the one percent level.

Equation 7 does well in the tests. Two of the 23 equations fail the lags test, 4 fail the RHO=4 test, 3 fail the T test, and 4 fail the stability test.

6.9 Equation 8: RB: Long Term Interest Rate

Equation 8 explains the long term interest rate. It is the same as equations 23 and 24 in the US model. For the quarterly countries the explanatory variables include the lagged dependent variable and the current and two lagged short rates. For the annual countries the explanatory variables include the lagged dependent variable and the current and one lagged short rates. The same restriction was imposed on equation 8 as was imposed on equations 23 and 24, namely that the coefficients on the short rate sum to one in the long run.

The test results in Table 6.8b show that the restriction that the coefficients sum to one in the long run is supported in 17 of the 19 cases. The equation does very well in the other tests. Two of the 19 equations fail the lags test, 1 fails the RHO=4 test, 2 fail the T test, and 2 fail the stability test. The led value of the short term interest rate was used for the leads test, and it is not significant at the one percent level in any of the 19 cases. As noted in Chapter 5, my experience with term structure equations like equation 8 is that they are quite stable and reliable, which the results in Table 6.8b support.

6.10 Equation 9 E: Exchange Rate

Equation 9 explains the country's exchange rate, E. A country's exchange rate is relative to the U.S. dollar, and an increase in E is a *depreciation* of the country's currency relative to the dollar. The theory behind the specification of this equation is discussed in Chapter 2. See in particular the discussion of the experiments in Section 2.2.6 and the discussion of reaction functions in Section 2.2.7. Equation 9 is interpreted as an exchange rate reaction function.

Two types of countries are assumed for the estimation. The first are those countries whose exchange rate is assumed to be at least partly tied to the German exchange rate. Germany is taken to be the leader among the European countries in this respect. The second are those whose exchange rate is assumed not to be tied to the German rate. The first set includes all the European countries. The second set includes Canada, Japan, Australia, South Africa, Korea, New Zealand, Jordan, India, and the Philippines.

Consider first the non European countries. The exchange rate for these countries is based on the following two equations.

$$E^* = e^{\alpha_0}\left(\frac{1 + RS/100}{1 + RSUS/100}\right)^{.25\alpha_1}\left(\frac{PY}{PYUS}\right) \tag{6.6}$$

$$\frac{E}{E_{-1}} = \left(\frac{E^*}{E_{-1}}\right)^{\lambda} \tag{6.7}$$

E is the exchange rate, PY is the country's domestic price deflator, $PYUS$ is the U.S. domestic price deflator (denoted $GDPD$ in the US model), RS is the country's short term interest rate, and $RSUS$ is the U.S. short term interest rate (denoted simply RS in the US model).[8] Equation 6.6 states that the long run exchange rate, E^*, depends on the relative price level, $PY/PYUS$, and the relative interest rate, $(1 + RS/100)/(1 + RSUS/100)$. The coefficient on the relative price level is constrained to be one, which means that in the long run the real exchange rate is assumed merely to fluctuate as the relative interest rate fluctuates. Equation 6.7 is a partial adjustment equation, which

[8] RS and $RSUS$ are divided by 100 because they are in percentage points rather than percents. Also, the interest rates are at annual rates, and so α_1 is multiplied by .25 to put the rates at quarterly rates. For the annual countries, the .25 is not used.

says that the actual exchange rate adjusts λ percent of the way to the long run exchange rate each period.

The use of the relative price level in equation 6.6 is consistent with the theoretical model in Chapter 2. In this model a positive price shock led to a depreciation of the exchange rate. (See experiments 3 and 4 in Section 2.2.6.) In other words, there are forces in the theoretical model that put downward pressure on a country's currency when there is a relative increase in the country's price level. Because equation 6.6 is interpreted as an exchange rate reaction function, the use of the relative price level in it is in effect based on the assumption that the monetary authority goes along with the forces on the exchange rate and allows it to change in the long run as the relative price level changes.

Similarly, the use of the relative interest rate in equation 6.6 is consistent with the theoretical model, where a fall in the relative interest rate led to a depreciation. (See experiments 1 and 2 in Section 2.2.6.) Again, the assumption in equation 6.6 is that the monetary authority goes along with the forces on the exchange rate from the relative interest rate change.

Equations 6.6 and 6.7 imply that

$$\log(E/E_{-1}) = \lambda\alpha_0 + \lambda\alpha_1(.25)\log[(1+RS/100)/(1+RSUS/100)] + \lambda[\log(PY/PYUS) - \log E_{-1}] \tag{6.8}$$

The restriction that the coefficient of the relative price term is one can be tested by adding $\log E_{-1}$ to equation 6.8. If the coefficient is other than one, this variable should have a nonzero coefficient. This is one of the tests performed in Table 6.9b.

Consider now the European countries (except Germany). The exchange rate for these countries is based on the adjustment equation 6.7 and on the following equation:

$$E^* = e^{\alpha_0}(\frac{1+RS/100}{1+RSUS/100})^{.25\alpha_1}(\frac{PY}{PYUS})^{1-\delta}EGE^{\delta} \tag{6.9}$$

EGE is the German exchange rate. Equation 6.9 differs from equation 6.6 in that the relative price term (with the coefficient of one) is replaced with a weighted average of the relative price term and the German exchange rate, where the weights sum to one. δ is the weight on the German exchange rate. If δ is one, then the exchange rate of the country relative to the German rate fluctuates in the long run merely as the relative interest rate fluctuates. If δ is zero, one is back to the case of the non European countries. For δ less than

Table 6.9a

$\Delta \log E = a_1 + \lambda[\log(PY/PYUS) - \log E_{-1}] + \lambda\delta[\log EGE - \log(PY/PYUS)]$
$+a_4(.25) \log[(1 + RS/100)/(1 + RSUS/100)]$

	a_1	λ	$\lambda\delta$	a_4	ρ	SE	DW	δ
Quarterly								
CA	.011	.052	–	-.206	.413	.0144	1.96	–
	(1.58)	(1.34)		(-0.29)	(3.51)			
JA	-.093	.047	–	-1.117	.371	.0483	1.94	–
	(-1.11)	(0.95)		(-0.87)	(3.01)			
AU	1.892	.964	.965	-.754	.930	.0051	1.63	1.001
	(22.94)	(50.25)	(75.85)	(-2.60)	(22.41)			
FR	1.033	.846	.821	–	.982	.0213	1.75	.970
	(2.22)	(13.14)	(16.97)		(88.23)			
GE	-.580	.090	–	-2.557	.335	.0514	1.96	–
	(-1.55)	(1.51)		(-1.50)	(2.52)			
IT	4.406	.699	.651	–	.971	.0253	2.23	.932
	(10.40)	(7.89)	(11.71)		(94.22)			
NE	.236	.990	1.010	–	.872	.0052	1.81	1.020
	(2.53)	(60.71)	(69.76)		(17.29)			
ST	-.359	1.003	.973	–	.950	.0259	1.58	.970
	(-0.78)	(14.14)	(15.81)		(41.25)			
UK	3.415	.874	.625	–	.932	.0378	2.00	.715
	(6.32)	(8.03)	(7.35)		(31.98)			
FI	5.073	.758	.626	-1.823	.930	.0241	2.03	.826
	(9.08)	(6.74)	(8.64)	(-1.21)	(23.79)			
AS	.007	.144	–	–	.365	.0422	2.24	–
	(0.98)	(1.67)			(1.91)			
SO	.098	.166	–	–	.191	.0726	1.92	–
	(2.29)	(1.66)			(0.93)			
KO	-.002	.039	–	–	.404	.0270	2.07	–
	(-0.25)	(1.35)			(2.97)			
Annual								
BE	3.664	.880	1.010	–	.940	.0335	1.81	1.147
	(6.83)	(12.06)	(14.56)		(17.07)			
DE	1.770	.955	.975	–	.950	.0293	1.60	1.021
	(3.19)	(14.23)	(15.60)		(28.16)			
NO	.210	.692	.552	-.425	.945	.0302	2.03	.798
	(0.28)	(7.07)	(7.40)	(-0.99)	(14.06)			
SW	1.114	.674	.666	–	.948	.0499	1.88	.989
	(1.09)	(5.16)	(6.57)		(16.11)			
GR	10.936	.606	.607	–	.991	.0436	2.31	1.002
	(0.45)	(4.63)	(7.02)		(42.95)			
IR	5.039	.998	.844	–	.888	.0436	1.71	.846
	(7.63)	(9.70)	(8.68)		(25.23)			
PO	4.707	.514	.633	–	.966	.0757	1.36	1.232
	(1.52)	(2.71)	(4.41)		(27.37)			
SP	3.559	.712	.760	–	.932	.0706	1.92	1.068
	(3.21)	(4.37)	(5.52)		(18.35)			
NZ	.088	.175	–	–	–	.1048	0.92	–
	(1.28)	(0.84)						
JO	-.631	.672	–	–	.856	.0919	1.37	–
	(-2.35)	(2.67)			(4.38)			
ID	-1.154	.272	–	–	.864	.0506	1.72	–
	(-1.23)	(1.21)			(3.13)			
PH	-2.771	.679	–	–	.814	.0685	1.69	–
	(-3.39)	(3.49)			(5.10)			

Table 6.9b
Test Results for Equation 9

	Restr[a] p-val	Lags p-val	RHO+ p-val	T p-val	Stability AP (df) λ	Sample
Quarterly						
CA	.718	.236	.102	.896	0.82 (4) 1.81	1972:2–1992:3
JA	.186	.594	.266	.052	3.16 (4) 1.81	1972:2–1992:3
AU	.461	.039	.772	.587	4.07 (5) 1.78	1972:2–1991:2
FR	.929	.458	.390	.577	*14.58 (4) 1.65	1972:2–1992:2
GE	.654	.654	.396	.976	3.73 (4) 1.58	1972:2–1991:4
IT	.009	.139	.111	.858	*12.00 (4) 1.58	1972:2–1991:4
NE	.011	.059	.001	.017	4.11 (4) 1.00	1978:2–1991:4
ST	.631	.170	.048	.793	2.94 (4) 1.75	1972:2–1991:4
UK	.267	.744	–	.095	3.67 (4) 1.41	1972:2–1992:3
FI	.579	.204	.804	.160	1.40 (5) 1.00	1976:1–1991:4
AS	.299	.369	.466	.279	2.11 (3) 1.35	1972:2–1992:2
SO	.775	.083	.136	.822	1.75 (3) 1.00	1981:1–1991:2
Annual						
BE	.999	.914	.150	.044	3.81 (4) 1.00	1972–1990
DE	.594	.663	.550	.838	5.45 (4) 1.00	1972–1990
NO	.153	.026	.259	.024	2.61 (5) 1.00	1974–1990
SW	.695	.752	.033	.097	2.60 (4) 1.00	1972–1990
GR	.563	.041	.572	.004	1.93 (4) 1.00	1972–1990
IR	.033	.906	.009	.984	0.14 (4) 1.00	1972–1990
PO	.010	.595	.018	.442	3.00 (4) 1.00	1972–1990
SP	.000	.784	.574	.824	3.17 (4) 1.00	1972–1990
NZ	.693	.000	.000	.983	1.99 (2) 1.00	1972–1990
JO	.005	.007	.160	.002	3.85 (3) 1.00	1972–1991
ID	.041	.863	.404	.018	1.96 (3) 1.00	1972–1989
PH	.117	.976	.996	.036	*12.72 (3) 1.00	1972–1991

[a] $\log E_{-1}$ added.
*Significant at the one percent level.

one and greater than zero, the exchange rate fluctuates in the long run as the relative price level, the relative interest rate, and the German rate fluctuate.

The monetary authorities of other European countries may be influenced by the German exchange rate in deciding their own exchange rate targets, and this is the reason for the use of the German rate in equation 6.9. This specification can also be looked upon as an attempt to capture some of the effects of the European Monetary System (EMS). Under the assumption that Germany is the dominant country in the EMS, the German rate will pick up some of the effects of the EMS agreement.

Equations 6.9 and 6.7 imply that

$$\log(E/E_{-1}) = \lambda\alpha_0 + \lambda\alpha_1(.25)\log[(1+RS/100)/(1+RSUS/100)]$$
$$+\lambda[\log(PY/PYUS) - \log E_{-1}] + \lambda\delta[\log EGE - \log(PY/PYUS)] \quad (6.10)$$

The restriction that the weights sum to one can be tested by adding log E_{-1} to equation 6.10. If the weights do not sum to one, this variable should have a nonzero coefficient. This is one of the tests performed in Table 6.9b.

Exchange rate equations were estimated for 25 countries. The implied value of δ is presented in Table 6.9a along with the other results. Consider first the relative interest rate variable. The results do not provide strong support for the use of this variable in the exchange rate equations. It is included for only 6 countries and is only significant for 1 of these (Austria). The variable had the wrong sign (and was almost always insignificant) for the other countries. Two of the countries for which the variable is included are Japan and Germany, which are important countries in the model, and so in this sense the relative interest rate variable is important. It will be seen in Chapter 12 that some of the properties of the model are sensitive to the inclusion of the relative interest rate in the exchange rate equations. Given that the relative interest rate is not significant in either the Japanese or German equation, the properties that are sensitive to the inclusion must be interpreted with considerable caution. This is discussed more in Chapter 12.

Regarding δ, for many countries δ is close to one in Table 6.9a (δ is in fact slightly greater than one in a few cases[9]), and for these countries the exchange rate effectively just follows the German rate in the long run. For many of these countries the estimates of λ are also close to one. This means that the adjustment to the long run value is estimated to be very rapid and thus that the exchange rate follows closely the German rate even in the short run.

For Germany and for most of the non European countries, the estimates of λ are small, which means that it takes considerable time for the exchange rate to adjust to, say, a relative price level change. This is contrary to the case for the European countries (except Germany), where the adjustment to a weighted average of the relative price level and the German exchange rate (with most of the weight on the German rate) is estimated to be quite rapid.

There is considerable first order serial correlation in the error terms in the exchange rate equations for most countries.

Equation 9 does well in the tests. The restriction discussed above that is tested by adding log E_{-1} to the equation is only rejected in 4 of the 25 cases. Two of the 25 equations fail the lags test, 3 fail the RHO+ test,[10] 2 fail the T test, and 3 fail the stability test. It is encouraging that so few equations fail the

[9] δ could have been constrained to be one when its estimate was greater than one, but this was not done here. Doing this would have had little effect on the model because the estimates that are greater than one are in fact quite close to one.

[10] Multicollinearity problems prevented the RHO+ test from being performed for the UK.

stability test. The key German exchange rate equation passes all the tests.

Since equation 9 is in log form, the standard errors are roughly in percentage terms. The standard errors for a number of the European countries are quite low, but this is because of the inclusion of the German rate. A better way of examining how well these equations fit is to solve the overall model, and this is done in Chapter 9. The standard error for Japan, whose rate is not tied to the German rate, is 4.83 percent, and the standard error for Germany is 5.14 percent.

Exchange rate equations are notoriously hard to estimate, and given this, the results in Tables 6.9a and 6.9b do not seem too bad. The test results suggest that most of the dynamics have been captured and that the equations are fairly stable. However, many of the key coefficient estimates have t-statistics that are less than two in absolute value, and there is substantial serial correlation of the error terms.

6.11 Equation 10 F: Forward Rate

Equation 10 explains the country's forward exchange rate, F. This equation is the estimated arbitrage condition, and although it plays no role in the model, it is of interest to see how closely the quarterly data on EE, F, RS, and $USRS$ match the arbitrage condition. The arbitrage condition in this notation is

$$\frac{F}{EE} = \left(\frac{1 + RS/100}{1 + RSUS/100}\right)^{.25}$$

In equation 10, log F is regressed on log EE and $.25 \log(1 + RS/100)/(1 + RSUS/100)$. If the arbitrage condition were met exactly, the coefficient estimates for both explanatory variables would be one and the fit would be perfect.

The results in Table 6.10a show that the data are generally consistent with the arbitrage condition, especially considering that some of the interest rate data are not exactly the right data to use. Note the t-statistic for France of 5586.14!

Table 6.10a

$\log F = a_1 \log EE + a_2(.25)\log[(1 + RS/100)/(1 + RSUS/100)]$

	a_1	a_2	ρ	SE	R^2	DW	Sample
Quarterly							
CA	.9917	.902	.436	.0021	.999	2.08	1972:2–1992:3
	(315.82)	(10.12)	(4.06)				
JA	1.0010	1.323	.392	.0105	.999	1.75	1972:2–1992:3
	(807.43)	(5.31)	(3.79)				
AU	1.0004	1.174	.137	.0064	.999	2.05	1972:2–1991:2
	(4375.14)	(6.61)	(1.17)				
FR	1.0007	.946	–	.0056	.999	2.04	1972:2–1991:1
	(5586.14)	(6.62)					
GE	1.0005	1.168	.618	.0036	.999	2.16	1972:2–1991:4
	(5425.53)	(9.17)	(6.75)				
IT	.9894	1.267	-.148	.0110	.998	2.02	1978:1–1991:4
	(155.45)	(8.60)	(-1.09)				
NE	.9999	1.612	–	.0099	.998	2.05	1978:2–1990:4
	(3268.23)	(4.75)					
ST	1.0003	.889	–	.0071	.999	1.82	1972:2–1991:4
	(5017.04)	(9.52)					
UK	1.0004	1.168	.383	.0063	.999	1.95	1972:2–1984:4
	(363.27)	(4.98)	(2.62)				
FI	.9976	1.479	.616	.0069	.998	2.57	1976:1–1989:3
	(471.03)	(5.54)	(5.77)				
AS	1.0044	1.213	–	.0041	.999	2.21	1977:1–1992:2
	(237.78)	(15.06)					

6.12 Equation 11 PX: Export Price Index

Equation 11 explains the export price index, PX. It provides a link from the GDP deflator, PY, to the export price index. Export prices are needed when the countries are linked together (see Table B.4 in Appendix B). If a country produced only one good, then the export price would be the domestic price and only one price equation would be needed. In practice, of course, a country produces many goods, only some of which are exported. If a country is a price taker with respect to its exports, then its export prices would just be the world prices of the export goods. To try to capture the in between case where a country has some effect on its export prices but not complete control over every price, the following equation is postulated:

$$PX = PY^{\lambda}(PW\$ \cdot E)^{1-\lambda} \tag{6.11}$$

$PW\$$ is the world price index in dollars, and so $PW\$ \cdot E$ is the world price index in local currency. Equation 6.11 thus takes PX to be a weighted average of PY and the world price index in local currency, where the weights sum to one. Equation 11 was not estimated for any of the major oil exporting countries, and so $PW\$$ was constructed to be net of oil prices. (See equations L-4 in Table B.4.)

Equation 6.11 was estimated in the following form:

$$\log PX - \log(PW\$ \cdot E) = \lambda[\log PY - \log(PW\$ \cdot E)] \qquad (6.12)$$

The restriction that the weights sum to one and that $PW\$$ and E have the same coefficient (i.e, that their product enters the equation) can be tested by adding $\log PY$ and $\log E$ to equation 6.12. If this restriction is not met, these variables should be significant. This is one of the tests performed in Table 6.11b.

Some of the estimates of λ in Table 6.11a are close to one (a few are slightly greater than one). For these countries, therefore, there is essentially a one to one link between PY and PX. Equation 11 was estimated under the assumption of a second order autoregressive error, and the estimates of the autoregressive parameters are generally large.

Equation 11 does reasonably well in the tests. The restriction discussed above is rejected in 10 of the 30 cases. The equation fails the RHO+ test in 3 cases. Multicollinearity problems prevented the stability test from being performed for 5 countries (FR, NE, FI, DE, and GR). Of the 25 remaining cases, the equation fails the stability test in 4 of them.

It should be kept in mind that equation 11 is meant only as a rough approximation. If more disaggregated data were available, one would want to estimate separate price equations for each good, where some goods' prices would be strongly influenced by world prices and some would not. This type of disaggregation is beyond the scope of the present work.

6.13 Equation 12: W: Wage Rate

Equation 12 explains the wage rate. It is similar to equation 16 for the US model. It includes as explanatory variables the lagged wage rate, the current price level, the lagged price level, one of three possible measures of labor market tightness (UR, JJS, and ZZ), and a time trend. Equation 16 of the US model included three further lags of the wage rate and price level, which equation 12 does not. Also, equation 16 of the US model does not include any demand pressure variables because none were significant. The same restriction imposed on the price and wage equations in the US model is also imposed here. Given the coefficient estimates of equation 5, the restriction is imposed on the coefficients in equation 12 so that the implied real wage equation does not

Table 6.11a

$\log PX - \log(PW\$ \cdot E) = \lambda[\log PY - \log(PW\$ \cdot E)]$

	λ	ρ_1	ρ_2	SE	R^2	DW
Quarterly						
CA	.743	1.307	-.300	.0167	0.975	2.14
	(13.43)	(13.08)	(-2.93)			
JA	.514	.919	.075	.0203	0.892	1.97
	(10.12)	(7.24)	(0.60)			
AU	.661	.817	.179	.0254	0.881	2.03
	(7.74)	(6.90)	(1.52)			
FR	.561	.924	.075	.0105	0.968	1.96
	(17.93)	(8.55)	(0.69)			
GE	.819	1.214	-.215	.0108	0.983	2.03
	(23.24)	(11.59)	(-2.06)			
IT	.458	.864	.135	.0184	0.936	2.00
	(7.11)	(7.62)	(1.19)			
NE	.551	1.476	-.476	.0145	0.884	1.92
	(8.99)	(12.13)	(-3.92)			
ST	.971	.877	.015	.0240	0.974	1.98
	(238.77)	(7.93)	(0.14)			
UK	.710	1.199	-.217	.0154	0.972	2.00
	(17.62)	(12.49)	(-2.21)			
FI	.496	.939	.062	.0139	0.970	1.98
	(7.36)	(7.35)	(0.49)			
AS	.626	1.261	-.267	.0308	0.945	1.95
	(8.38)	(11.64)	(-2.41)			
SO	.695	.866	.140	.0325	0.939	2.05
	(10.88)	(9.44)	(1.49)			
KO	.091	1.167	-.194	.0325	0.869	1.98
	(2.18)	(12.20)	(-2.03)			
Annual						
BE	.963	1.049	-.394	.0479	0.493	1.86
	(92.62)	(4.81)	(-1.84)			
DE	.549	.983	.014	.0188	0.911	1.84
	(9.91)	(4.64)	(0.07)			
NO	.965	1.169	-.453	.0898	0.591	1.74
	(59.86)	(4.85)	(-1.82)			
SW	.988	1.148	-.433	.0444	0.605	1.69
	(139.63)	(5.02)	(-1.83)			
GR	.982	.906	-.129	.0608	0.821	1.81
	(28.66)	(4.07)	(-0.62)			
IR	.422	1.053	-.144	.0294	0.480	1.82
	(4.55)	(4.17)	(-0.57)			
PO	1.026	1.266	-.029	.0356	0.918	1.94
	(63.90)	(6.26)	(-0.11)			
SP	.413	1.277	-.292	.0352	0.906	1.56
	(3.93)	(5.98)	(-1.39)			
NZ	1.007	.846	-.087	.0817	0.584	1.92
	(10.03)	(4.27)	(-0.42)			
CO	1.004	.900	-.275	.1391	0.772	2.06
	(21.71)	(3.87)	(-1.19)			
JO	.380	1.145	-.092	.0361	0.891	1.90
	(3.31)	(4.58)	(-0.35)			
SY	1.179	1.303	-.378	.1812	0.875	2.20
	(7.93)	(6.61)	(-1.79)			
ID	.976	1.187	-.354	.0545	0.795	1.85
	(69.58)	(6.33)	(-1.87)			
MA	.959	.837	-.234	.1378	0.667	1.95
	(11.68)	(3.16)	(-0.88)			
PA	1.014	.601	-.346	.0737	0.636	1.83
	(177.43)	(5.34)	(-3.74)			
PH	1.039	.262	.046	.1828	0.629	1.20
	(85.10)	(1.46)	(0.27)			
TH	1.005	.966	-.468	.0655	0.744	1.84
	(153.42)	(5.62)	(-2.78)			

Table 6.11b
Test Results for Equation 11

	Restr[a] p-val	RHO+ p-val	Stability AP (df) λ	Sample
Quarterly				
CA	.609	.011	3.56 (3) 5.57	1969:1–1992:3
JA	.000	.457	1.21 (3) 3.57	1976:1–1992:3
AU	.000	.001	3.02 (3) 1.05	1971:1–1991:2
FR	.003	.875	–	1971:1–1992:2
GE	.011	.517	1.95 (3) 2.66	1969:1–1991:4
IT	.155	.681	1.89 (3) 1.97	1972:1–1991:4
NE	.286	.839	–	1978:2–1991:4
ST	.144	.885	2.86 (3) 2.17	1971:1–1991:4
UK	.147	.919	4.73 (3) 3.92	1966:1–1992:3
FI	.778	.023	–	1976:1–1991:4
AS	.001	.496	4.07 (3) 1.69	1971:1–1992:2
SO	.008	.044	1.37 (3) 4.51	1962:1–1991:2
KO	.000	.912	*11.75 (3) 2.03	1964:1–1991:4
Annual				
BE	.676	.696	1.61 (3) 1.00	1969–1990
DE	.602	.193	–	1969–1990
NO	.567	.897	1.60 (3) 1.00	1974–1990
SW	.091	.524	3.95 (3) 1.00	1969–1990
GR	.635	.002	–	1965–1990
IR	.522	.430	2.39 (3) 1.00	1969–1990
PO	.957	.006	*17.43 (3) 1.00	1962–1990
SP	.266	.012	1.70 (3) 1.00	1969–1990
NZ	.218	.295	4.69 (3) 1.00	1962–1990
CO	.287	.509	2.09 (3) 1.00	1972–1991
JO	.000	.992	2.44 (3) 1.00	1971–1991
SY	.050	.138	2.95 (3) 1.00	1965–1990
ID	.005	.583	*14.54 (3) 1.00	1962–1989
MA	.329	.677	0.10 (3) 1.00	1972–1987
PA	.009	.069	1.96 (3) 1.00	1972–1991
PH	.001	.944	*5.92 (3) 1.00	1962–1991
TH	.075	.508	1.11 (3) 1.00	1962–1990

[a] log PY and log E added.
*Significant at the one percent level.

have the real wage depend on either the nominal wage rate or the price level separately. (See the discussion of equations 5.35, 5.36, and 5.37 in Section 5.4.)

The estimate of the constant term is not presented in Table 6.12a. The results show that there is a scattering of support for the labor market tightness variables having an effect on the wage rate. One of the variables appears in 12 of the 18 equations, although in half of the 12 the variable is not significant.

The test results in Table 6.12b show that the real wage restriction is rejected in 5 of the 18 cases. Three of the 18 equations fail the lags test, 7 fail the

Table 6.12a

$\log W = a_1 + a_2 T + a_3 \log W_{-1} + a_4 \log PY$
$+ a_5 (UR or JJS or ZZ) + a_6 \log PY_{-1}$

	a_2	a_3	a_4	a_5	ρ	SE	DW	a_6
Quarterly								
CA	.00009	.955	1.034	–	.108	.0095	1.97	-.986
	(0.62)	(30.20)	(9.07)		(1.03)			
JA	.00032	.916	1.025	–	-.169	.0093	1.86	-.937
	(2.22)	(23.03)	(10.04)		(-1.54)			
AU	.00098	.824	-.425	[c].147	–	.0232	2.87	.553
	(3.53)	(13.27)	(-1.36)	(0.89)				
FR	-.00010	1.001	.927	–	–	.0107	1.92	-.933
	(-0.69)	(22.21)	(3.64)					
GE	.00036	.902	1.109	-.069	–	.0110	2.20	-1.004
	(1.79)	(20.37)	(2.19)	(-0.74)				
IT	.00039	.943	.990	[a]-.377	–	.0135	1.72	-.934
	(1.40)	(25.09)	(4.82)	(-1.80)				
NE	.00157	.552	.153	[c]-.029	-.241	.0073	1.74	.111
	(7.96)	(7.80)	(1.26)	(-0.55)	(-1.56)			
UK	.00101	.901	.789	–	–	.0117	2.18	-.711
	(3.84)	(26.36)	(12.37)					
FI	.00278	.406	.213	[a]-.535	–	.0186	2.24	.340
	(4.65)	(3.41)	(0.49)	(-2.41)				
KO	.00786	.582	.809	[c]-.560	–	.0403	2.02	-.444
	(7.22)	(8.68)	(13.36)	(-3.55)				
Annual								
BE	-.00035	1.147	.793	-1.013	–	.0154	1.54	-.989
	(-0.19)	(15.53)	(3.51)	(-4.34)				
DE	-.00273	1.003	1.290	-.840	-.373	.0179	2.18	-1.239
	(-1.57)	(8.51)	(5.30)	(-4.06)	(-1.52)			
NO	.04361	.477	-.049	[b].628	–	.0265	1.72	.064
	(5.45)	(4.45)	(-0.24)	(2.10)				
SW	.00175	-.277	.890	-5.347	.589	.0184	2.14	.371
	(0.49)	(-1.74)	(3.07)	(-4.99)	(4.08)			
GR	.03361	.444	.659	–	.829	.0365	1.89	-.185
	(2.51)	(1.44)	(2.88)		(3.64)			
IR	.00331	1.096	.704	–	–	.0253	1.73	-.879
	(1.17)	(6.81)	(4.63)					
SP	-.01438	.579	.574	-.493	.905	.0143	1.95	-.220
	(-0.24)	(2.08)	(2.87)	(-1.08)	(6.67)			
NZ	.00302	.493	.687	[c]-.407	.815	.0307	1.46	-.210
	(0.68)	(2.01)	(4.27)	(-1.82)	(4.32)			

[a]Variable lagged once. [b]JJS rather than UR. [c]ZZ rather than UR.

RHO+ test, and 8 fail the stability test. The overall test performance is thus only modest.

Table 6.12b
Test Results for Equation 12

	Restr[a] p-val	Lags p-val	RHO+ p-val	Stability AP (df) λ	Sample
Quarterly					
CA	.850	.824	.000	*29.49 (6) 4.25	1966:1–1992:3
JA	.002	.094	.035	4.63 (5) 2.21	1971:1–1992:3
AU	.067	.000	.000	*21.80 (5) 2.21	1971:1–1991:2
FR	.140	.836	.031	*20.23 (4) 2.03	1971:1–1992:2
GE	.000	.369	.000	*13.95 (5) 2.66	1969:1–1991:4
IT	.297	.241	.002	7.20 (5) 2.01	1972:1–1991:4
NE	.070	.218	.008	6.34 (6) 1.00	1978:2–1991:4
UK	.215	.262	.481	*13.56 (4) 3.92	1966:1–1992:3
FI	.003	.081	.000	*15.33 (5) 1.00	1976:1–1991:4
KO	.000	.004	.000	*31.46 (5) 2.03	1964:1–1991:4
Annual					
BE	.010	.076	.528	4.90 (5) 1.00	1969–1990
DE	.494	.313	.038	3.08 (6) 1.00	1969–1990
NO	.341	.000	.600	7.22 (5) 1.00	1974–1990
SW	.517	.209	.869	7.64 (6) 1.00	1969–1990
GR	.199	.829	.465	6.49 (5) 1.00	1964–1990
IR	.348	.746	.486	*7.11 (4) 1.00	1969–1990
SP	.207	.666	.193	4.26 (6) 1.00	1972–1990
NZ	.744	.077	.041	5.04 (6) 1.00	1962–1990

[a] log PY_{-1} added.
*Significant at the one percent level.

6.14 Equation 13: J: Employment

Equation 13 explains the change in employment. It is in log form, and it is similar to equation 13 for the US model. It includes as explanatory variables the amount of excess labor on hand, the change in output, the lagged change in output, and a time trend. Equation 13 for the US model does not include the lagged change in output because it was not significant. On the other hand, US equation 13 includes terms designed to pick up a break in the sample period, which equation 13 does not, and it includes the lagged change in employment, which equation 13 does not.

Most of the coefficient estimates for the excess labor variable are significant in Table 6.13a, which is at least indirect support for the theory that firms at times hold excess labor and that the amount of excess labor on hand affects current employment decisions. Most of the change in output terms are also significant. The equation fails the lags test in 4 of the 15 cases. It passes the RHO+ test and the leads test in all cases.[11] The led value of the change in

[11] Multicollinearity problems prevented the leads test from being performed for the UK.

Table 6.13a

$\Delta \log J = a_1 + a_2 T + a_3 \log(J/JMIN)_{-1} + a_4 \Delta \log Y + a_5 \Delta \log Y_{-1}$

	a_1	a_2	a_3	a_4	a_5	ρ	SE	DW
Quarterly								
CA	.006	-.000023	-.144	.352	.202	.152	.0045	1.92
	(2.03)	(-1.18)	(-3.64)	(4.38)	(3.59)	(1.36)		
JA	–	.000023	-.059	.135	–	-.203	.0041	2.11
	(-0.17)	(1.61)	(-2.47)	(2.54)		(-2.05)		
AU	-.009	.000084	-.046	.124	.072	-.305	.0070	1.96
	(-2.29)	(2.49)	(-1.31)	(1.34)	(1.03)	(-2.72)		
GE	-.006	.000060	-.145	.156	.038	.482	.0021	2.06
	(-2.77)	(3.79)	(-4.50)	(3.67)	(1.01)	(4.99)		
IT	.002	-.000004	-.069	.105	.031	–	.0056	2.25
	(0.50)	(-0.16)	(-1.83)	(0.91)	(0.32)			
ST	-.004	.000067	-.282	.116	–	.739	.0038	2.53
	(-0.46)	(1.01)	(-4.65)	(1.13)		(8.58)		
UK	.004	.000000	-.229	.174	–	.556	.0034	1.89
	(1.41)	(0.00)	(-5.45)	(4.47)		(5.67)		
FI	.035	-.000259	-.160	.210	.145	–	.0056	2.10
	(3.67)	(-3.93)	(-3.47)	(4.11)	(2.83)			
AS	.007	-.000006	-.322	.182	–	.274	.0046	2.03
	(2.04)	(-0.21)	(-6.26)	(2.83)		(2.26)		
Annual								
BE	-.036	.001245	-.274	.372	.065	–	.0098	2.02
	(-3.22)	(2.96)	(-1.40)	(3.26)	(0.53)			
DE	-.001	.000224	-.729	.424	–	–	.0125	1.61
	(-0.05)	(0.51)	(-4.50)	(3.27)				
NO	-.007	.000042	-.715	.381	–	–	.0099	1.28
	(-0.37)	(0.07)	(-4.29)	(2.68)				
SW	-.004	.000299	-.134	.274	.103	.364	.0072	2.08
	(-0.36)	(0.75)	(-0.82)	(2.48)	(0.75)	(1.24)		
IR	-.020	.001236	-.411	.268	–	–	.0129	1.30
	(-1.78)	(2.25)	(-3.02)	(2.05)				
SP	-.085	.002402	-.103	.601	.378	–	.0107	1.91
	(-5.32)	(5.40)	(-0.61)	(3.91)	(2.96)			

output was used for the leads tests. The equation fails the stability test in 4 cases. The overall tests results for equation 13 are thus quite good.

6.15 Equation 14: $L1$: Labor Force—Men; Equation 15: $L2$: Labor Force—Women

Equations 14 and 15 explain the labor force participation rates of men and women, respectively. They are in log form and are similar to equations 5, 6, and 7 in the US model. The explanatory variables include the real wage, the labor constraint variable, a time trend, and the lagged dependent variable.

The labor constraint variable is significant in most cases in Tables 6.14a and 6.15a, which provides support for the discouraged worker effect. There is only very modest support for the real wage. When the real wage appeared

Table 6.13b
Test Results for Equation 13

	Lags p-val	RHO+ p-val	Leads p-val	Stability AP (df) λ	Sample
Quarterly					
CA	.130	.787	.826	8.11 (6) 4.25	1966:1–1992:3
JA	.650	.013	.045	2.08 (5) 3.57	1967:3–1992:3
AU	.114	.648	.860	*8.86 (6) 2.21	1971:1–1991:2
GE	.053	.043	.918	6.64 (6) 2.66	1969:1–1991:4
IT	.627	.028	.093	0.61 (5) 1.98	1972:1–1991:4
ST	.000	.022	.098	*17.19 (5) 2.17	1971:1–1991:4
UK	.000	.823	–	*10.66 (5) 3.92	1966:1–1992:3
FI	.229	.013	.075	*8.48 (5) 1.00	1977:1–1991:4
AS	.066	.469	.380	6.42 (5) 1.69	1971:1–1992:2
Annual					
BE	.973	.023	.274	1.50 (5) 1.00	1969–1990
DE	.295	.371	.421	3.46 (4) 1.00	1969–1990
NO	.002	.034	.543	0.75 (4) 1.00	1974–1990
SW	.011	.775	.313	3.51 (6) 1.00	1969–1990
IR	.000	.859	.725	5.27 (4) 1.00	1969–1990
SP	.051	.393	.027	2.62 (5) 1.00	1969–1990

*Significant at one the percent level.

in the equation, the log of the price level was added to the equation for one of the tests to test the real wage restriction. The log of the price level was significant (and thus the restriction rejected) in 2 of the 7 cases.

Equation 14 fails the lags test in 2 of the 14 cases and the RHO+ in 5 cases. Equation 15 fails no lags tests out of 10 and 3 RHO+ tests. Both equations do poorly in the stability test. Equation 14 fails the test in 11 of the 14 cases, and equation 15 fails in 7 of 10.

6.16 The Trade Share Equations

As discussed in Chapter 3, α_{ij} is the fraction of country i's exports imported by j, where i runs from 1 to 44 and j runs from 1 to 45. The data on α_{ij} are quarterly, with observations for most ij pairs beginning in 1960:1.

One would expect α_{ij} to depend on country i's export price relative to an index of export prices of all the other countries. The empirical work consisted of trying to estimate the effects of relative prices on α_{ij}. A separate equation was estimated for each ij pair. The equation is the following:

$$\alpha_{ijt} = \beta_{ij1} + \beta_{ij2}\alpha_{ijt-1} + \beta_{ij3}\left(\frac{PX\$_{it}}{\sum_{k=1}^{44}\alpha_{kit}PX\$_{kt}}\right) + \mu_{ijt}$$

$$(t = 1, \cdots, T) \tag{6.13}$$

Table 6.14a

$$\log(L1/POP1) = a_1 + a_2 T + a_3 \log(L1/POP1)_{-1} + a_4 \log(W/PY) + a_5 Z$$

	a_1	a_2	a_3	a_4	a_5	ρ	SE	DW
Quarterly								
CA	-.252	-.000315	.764	.050	.097	–	.0035	1.97
	(-3.87)	(-4.20)	(11.69)	(3.59)	(3.34)			
JA	-.012	-.000097	.897	–	.241	–	.0028	2.21
	(-1.69)	(-2.81)	(19.52)		(2.29)			
AU	-.196	-.000559	.830	[a].019	.142	–	.0062	2.00
	(-2.54)	(-2.64)	(12.68)	(1.08)	(1.48)			
GE	.003	0.000016	.972	–	.038	.148	.0016	1.97
	(0.65)	(1.05)	(61.27)		(2.01)	(1.46)		
IT	-.063	-.000729	.578	–	.087	–	.0033	2.01
	(-4.55)	(-4.72)	(6.50)		(1.44)			
ST	-.005	-.000165	.868	–	.109	–	.0039	1.93
	(-1.94)	(-3.46)	(25.43)		(4.18)			
UK	.014	0.000001	.940	–	.009	–	.0029	1.21
	(1.27)	(0.07)	(19.96)		(0.57)			
FI	-.206	-.000766	.044	–	[a].295	–	.0051	1.69
	(-8.06)	(-8.56)	(0.39)		(5.56)			
AS	.045	0.000229	.843	–	.096	–	.0034	2.10
	(3.34)	(2.99)	(16.85)		(3.46)			
Annual								
BE	-.095	-.001298	.858	.014	.150	–	.0045	1.37
	(-0.74)	(-0.50)	(3.15)	(0.73)	(1.89)			
DE	-.053	0.000098	.827	–	–	–	.0077	1.87
	(-1.99)	(0.20)	(6.64)					
NO	-.384	-.002777	.329	.052	.333	–	.0035	2.47
	(-5.46)	(-7.31)	(3.11)	(3.94)	(6.07)			
SW	-.148	-.003189	.352	–	.595	–	.0057	1.13
	(-3.05)	(-2.68)	(1.58)		(2.63)			
SP	-.029	-.004326	.618	–	.064	–	.0121	1.78
	(-2.44)	(-1.36)	(2.53)		(1.08)			

[a]Variable lagged once.

$PX\$_{it}$ is the price index of country i's exports, and $\sum_{k=1}^{44} \alpha_{kit} PX\$_{kt}$ is an index of all countries' export prices, where the weight for a given country k is the share of k's exports to j in the total imports of i. (In this summation $k = i$ is skipped.)

With i running from 1 to 44, j running from 1 to 45, and not counting $i = j$, there are 1936 ($= 44 \times 44$) ij pairs. There are thus 1936 potential trade share equations to estimate. In fact, only 1560 trade share equations were estimated. Data did not exist for all pairs and all quarters, and if fewer than 26 observations were available for a given pair, the equation was not estimated for that pair. A few other pairs were excluded because at least some of the observations seemed extreme and likely suffering from measurement error. Almost all of these cases were for the smaller countries.

Table 6.14b
Test Results for Equation 14

	Lags p-val	log PY p-val	RHO+ p-val	Stability AP (df) λ	Sample
Quarterly					
CA	.745	.000	.001	*24.85 (5) 3.36	1968:1–1992:3
JA	.038	–	.007	4.13 (4) 3.57	1967:3–1992:3
AU	.738	.292	.113	*24.58 (5) 2.21	1971:1–1991:2
GE	.760	–	.012	*12.50 (5) 2.66	1969:1–1991:4
IT	.263	–	.000	*20.21 (4) 1.98	1972:1–1991:4
ST	.642	–	.000	*23.57 (4) 2.17	1971:1–1991:4
UK	.000	–	.000	*22.31 (4) 4.25	1968:1–1992:3
FI	.755	–	.137	*11.60 (5) 1.00	1976:1–1991:4
AS	.362	–	.614	4.18 (4) 1.69	1971:1–1992:2
Annual					
BE	.513	.008	.713	*10.82 (5) 1.00	1971–1990
DE	.771	–	.255	2.28 (3) 1.00	1969–1990
NO	.731	.015	.284	*13.11 (5) 1.00	1974–1990
SW	.006	–	.231	*7.88 (4) 1.00	1969–1990
SP	.755	–	.957	*8.36 (4) 1.00	1972–1990

*Significant at the one percent level.

Each of the 1560 equations was estimated by ordinary least squares. The main coefficient of interest is β_{ij3}, the coefficient of the relative price variable. Of the 1560 estimates of this coefficient, 83.3 percent (1299) were of the expected negative sign. 44.4 percent had the correct sign and a t-statistic greater than two in absolute value, and 68.1 percent had the correct sign and a t-statistic greater than one in absolute value. 3.2 percent had the wrong sign and a t-statistic greater than two, and 7.5 percent had the wrong sign and a t-statistic greater than one. The overall results are thus quite supportive of the view that relative prices affect trade shares.

The average of the 1299 estimates of β_{ij3} that were of the right sign is $-.0132$. β_{ij3} measures the short run effect of a relative price change on the trade share. The long run effect is $\beta_{ij3}/(1-\beta_{ij2})$, and the average of the 1299 values of this is $-.0580$.

The trade share equations with the wrong sign for β_{ij3} were not used in the solution of the model. The trade shares for these ij pairs were taken to be exogenous.

It should be noted regarding the solution of the model that the predicted values of α_{ijt}, say, $\hat{\alpha}_{ijt}$, do not obey the property that $\sum_{i=1}^{44} \hat{\alpha}_{ijt} = 1$. Unless this property is obeyed, the sum of total world exports will not equal the sum of total world imports. For solution purposes each $\hat{\alpha}_{ijt}$ was divided by $\sum_{i=1}^{44} \hat{\alpha}_{ijt} = 1$, and this adjusted figure was used as the predicted trade share.

Table 6.15a
$\log(L2/POP2) = a_1 + a_2 T + a_3 \log(L2/POP2)_{-1}$
$+a_4 \log(W/PY) + a_5 Z$

	a_1	a_2	a_3	a_4	a_5	ρ	SE	DW
Quarterly								
JA	-.053	.000067	.938	–	–	–	.0081	2.28
	(-2.61)	(2.40)	(34.89)					
AU	-.167	-.000157	.876	–	.116	-.276	.0101	1.97
	(-3.19)	(-1.60)	(20.72)		(1.25)	(-2.43)		
IT	-.909	.000988	.551	.065	.558	–	.0111	1.81
	(-3.81)	(3.91)	(5.69)	(2.18)	(2.16)			
ST	-.199	.000207	.779	–	.249	–	.0048	1.35
	(-5.31)	(5.06)	(18.58)		(5.23)			
FI	-.049	-.000015	.904	–	.101	–	.0046	2.47
	(-1.60)	(-0.33)	(18.97)		(2.75)			
AS	-.150	.001040	.846	–	.237	.144	.0079	1.97
	(-2.80)	(2.96)	(16.22)		(3.21)	(1.17)		
Annual								
BE	-.662	.002545	.701	.071	.019	-.492	.0031	2.46
	(-5.05)	(2.30)	(7.96)	(9.86)	(0.40)	(-2.50)		
DE	-.429	.003224	.689	.040	–	–	.0129	1.71
	(-1.40)	(1.20)	(3.72)	(0.69)				
SW	-.035	.000124	.918	–	.712	–	.0057	1.57
	(-0.64)	(0.14)	(14.81)		(3.41)			
SP	-1.467	.012422	–	–	.726	–	.0207	1.77
	(-74.12)	(12.97)			(10.41)			

In other words, the values predicted by the equations in 6.13 were adjusted to satisfy the requirement that the trade shares sum to one.

6.17 Additional Comments

The following are a few general remarks about the results in this chapter.

1. Of the equations explaining the components of GDP—M (equation 1), C (equation 2), I (equation 3), and $V1$ (equation 4)—equation 3 is by far the weakest. It may be that the construction of the capital stock series is too crude to allow good results to be obtained, or it may be that the sample sizes are too small to allow the simultaneity issue to be handled well.

2. The strong rejection of the change form of the price equation in Table 6.5b is an important result. As discussed in point 11 in Section 5.10, this has important implications for the long run properties of the model. The significance of the import price index in the price equations is also

Table 6.15b
Test Results for Equation 15

	Lags p-val	log PY p-val	RHO+ p-val	Stability AP (df) λ	Sample
Quarterly					
JA	.095	–	.242	*14.15 (3) 3.57	1967:3–1992:3
AU	.410	–	.168	*22.28 (5) 2.21	1971:1–1991:2
IT	.645	.692	.000	*9.79 (5) 1.98	1972:1–1991:4
ST	.025	–	.000	*39.17 (4) 2.17	1971:1–1991:4
FI	.156	–	.214	*11.46 (5) 1.00	1976:1–1991:4
AS	.548	–	.501	*21.35 (5) 1.42	1971:1–1992:2
Annual					
BE	.167	.371	.243	3.09 (6) 1.00	1971–1990
DE	.320	.253	.534	4.33 (4) 1.00	1969–1990
SW	.420	–	.000	*8.64 (4) 1.00	1969–1990
SP	.131	–	.888	4.64 (3) 1.00	1972–1990

*Significant at the one percent level.

important. This shows how price levels in different countries affect each other.

3. The results of estimating the demand for money equations in Table 6.6a provide further support for the nominal adjustment hypothesis over the real adjustment hypothesis. See also point 5 in Section 5.10.

4. The U.S. interest rate is significant in 11 of the interest rate reaction functions in Table 6.7a. This is evidence that the Fed influences the economies of other countries by influencing other countries' interest rates. It will be seen in Chapter 12 that this is an important link.

5. A key question for the exchange rate equations in Table 6.9a is whether one can trust the inclusion of the relative interest rate variable in the equations. The verdict is not yet in on this question.

6. The excess labor variable is significant in most of the equations in Table 6.13a, which adds further support to the theory that firms at times hoard labor.

7. As was the case for the US model, the results support the use of nominal interest rates over real interest rates. In very few cases is the inflation expectations variable significant.

8. There is little support for the use of the led values and thus little support for the rational expectations hypothesis. The led values are significant

at the one percent level in only 18 of the 153 cases in which they were tried.

9. The equations in general do well for the lags, T, and RHO+ tests. For the lags test there are 45 failures out of 274 cases; for the T test there are 44 failures out of 217 cases; and for the RHO+ test there are 43 failures out of 304 cases. These results suggest that the dynamic specification of the equations is reasonably good. The results are not as good for the stability test, where there are 105 failures out of 299 cases. More observations are probably needed before much can be done about this problem.