Monetary Policy in a Heterogeneous Monetary Union: The Australian Experience

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Abstract

The geological and climatic conditions of the Australian continent have made Australia a heterogeneous monetary union. Manufacturing and service industries are located in the population centers in the temperate southeast, and mining and pastoral activities take place in the vast expanses of the interior and north. In a small open economy with easy access to international capital markets, monetary policy is transmitted through the exchange rate. Monetary policy affects the interior and north more strongly than the southeastern seaboard because primary goods are mainly exported, whereas services and manufactures are mostly consumed domestically. As a consequence, the Reserve Bank of Australia must reconcile the economic interests of the interior and north and the southeastern seaboard.

Australia is a federation with six states and two state-like territories. The states are New South Wales, Victoria, Queensland, South Australia, Western Australia and Tasmania. The territories include the Northern Territory and the Australian Capital Territory (ACT), which harbors the national capital, Canberra. Australia’s population is concentrated along the southeastern seaboard, where the climate is Mediterranean. The arid interior of the continent and the tropical north remain sparsely populated. Temperatures reach 50° C in the interior, and the rainy season makes live miserable in the north, combining heat with humidity and inundating vast tracts of land. The economic structure of the states reflects the geological and climatic conditions of the Australian continent. Manufacturing and service industries are located in the population centers in the temperate southeast, and mining and pastoral activities take place in the vast expanses of the interior and north.

The industry contribution to factor income differs markedly across Australian states (Table 1). The service industry contributes more than 70 percent to total factor income in New South Wales and Victoria. Sydney and Melbourne, the state capitals of New South Wales and Victoria, are the administrative and financial centers of the Australian economy. The mining industry plays an important role in Western Australia and the Northern Territory, where it accounts for 21 and 24 percent of state output. In Queensland the share of mining is eight percent, which is much less than in Western Australia and the Northern Territory, but still four times more than in New South Wales, Victoria and Tasmania. Manufacturing, which is modest in Australia, is concentrated in New South Wales, Victoria, South Australia and Tasmania, where it contributes between 12 and 14 percent to output. Agriculture (including fishery and forestry) is about twice as important in South Australia than in most other states. Finally, government services account for the ACT’s high share of services in output.

Table 1. Industry Contribution to Total Factor Income (%), 2001-02

	NSW	VIC	QLD	SA	TAS	WA	NT	ACT
Agriculture	3	4	5	8	6	4	4	0
Mining	2	2	8	3	2	21	24	0
Manufacturing	12	14	10	14	14	9	4	2
Services	75	71	68	67	67	56	60	88
Other	8	9	9	8	11	10	8	10
Total	100	100	100	100	100	100	100	100

Source: ABS 5220.0.

Western Australia and the Northern Territory supply a disproportionate amount of Australian exports. In 2001-02, Western Australia, whose share in GDP was 11.1 percent, produced 27.3 percent of merchandise exports and 23.3 percent of total exports (Year Book of Australia, 2003). Similarly, the Northern Territory, whose share in GDP was only 1.3 percent, supplied 3.0 percent of merchandise exports and 2.8 percent of total exports. Australia's primary goods are destined for the world markets, therefore Western Australia and the Northern Territory have the most open economies among the Australian states. In 2001-02, the share of exports of goods and services in the gross state product (GSP) was 45 percent in Western Australia and 46 percent in the Northern Territory. Among the other states, Queensland had the highest share of exports in GSP (24 percent). Queensland's economy is fairly open because mining is significant and the service component of total factor income includes services to tourists who visit the Great Barrier Reef. In New South Wales and Victoria the share of exports in GSP is less than 20 percent because the administrative and financial services that are produced in Sydney and Melbourne are consumed domestically.

Australia has been a monetary union since the introduction of the Sterling standard in 1826, and an economic union since federation of the Australian colonies in 1901. The economic diversity of the Australian states, which has arisen naturally from their varied geological and climatic endowments, has produced a heterogeneous monetary union. As a consequence, the Australian states experience different business cycles, and monetary policy affects them differently. The purpose of this paper is to determine the effect of monetary policy on the Australian states. The experience of Western Australia shows that monetary policy affects the interior and north, which specialize in mining and pastoralism, more strongly than the eastern seaboard, where services and manufacturing industries are located. The reason for this is that in a small open economy with easy access to international capital markets, monetary policy is transmitted through the exchange rate.[1] Western Australia responds more strongly to monetary policy because primary commodities are mostly exported and the exchange rate provides the main transmission channel for monetary policy.

State Business Cycles

Business cycle research usually employs quarterly economic data, but few countries publish quarterly regional data. In 1997, the *Australian Bureau of Statistics* (ABS) discontinued the series on quarterly gross state product (GSP), replacing them with quarterly state final demand (SFD).[2] An unintended consequence of this was that authors of state treasury publications now find it difficult to distinguish between GSP and SFD. However,

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[1] This is the standard inference of the Mundell-Fleming model of a small open economy with perfect international capital markets. The real exchange rate plays an important role in the model of de Brower and O'Regan (1997), which is used by the *Reserve Bank of Australia*, but, as noted by Dennis (2003), it is less critical in macroeconomic models with micro foundations.

[2] Annual GSP figures are still available.

SFD is an imperfect measure of state economic activity because it does not take account of trade flows between states. For example, an increase in SFD in Western Australia may lead to higher imports of manufactures from Victoria. Then, economic activity expands in Victoria, but it remains unchanged in Western Australia, the source of the extra demand. For this reason, *Econtech*, a private economic forecasting group, has continued to estimate quarterly GSP, using the same methodology as the ABS prior to 1997, as far as possible. In this study, both *Econtech's* estimates of quarterly GSP and the official figures of quarterly SFD are used. As it turns out, both data sets support the main conclusions on state business cycles and the effect of monetary policy.

This study covers the time since the deregulation of the Australian economy in the early and mid-1980s, from the fourth quarter 1985 until the first quarter 2001. The Labor government that broke with Australia's protectionist past aimed at the welfare gains that can be achieved through specialization and trade. Since Australia has a comparative advantage in primary commodities, the mining states benefited most from the deregulation of the economy.[3] From 1985 to 2001, real GSP grew at an average rate of 4.4 percent per year in the Northern Territory and Queensland and at 4.2 percent in Western Australia, exceeding the nationwide growth rate of 3.4 percent. The standard deviation of the growth rate of real GSP, which is shown in italics along the diagonal in Table 2, varied widely across states. New South Wales, whose standard deviation was 1.7 percent, had the most stable state economy. At the other extreme, the standard deviation was 7.1 percent in the Northern Territory, 4.9 percent in the ACT and 3.5 percent in Western Australia. Overall, the standard deviation of the growth rate of Australian GDP was 1.7 percent. These figures confirm the widely held

[3] Clements and Sjaastad (1984) analyze the detrimental effect of import protection on export industries, which had held back economic growth in the primary commodity producing Australian states before the 1980s.

Table 2. Gross State Products
Correlation Matrix of Annual Growth Rates

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
NSW	*1.68*							
VIC	0.67	*2.63*						
QLD	0.33	0.51	*2.38*					
SA	0.46	0.40	0.30	*2.51*				
WA	0.35	0.11	0.47	0.36	*3.49*			
TAS	0.13	0.29	0.27	0.14	0.18	*2.52*		
NT	0.21	0.23	0.11	0.28	0.21	0.22	*7.14*	
ACT	0.13	0.23	0.11	0.07	-0.01	-0.04	0.05	*4.89*
AUS	0.67	0.64	0.54	0.52	0.35	0.29	0.27	0.17

Notes: The diagonal shows the standard deviation of the growth rate in each state, and the cross correlations between states are shown below. The bottom row displays the correlations between output in a single state and total output in all other states. The annual growth rate is the logarithmic difference over four quarters. There are 63 observations, running from 1986:3 to 2002:1.

Source: Econtech

Table 3. State Final Demands
Correlation Matrix of Annual Growth Rates

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
NSW	*2.68*							
VIC	0.61	*3.27*						
QLD	0.54	0.66	*2.98*					
SA	0.54	0.42	0.40	*2.77*				
WA	0.36	0.53	0.49	0.34	*4.36*			
TAS	0.32	0.55	0.49	0.49	0.33	*3.18*		
NT	0.22	0.30	0.28	0.22	0.24	0.29	*8.05*	
ACT	0.15	0.12	0.25	0.11	-0.05	-0.14	-0.24	*5.14*
AUS	0.65	0.75	0.70	0.55	0.52	0.52	0.30	0.14

Notes: The diagonal shows the standard deviation of the growth rate of state final demands, and the cross correlations between states are shown below. The bottom row displays the correlations between final demand in a single state and final demand in all other states. The annual growth rate is the logarithmic difference over four quarters. There are 63 observations, running from 1986:3 to 2002:1.

Source: AusStats

view that primary commodity producing economies, here Western Australia and the Northern Territory, are prone to volatile business fluctuations, but the lives of bureaucrats in the ACT seem to be more risky than commonly thought.

The lower triangle in Table 2 shows correlation coefficients between annual growth rates of state outputs. The three largest correlations occur between the growth rates of GSP in New South Wales and Victoria (0.67), Queensland and Victoria (0.51), and Queensland and Western Australia (0.47). The business cycles of New South Wales and Victoria are related because both states are service-oriented and they share a common border, which enhances bilateral trade. Mining and exports account for the correlation between the business cycles of Queensland and Western Australia, and both Queensland and Victoria belong to the eastern population center. South Australia somewhat interacts with New South Wales and Victoria because of the proximity to the eastern markets. Nevertheless, the overwhelming impression that one gains from inspecting Table 2 is that there is no strong relationship between state business cycles. None of the correlation coefficients exceeds 0.7, which is a convenient benchmark because it corresponds to an R^2 of about 50 percent in a bivariate regression between output growth in a pair of states. Finally, the bottom row of Table 2 shows correlations between output growth in a single state and growth in all other states. Note that GSP outside of a state is used and not total Australian GDP. The correlation between GSP in a single state and Australian GDP would be distorted because a large state accounts for much of Australian GDP. As can be seen, the business cycles of New South Wales and Victoria are most representative of the Australian business cycle, but none of the correlation coefficients in the bottom row reaches the benchmark value of 0.7. In particular, Western Australia, Tasmania, the Northern Territory and the ACT experience independent business cycles. Using SFD confirms these findings on state business cycles (Table 3).

To sum up, Australia consists of two large economic regions that experience independent business cycles. Manufacturing and service industries are located in the population centers along the southeastern seaboard, and mining and pastoralism take place in the interior and north of the continent. Business cycles differ between these regions for two reasons: (1) they are subject to independent sectoral shocks, and (2) the transmission of monetary policy is different. Since Australia is a small open economy with easy access to international capital markets, monetary policy is mainly transmitted through the exchange rate. Monetary policy affects the interior and north more strongly than the southeastern seaboard because the share of exports is higher in the primary sector than in manufacturing and services. New South Wales and Victoria typify the eastern states, and Western Australia and the Northern Territory are the states in the interior and north. The two economic regions of Australia overlap in Queensland. Therefore, economic activity in Queensland is correlated with economic activity in Victoria, and, across the continent, in Western Australia.

Transmission of Monetary Policy

Australia is a heterogeneous monetary union with strong regional specialization. This poses a challenge to monetary policy because the economic interests of two regions, the southeastern seaboard and the interior and north, must be reconciled.[4] For this the Reserve Bank needs to know the regional effects of monetary policy.[5] In this section the effect of

[4] An emerging literature applies the theory of common agency to the political economy of central banking in a heterogeneous monetary union. See Dixit and Jensen (2002), Dixit (2001) and Drazen (2000) for the common agency approach to central banking in a heterogeneous monetary union.

[5] Lawson and Dwyer (2002) investigate labor market adjustment in regional Australia. Dixon and Shepherd (2001) provide an empirical analysis of trends and cycles in Australian state and territory unemployment rates. They find no common trend in state unemployment rates, but the cycles of the large states are correlated.

monetary policy on New South Wales, Victoria, Queensland, South Australia and Western Australia is determined. These five states account for about 95 percent of Australian GDP. The remaining states – Tasmania, the Northern Territory and the ACT – are excluded because they are small, each contributing less than two percent to GDP, and their business cycles are idiosyncratic. The discussion in the preceding section suggests that Western Australia, which covers much of the interior and north, should respond more strongly to monetary policy than New South Wales, Victoria and South Australia, while Queensland should hold an intermediate position.

Vector autoregressions (VARs) are a standard tool in empirical macroeconomic research. Sims (1980) introduced a basic three variable model that includes an indicator of the price level, a measure of economic activity and a monetary aggregate. This model can be adapted to a small open economy by adding a measure of world economic activity and the world interest rate. Weber (1994) developed a VAR model of the Australian economy, using US real GDP and the 90 day UK Treasury bill rate as proxies for world variables.[6] This paper further extends Sims' framework to a heterogeneous monetary union by disaggregating domestic economic activity. Australian real GDP is replaced with gross state product (GSP) and state final demand (SFD) in five states. The new model includes nine variables: US real GDP; real US federal funds rate; Australian consumer price index; real GSP (or SFD) in New South Wales, Victoria, Queensland, South Australia and Western Australia; and money stock M1.

A VAR model is a simultaneous equation model in which each variable is regressed on its own lagged values and on lagged values of all other variables. However, this symmetric treatment of variables is inappropriate when dealing with the interaction between US and

[6] Dungey (1997, pp. 141-146) discusses Weber's model. Pagan and Dungey (2000) and Brischetto and Voss (1999) developed VAR models for Australia. De Roos and Russel (2002) estimate the effect of US GDP on Australian exports.

Australian economic variables. Australia is a small open economy that is subject to foreign influences, but it does not influence the rest of the world. For this reason, a 'near' VAR is used, in which American variables are included in the equations with Australian dependent variables, while Australian variables are excluded from the American equations. The model is estimated with the seemingly unrelated regression (SUR) estimator, a system estimator that uses all equations of the model. Two conditions must be met for SUR to produce an efficiency gain over applying OLS to each equation. First, the equations must constitute a system of seemingly unrelated equations – hence the name – in which regressors differ across equations. This condition is met because Australian variables are excluded from the American equations. Since the regressors in the American equations are a subset of those in the Australian equations, the efficiency gain arises in the latter (Greene 2003, p. 616). Second, the equation residuals must be correlated, establishing a linkage among the equations that warrants the application of a system estimator. Breusch and Pagan (1980) proposed a Lagrange multiplier test for the second condition. This test shows that the equation residuals are correlated across equations, using both GSP and SFD.[7]

Except for the US interest rate, all variables are converted into logarithms. The results of two models are reported in which variables are detrended in different ways: the Hodrick-Prescott filter is used in the first model and a trend term is added to each equation in the second.[8] The impulse responses of both models are similar, supporting the main conclusions on the effect of monetary policy on the state economies. The original VAR methodology, which is still popular, did not detrend variables, nor was a trend term included in the equations. This type of model also supports the conclusions in this study, although the results are not reported.

[7] The regression output is included in the Appendix.

[8] In the first model all variables are detrended except for the US interest rate, and in the second model no trend term is used in the equation with the US interest rate as dependent variable.

The findings in this study hold for models with up to four lags; more lags are not practical because of degrees of freedom considerations. The lag length was determined in simplified symmetric versions of the models, which were estimated using OLS. The Akaike (AIC) and Schwartz Bayesian (BIC) information criteria suggest models with one lag. Likelihood ratio tests imply two lags for most models and variable specifications, and in one instance one lag. For this reason, two lags were used and an extra lag was added in equations that exhibited serial correlation. Using an extra lag always succeeded in removing serial correlation.

Figures 1 and 2 show the responses of GSP to a policy-induced change in the money stock in five states, using either the Hodrick-Prescott filter (Figure 1) or trend terms (Figure 2). Since GSP is logarithmic, the impulse responses, which are plotted for 24 quarters, are measured in percent. The standard error of the money equation, which was 0.8 percent with both the HP-filter and trend terms, yields historically relevant monetary policy shocks. In Figure 1, a one standard deviation shock to the money stock increases Western Australia's GSP by 0.6 percent within two quarters and the effect starts to dissipate after six quarters. The timing of the response of GSP is similar in the other states, but the peak lies between 0.2 and 0.4 percent. Figure 2 displays similar responses: a monetary shock leads to a temporary increase in economic activity that reaches 0.6 percent in Western Australia within two to six months, and between 0.2 and 0.3 percent in the other states. Thus, the effect of monetary policy on the state economy is about twice as strong in Western Australia than in the other states. This is as expected. Australia is a small open economy in which monetary policy is transmitted mainly through the exchange rate. Monetary policy affects Western Australia more strongly than the other states because the share of exports in GSP is high.

Figure 1. Gross State Product: Responses to M1
HP Filter

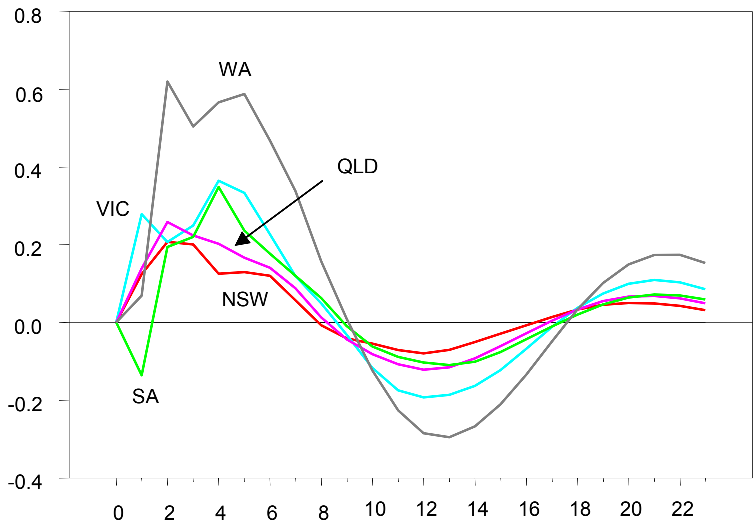


Figure 2. Gross State Product: Responses to M1
Linear Trend

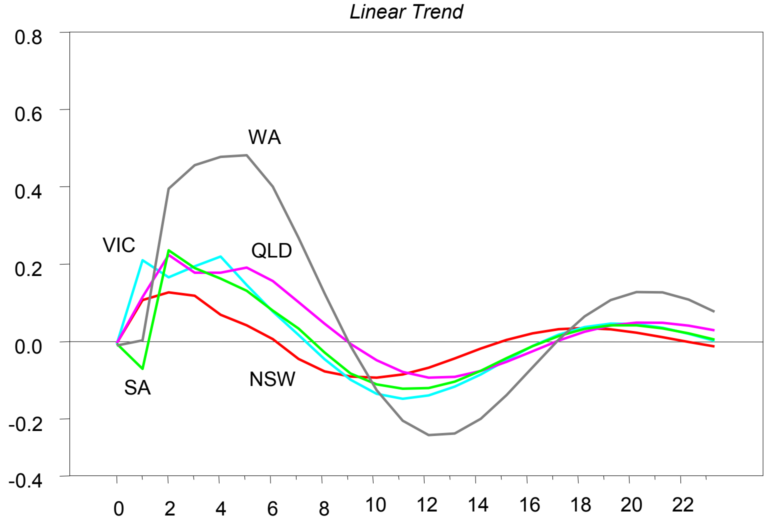


Figure 3. State Final Demand: Responses to M1

HP Filter

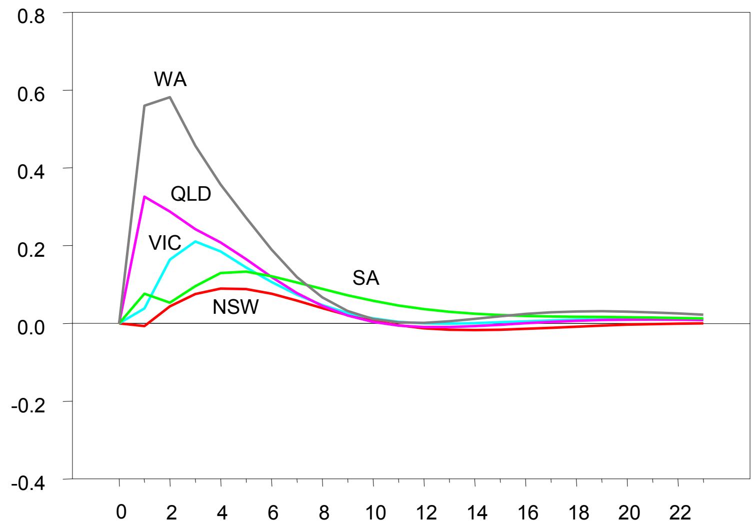
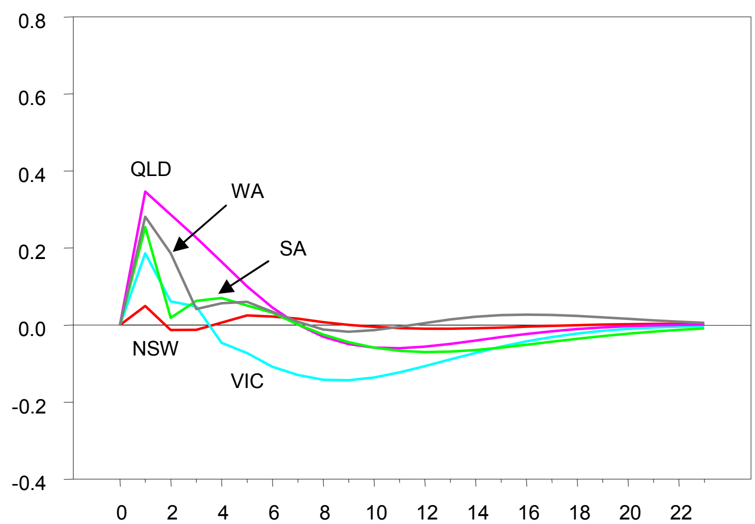


Figure 4. State Final Demand: Responses to M1

Linear Trend



In general, the effect of monetary policy on SFD occurs faster and it dissipates more quickly than the effect on GSP. In Figure 3, SFD in Western Australia increases by almost 0.6 percent after one quarter and it starts to fall off after two quarters. In Figure 4, the response of SFD in Western Australia is muted, peaking at 0.3 percent after one quarter, which is close to the response in Queensland in Figures 1 to 4. As argued, the two economic regions of Australia, the southeastern seaboard and the interior and north, overlap in Queensland. Mining is significant in Queensland and part of the service sector – tourism along the Great Barrier Reef – is export-oriented. Therefore, the response of Queensland to monetary shocks is fairly strong, exceeding the response in all states except Western Australia in Figures 2 and 3, and matching the response in Western Australia in Figure 4. Finally, in all figures monetary policy is least effective in New South Wales and Victoria, which produce manufactures and services for the home market.

The model yields a large number of impulse responses that cannot all be shown.[9] The omitted impulse responses do not vary greatly across models and variable specifications and the following comments concentrate on their most noteworthy features. First, an increase in US real GDP is followed by an increase in economic activity in all states except Western Australia (Figure 5). Most mining exports of Western Australia are destined for Asian markets: iron ore for China, natural gas for Japan, and gold for Asia, India and the Middle East. Therefore, the Western Australian business cycle does not depend directly on economic activity in the United States. Next, an increase in the US interest rate, the proxy for the world interest rate, leads to an economic expansion in all states within two to four quarters, peaking after six to eight quarters (Figure 6). The positive response of the Australian economy to an increase in the world interest

[9] A VAR model with n variables generates n^2 impulse responses. The near VAR that is used in this paper has 9^2-14=67 impulse responses because Australian variables do not affect American ones. Since there are four versions of the model, there are a total of 268 impulse responses.

Figure 5. Gross State Product: Responses to US GDP
HP Filter

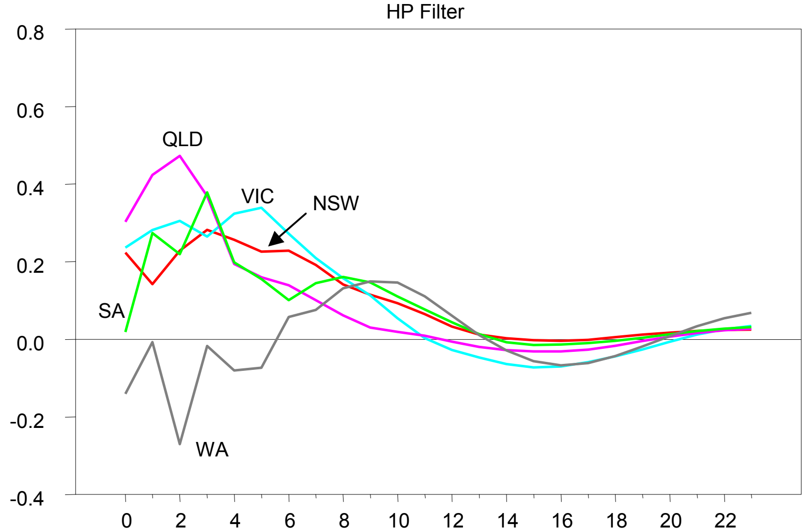
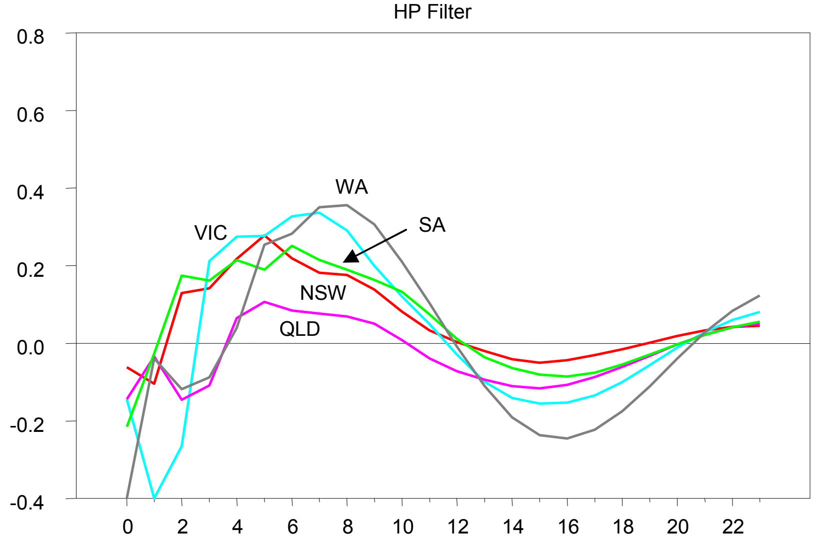


Figure 6. Gross State Product: Responses to US Interest Rate
HP Filter



rate seems counterintuitive, but it is predicted by the Mundell-Fleming model. An increase in the world interest rate raises domestic interest rates, investment demand falls and the IS curve shifts to the left. However, given the real money stock, a rise in interest rates must increase aggregate demand and output (LM curve). Since aggregate demand increases, the exchange rate must depreciate sufficiently, raising exports more than the fall in investment. This analysis is supported by the fact that the positive effect of the US interest rate on GSP is strong in Western Australia, the state with the biggest export share in GSP. Turning to domestic shocks, as expected an increase in the money stock induces an increase in the price level. Somewhat disappointingly, there are no interesting dynamics among state outputs, and autonomous price level shocks do not lead to a consistent response across states. The reason that these domestic shocks do not yield stable impulse responses is that they were small in the period under consideration.

Monetary Unions

The current research on monetary unions was preceded by an earlier literature that coincided with the creation of the *European Economic Community* (EEC) in 1957. Mundell (1961/68) argued that it was essentially an empirical question whether or not Europe constituted an optimum currency area. The crucial issue is whether labor is sufficiently mobile to prevent local unemployment in the presence of country-specific economic shocks. Other important contributors to this early debate on European monetary unification included Meade (1957), Scitovsky (1958), McKinnon (1963) and Kenen (1969). Afterwards, the interest of monetary economists shifted away from monetary unions, undoubtedly because European political integration had stalled, making monetary unification an unlikely prospect for the foreseeable future.

In the 1980s, European political integration was relaunched. The *Single European Act* of 1986 provided for the free movement of goods, capital and people within a period of six years. In 1993, the EEC gave way to the *European Union* (EU), whose ultimate goal is full economic and political integration. The *Maastricht Treaty* (officially the *Treaty of European Union*) put the EU on a course of monetary unification over a period of ten years. The *European Monetary Institute*, the precursor of the *European Central Bank* (ECB), was established in 1994; the ECB opened its doors in 1998; exchange rates between members of the *European Monetary Union* were irrevocably fixed on January 1, 1999; and concluding the process of monetary unification within the agreed ten year period, euro coins and bank notes replaced national currencies in the first half of 2002. The Maastricht process of European monetary unification set off a second wave of research on monetary unions in the 1990s. Applying econometric techniques that had not yet been available in the 1950s and 60s, a new generation of monetary economists again turned to the question of whether or not Europe constitutes an optimum currency area.[10]

Despite the common empirical orientation, the modern research on European monetary unification differs markedly from Mundell's approach. Two empirical issues figure prominently in the current research: the closeness of national business cycles and the degree of factor mobility across countries. Mundell mentions only the degree of factor mobility as a criterion for an optimum currency area, taking structural differences between national economies that account for independent national shocks as given. It is not fully appreciated that the main thrust of Mundell's paper was to caution against the adoption of flexible exchange rates by a multiregional country. Mundell argued, "Because of the factor immobility between

[10] The empirical research on European monetary unification is immense. Representative studies include Askoy, de Grauwe and Dewachter (2002), Mojon and Peersman (2001) and Rawaswamy and Sløk (1998). Von Hagen (2000) contains a collection of essays on regional aspects of monetary policy in Europe.

regions, an increase in foreign demand for the products of one of the regions would cause an appreciation of the exchange rate and therefore increased unemployment in the remaining regions .....” Thus, regional differences in unemployment arise because of limited factor mobility. Once factor mobility is improved between two regions, they merge and it is immaterial that the old regions may experience independent economic shocks. From this viewpoint, the modern research on monetary unions puts excessive emphasis on the prevalence of local economic shocks, which are a fact of life even in a unitary country in which labor and capital move freely. Using Mundell’s terminology, Australia is a bi-regional country that consists of the eastern seaboard and the interior and north. The reason for the existence of these regions is limited mobility of physical capital. It is hardly possible to conceive of less mobile capital goods than the physical capital that is employed in the primary sector, including the ore reserves of mines and their above and below ground infrastructure, as well as agricultural land and its improvements.

The empirical research on European monetary unification that was conducted in the 1990s had to rely on economic data prior to the inception of the *European Monetary Union* on January 1, 1999. This was a serious handicap because, as pointed out by Frankel and Rose (1998), a country’s economic structure changes when it enters a monetary union. In fact, the main benefit of monetary unification is the efficiency gain that can be achieved by using a single currency unit. This efficiency gain involves an increase in international economic integration that affects a country’s susceptibility to economic shocks. Entry into a monetary union also constitutes a switch in the monetary policy regime, which, in accordance with the Lucas critique, changes macroeconomic relationships. In particular, the real effects of monetary policy depend on the reputation of the new monetary authority and inflationary expectations. For both reasons, it is impossible to determine a country’s suitability for a monetary union by comparing national business cycles before it joins the union. In this regard, it is notable that Mundell focused on factor mobility as the criterion for an optimum currency area. Unlike national economic shocks, which depend on the degree of monetary integration, factor mobility is invariant to monetary integration. In Australia physical capital is immobile because geological and climatic conditions account for the location of the mining industry and farming in the interior and north. Similarly, European monetary unification has no direct effect on language and cultural barriers that restrict labor mobility. Thus, anticipating the Lucas critique, Mundell concentrated on policy-invariant structural factors that are independent of monetary unification in his analysis of optimum currency areas.

The introduction of a single currency benefits international trade by reducing transaction and information costs. Until recently, it was taken for granted that international trade would expand only modestly, especially between developed countries, where it is easy to hedge the currency risk. Monetary economists ignored monetary unions because they believed that the welfare gain from enhanced international trade was outweighed by the welfare loss from the imposition of supranational monetary policy that would inevitably conflict with some national economic interests, at times. This consensus has recently been challenged by Rose (2000), Frankel and Rose (2002) and Glick and Rose (2002), who all argue that the trade effect of currency unions is large, perhaps tripling the size of trade between union members. This would greatly strengthen the case for monetary unification, but the size of the trade effect remains controversial. Persson (2001) points out that the original study of Rose (2000) is subject to selection bias. Aristotelous (2001), Flandreau (2001) and Thom and Walsh (2002) find that the formation and break-up of monetary unions in the 19th and 20th centuries did not give rise to significant trade effects.

Monetary integration encourages specialization, both between industries and across different stages of production in a single industry. Depending on the type of specialization, national business cycles become either more or less synchronized. The traditional view, which was recently restated by Krugman (1991, 1993), holds that national business cycles become more idiosyncratic because monetary integration enhances interindustry specialization, exposing countries to sectoral shocks. De Grauwe (1997) adopts the more optimistic view of the *Commission of the European Communities* (1992), which claims that monetary integration benefits mostly intraindustry trade. Then, the emergence of supranational industries would make national business cycles more uniform. Business cycles may also become more uniform because the end of national monetary policy removes a potential source of country-specific shocks. Clark and van Wincoop (2001) find that business cycles of US regions are more synchronized than those of European countries. They take this as evidence that monetary unification makes national business cycles more uniform, reducing the cost associated with the loss of national monetary policy. Studies of historical currency unions by Rose and Engel (2002) and Frankel and Rose (1998) also suggest that monetary integration makes national business cycles more uniform.

Like the *Reserve Bank of Australia*, the *European Central Bank* needs to know the impact of monetary policy on regional (national) economies. But the structural economic changes that occur when a monetary union is formed make it impossible to determine the regional transmission of monetary policy with macroeconomic data prior to the adoption of the euro. Today, only four years of data have accumulated since European monetary unification on January 1, 1999, and the upcoming eastward expansion of the EU will create new structural breaks.[11] The reliance on macroeconomic data from the 1980s and 90s to estimate fixed parameter values in VAR models is a serious flaw in the vast empirical literature on European monetary policy. For this reason, Ciccarelli and Rebucci (2002) employ a time-varying panel VAR in which "parameters of the [monetary] transmission mechanism differ both across countries and over time periods." This method captures the process of monetary integration within the sample period, but any pretence that parameter values will not be subject to further changes after the end of the sample period is purely speculative. The authors conjecture "that the transmission mechanism of monetary policy had already become relatively homogenous [across European countries] in the second part of the 1990s". The experience of existing monetary unions casts doubt upon their tacit assumption that a homogenous transmission mechanism will prevail forever in Europe.

An alternative approach, which is surprisingly little employed, investigates the operation of existing monetary unions. The United States, Canada and Australia are all large monetary unions with a federal political structure. Mundell (1961/68) used Canada to illustrate his arguments. Like Australia, Canada is a multiregional country in which capital is immobile. Carlino and DeFina (1999, 1998) find that American states respond differently to monetary policy, depending on the composition of their outputs. The Great Lakes region, the home of manufacturing, responds more strongly to monetary policy than the Rocky Mountains region, which produces primary goods. The Australian experience confirms that economic structure determines the responsiveness of state economies to monetary policy, but the ordering of industries is reversed. Monetary policy affects the eastern states, which specialize in services

[11] Ten countries – Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia – will join the EU on May 1, 2004. These countries will adopt the euro once they fulfill the Maastricht convergence criteria, which will take several years. Unlike Denmark and the United Kingdom, they do not have the right to opt out of the single currency.

and manufacturing, less strongly than the interior and north, which produce primary goods. This difference in the regional effects of monetary policy arises because in a large country – the United States – the primary monetary transmission channel is the interest rate, whereas in a small open economy – Australia – monetary policy is mostly transmitted through the exchange rate. US monetary policy affects the Great Lakes region more strongly than the Rocky Mountains because the demand for manufactures is more sensitive to interest rate changes than the demand for primary goods (Carlino and DeFina 1999, 1998). In Australia monetary policy induces exchange rate changes, which mainly affect the export of primary goods by the interior and north. The experiences of the United States and Australia show that macroeconomic relationships differ significantly between monetary unions; each monetary union requires careful consideration. Any conjecture that the effect of monetary policy has become relatively homogenous across European countries in the second part of the 1990s, and that it will stay this way, is surely premature.

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Appendix. Econometric Work

The software package RATS (version 5) was used for the econometric work.

```
* 1. Gross State Product
* ______________________

* 1.1. Correlations
* _________________

cal 1985 3 4
all 0 2002:1
open data
data(format=rats) 1985:3 2002:1 NSWGSP VICGSP QLDGSP SAGSP WAGSP TASGSP $
   NTGSP ACTGSP AUSGDP

* Datafile: STATEGDPQ.rat



* Data Transformations
* ____________________

* For each quarter the growth rate of a variable is computed over the preceding
* four quarters, using logarithmic differences. The prefix DLN is added to the
* name of each variable. For example, DLNNSWGSP is the four quarter growth rate
* of New South Wales GSP.

dofor i = NSWGSP VICGSP QLDGSP SAGSP WAGSP TASGSP NTGSP ACTGSP AUSGDP
   compute [label] logs = 'dln'+%l(i)
   set %s(logs) = log(i{0})-log(i{4})
end dofor i

* Four observations are lost because of the transformation of level data into
* four-quarter growth rates.



* Correlation Matrix of Gross State Products (Growth Rates)
* _________________________________________________________

* The table command produces some basic statistics for each time series.

table / DLNNSWGSP DLNVICGSP DLNQLDGSP DLNSAGSP DLNWAGSP DLNTASGSP DLNNTGSP $
   DLNACTGSP DLNAUSGDP

Series             Obs       Mean         Std Error      Minimum        Maximum
DLNNSWGSP            63  0.0337420121  0.0167542480 -0.0156481115  0.0664020203
DLNVICGSP            63  0.0305035241  0.0263153579 -0.0599765807  0.0845704469
DLNQLDGSP            63  0.0440276493  0.0237957278 -0.0368240960  0.0961282709
DLNSAGSP             63  0.0193367936  0.0250852369 -0.0320373769  0.0760541448
DLNWAGSP             63  0.0428561032  0.0348871955 -0.0634451910  0.1076162742
DLNTASGSP            63  0.0119574532  0.0251971835 -0.0421001810  0.0635508125
DLNNTGSP             63  0.0444892851  0.0714243098 -0.0893463640  0.1790375353
DLNACTGSP            63  0.0268743510  0.0489344791 -0.1369762395  0.1157696989
DLNAUSGDP            63  0.0338100322  0.0169384582 -0.0112032263  0.0609396534
```

```
* The cmom command produces the correlation matrix of the growth rates of GSP
* between different states.

cmom(corr,matrix=cormatrix,print) 1986:3 2002:1
# DLNNSWGSP DLNVICGSP DLNQLDGSP DLNSAGSP DLNWAGSP DLNTASGSP DLNNTGSP DLNACTGSP

Correlation Matrix
Quarterly Data From 1986:03 To 2002:01
              DLNNSWGSP      DLNVICGSP      DLNQLDGSP      DLNSAGSP
DLNNSWGSP  1.00000000000  0.67317993852  0.33051571524  0.45574100222
DLNVICGSP  0.67317993852  1.00000000000  0.50595378889  0.40011058104
DLNQLDGSP  0.33051571524  0.50595378889  1.00000000000  0.30397024244
DLNSAGSP   0.45574100222  0.40011058104  0.30397024244  1.00000000000
DLNWAGSP   0.34977857790  0.10533731202  0.47135721709  0.36318461167
DLNTASGSP  0.12782997444  0.28905225642  0.27463724028  0.14460829741
DLNNTGSP   0.20604950239  0.22976842825  0.11252686828  0.28101878395
DLNACTGSP  0.13446273164  0.22873776617  0.10602144997  0.07327441946


              DLNWAGSP       DLNTASGSP      DLNNTGSP       DLNACTGSP
DLNNSWGSP  0.34977857790  0.12782997444  0.20604950239  0.13446273164
DLNVICGSP  0.10533731202  0.28905225642  0.22976842825  0.22873776617
DLNQLDGSP  0.47135721709  0.27463724028  0.11252686828  0.10602144997
DLNSAGSP   0.36318461167  0.14460829741  0.28101878395  0.07327441946
DLNWAGSP   1.00000000000  0.18118660440  0.20610470214 -0.00828098728
DLNTASGSP  0.18118660440  1.00000000000  0.21720777861 -0.03622642152
DLNNTGSP   0.20610470214  0.21720777861  1.00000000000  0.04999479352
DLNACTGSP -0.00828098728 -0.03622642152  0.04999479352  1.00000000000



* Correlation Between GSP and GSP Outside of a State (Growth Rates)
* _________________________________________________________________


* This section computes the correlation between the growth rate of GSP in a
* single state and all other states. Note that GSP outside of the state is
* used and not total Australian GDP. The correlation between GSP in a single
* state and Australian GDP would be distorted because a large state accounts
* for a big share of GDP.

* (AUSGDP{0}-i{0}) is Australian GDP minus GSP in state i. The set command
* computes the four-quarter growth rate of this quantity. The compute command
* adds the prefix AUSADJ to each time series. For example, AUSADJNSWGSP is
* Australian GDP minus New South Wales GSP.

dofor i = NSWGSP VICGSP QLDGSP SAGSP WAGSP TASGSP NTGSP ACTGSP
   compute [label] adjust = 'ausadj'+%l(i)
   set %s(adjust) = log(AUSGDP{0}-i{0})-log(AUSGDP{4}-i{4})
end dofor i

* The cross command yields the correlation between the growth rate of GSP in a
* single state and the growth rate of Australian GDP outside of that state.

cross DLNNSWGSP AUSADJNSWGSP 1986:3 2002:1 0 0
Cross Correlations of Series DLNNSWGSP and AUSADJNSWGSP
Quarterly Data From 1986:03 To 2002:01
     0: 0.67087155
```

```
cross DLNVICGSP AUSADJVICGSP 1986:3 2002:1 0 0
Cross Correlations of Series DLNVICGSP and AUSADJVICGSP
Quarterly Data From 1986:03 To 2002:01
     0: 0.64479943

cross DLNQLDGSP AUSADJQLDGSP 1986:3 2002:1 0 0
Cross Correlations of Series DLNQLDGSP and AUSADJQLDGSP
Quarterly Data From 1986:03 To 2002:01
     0: 0.54212152

cross DLNSAGSP AUSADJSAGSP 1986:3 2002:1 0 0
Cross Correlations of Series DLNSAGSP and AUSADJSAGSP
Quarterly Data From 1986:03 To 2002:01
     0: 0.52027256
     0: 0.52027256

cross DLNWAGSP AUSADJWAGSP 1986:3 2002:1 0 0
Cross Correlations of Series DLNWAGSP and AUSADJWAGSP
Quarterly Data From 1986:03 To 2002:01
     0: 0.34820396

cross DLNTASGSP AUSADJTASGSP 1986:3 2002:1 0 0
Cross Correlations of Series DLNTASGSP and AUSADJTASGSP
Quarterly Data From 1986:03 To 2002:01
     0: 0.28923549

cross DLNNTGSP AUSADJNTGSP 1986:3 2002:1 0 0
Cross Correlations of Series DLNNTGSP and AUSADJNTGSP
Quarterly Data From 1986:03 To 2002:01
     0: 0.27130432

cross DLNACTGSP AUSADJACTGSP 1986:3 2002:1 0 0
Cross Correlations of Series DLNACTGSP and AUSADJACTGSP
Quarterly Data From 1986:03 To 2002:01
     0: 0.17187957



* 1.2. HP-Filter
* ______________


* This section studies the joint dynamics of Gross State Product in New
* South Wales, Victoria, Queensland, South Australia and Western Australia.
* The Hodrick-Prescott filter is used to detrend variables.

* Use clear program in the file menu.

cal 1984 3 4
allocate 2002:1
open data
data(format=rats) 1984:3 2002:1 NSWGSP VICGSP QLDGSP SAGSP WAGSP AUSCPI $
   AUSM1 USCPI USINT USGDP

* Datafile: STATEGDPQ.rat
```

```
* Data Transformations
* ____________________


* Compute the logarithm of each time series (except for the US interest rate)
* and add the prefix LN to the series names.

dofor i = NSWGSP VICGSP QLDGSP SAGSP WAGSP AUSCPI AUSM1 USCPI USGDP
   compute [label] logs = 'ln'+%l(i)
   set %s(logs) = log(i{0})
end dofor i

* Compute the US inflation rate and US real interest rate. Create a trend
* series.

set USINFL = (LNUSCPI - LNUSCPI{4})*100
set USRINT = USINT - USINFL

set TREND = T

* The source command initiates the HP filter.

source(noecho) hpfilter.src

* The dofor loop computes the trend and the cyclical component for each
* variable, except the US interest rate. @hpfilter calls up the HP-filter.
* %s creates the trend series, which is saved with the prefix G (Growth). For
* example, GLNNSWGSP is the trend of New South Wales GDP. (j{0}-%s(growth))
* is the cyclical component, for which the prefix C is used. The dofor loop
* draws a graph for each series, showing the trend and series.

dofor j = LNNSWGSP LNVICGSP LNQLDGSP LNSAGSP LNWAGSP LNAUSCPI LNAUSM1 $
   LNUSCPI LNUSGDP
   compute [label] growth = 'G'+%l(j)
   @hpfilter j / %s(growth)
   compute [label] cycle = 'C'+%l(j)
   set %s(cycle) = j{0} - %s(growth)
   graph(header=%l(j)) 2
   # j
   # %s(growth)
end dofor j

* Draw graphs showing the cyclical component.

dofor k = CLNNSWGSP CLNVICGSP CLNQLDGSP CLNSAGSP CLNWAGSP CLNAUSCPI $
   CLNAUSM1 CLNUSCPI CLNUSGDP
   graph(header=%l(k)) 1
   # k
end dofor k



* SUR Estimation
* ______________


* A nine equation model is estimated with SUR. Note that the regressors differ
* across equations, including different variables and lags.
```

```
compute neqn  = 9
compute nlags = 2

equation usgdpeq CLNUSGDP
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags}
equation usrinteq USRINT
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags}
equation auscpieq CLNAUSCPI
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWGSP{1 to nlags} CLNVICGSP{1 to nlags} CLNQLDGSP{1 to nlags} $
  CLNSAGSP{1 to nlags} CLNWAGSP{1 to nlags} CLNAUSM1{1 to nlags}
equation nswgspeq CLNNSWGSP
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWGSP{1 to nlags} CLNVICGSP{1 to nlags} CLNQLDGSP{1 to nlags} $
  CLNSAGSP{1 to nlags} CLNWAGSP{1 to nlags} CLNAUSM1{1 to nlags}
equation vicgspeq CLNVICGSP
# CONSTANT CLNUSGDP{1 to nlags+1} USRINT{1 to nlags+1} CLNAUSCPI{1 to nlags+1} $
  CLNNSWGSP{1 to nlags+1} CLNVICGSP{1 to nlags+1} CLNQLDGSP{1 to nlags+1} $
  CLNSAGSP{1 to nlags+1} CLNWAGSP{1 to nlags+1} CLNAUSM1{1 to nlags+1}
equation qldgspeq CLNQLDGSP
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWGSP{1 to nlags} CLNVICGSP{1 to nlags} CLNQLDGSP{1 to nlags} $
  CLNSAGSP{1 to nlags} CLNWAGSP{1 to nlags} CLNAUSM1{1 to nlags}
equation sagspeq CLNSAGSP
# CONSTANT CLNUSGDP{1 to nlags+1} USRINT{1 to nlags+1} CLNAUSCPI{1 to nlags+1} $
  CLNNSWGSP{1 to nlags+1} CLNVICGSP{1 to nlags+1} CLNQLDGSP{1 to nlags+1} $
  CLNSAGSP{1 to nlags+1} CLNWAGSP{1 to nlags+1} CLNAUSM1{1 to nlags+1}
equation wagspeq CLNWAGSP
# CONSTANT CLNUSGDP{1 to nlags+1} USRINT{1 to nlags+1} CLNAUSCPI{1 to nlags+1} $
  CLNNSWGSP{1 to nlags+1} CLNVICGSP{1 to nlags+1} CLNQLDGSP{1 to nlags+1} $
  CLNSAGSP{1 to nlags+1} CLNWAGSP{1 to nlags+1} CLNAUSM1{1 to nlags+1}
equation ausm1eq CLNAUSM1
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWGSP{1 to nlags} CLNVICGSP{1 to nlags} CLNQLDGSP{1 to nlags} $
  CLNSAGSP{1 to nlags} CLNWAGSP{1 to nlags} CLNAUSM1{1 to nlags}

* The sur command performs a seemingly unrelated regression estimation. The
* residuals of each equation are saved for diagnostic checks. For example,
* USGDPEQRES is the residual series of the equation with USGDP as dependent
* variable.

sur(noprint) neqn
# usgdpeq USGDPEQRES
# usrinteq USRINTEQRES
# auscpieq AUSCPIEQRES
# nswgspeq NSWGSPEQRES
# vicgspeq VICGSPEQRES
# qldgspeq QLDGSPEQRES
# sagspeq SAGSPEQRES
# wagspeq WAGSPEQRES
# ausm1eq AUSM1EQRES
```

```
Covariance\Correlation Matrix of Residuals
             CLNUSGDP        USRINT       CLNAUSCPI      CLNNSWGSP
CLNUSGDP   0.00002126041   0.2107317514  -0.2481211583   0.3469643239
USRINT     0.00042999622  0.19583828162  -0.0522969353  -0.0217400976
CLNAUSCPI -0.00000580793 -0.00011748881  0.00002577169   0.0348033647
CLNNSWGSP  0.00001029610 -0.00006191735  0.00000113709  0.00004141943
CLNVICGSP  0.00001086396 -0.00040728729  0.00000108983  0.00002211536
CLNQLDGSP  0.00001395017 -0.00034435488 -0.00000263835  0.00000069317
CLNSAGSP   0.00000084871 -0.00091594512 -0.00000653760  0.00000268115
CLNWAGSP  -0.00000649331 -0.00207105988 -0.00000265177  0.00001215793
CLNAUSM1   0.00002385482  0.00095499369 -0.00002435299  0.00000197851


             CLNVICGSP      CLNQLDGSP      CLNSAGSP       CLNWAGSP
CLNUSGDP    0.3086256633   0.3440430126   0.0214916269  -0.1300435076
USRINT     -0.1205540719  -0.0884864039  -0.2416676610  -0.4321676619
CLNAUSCPI   0.0281200509  -0.0590989509  -0.1503643262  -0.0482361583
CLNNSWGSP   0.4501132484   0.0122477592   0.0486426209   0.1744479800
CLNVICGSP  0.00005828279   0.0753090724   0.1260492689  -0.1700305970
CLNQLDGSP  0.00000505590  0.00007733246   0.1233019241   0.1016925317
CLNSAGSP   0.00000824162  0.00000928652  0.00007335070  -0.1138636275
CLNWAGSP  -0.00001405688  0.00000968415 -0.00001056036  0.00011726899
CLNAUSM1   0.00001492290  0.00002968400  0.00001231868 -0.00003063492


             CLNAUSM1
CLNUSGDP    0.3438867864
USRINT      0.1434421710
CLNAUSCPI  -0.3188642927
CLNNSWGSP   0.0204343936
CLNVICGSP   0.1299296091
CLNQLDGSP   0.2243709432
CLNSAGSP    0.0956064130
CLNWAGSP   -0.1880400089
CLNAUSM1   0.00022633396



* Impulse Responses
* _________________


* This part of the program computes impulse responses and it graphs them. The
* code is the same as in Example 10.3 in the RATS User's Guide (Version 5) with
* some adjustments.

declare rect[series] impblk(neqn,neqn)
declare vect[series] noscaled(neqn)
declare vect[strings] implabel(neqn)

compute implabel=|| $
  'USRGDP',$
  'USRINT',$
  'AUSCPI',$
  'NSWGSP',$
  'VICGSP',$
  'QLDGSP',$
  'SAGSP',$
  'WAGSP',$
  'AUSM1'||
```

```
compute  nsteps = 24
list ieqn = 1 to neqn
smpl 1 nsteps

impulse(results=impblk,noprint) neqn nsteps * %sigma
# usgdpeq
# usrinteq
# auscpieq
# nswgspeq
# vicgspeq
# qldgspeq
# sagspeq
# wagspeq
# ausm1eq

do i=1,neqn
  compute header='Plot of Responses to '+implabel(i)
  do j=1,neqn
     set noscaled(j) = (impblk(j,i))*100
  end do j
  graph(header=header,key=below,klabels=implabel,number=0, $
  window='TO_'+implabel(i),max=0.8,min=-0.4) neqn
  cards noscaled(ieqn)
end do i

do i=1,neqn
  compute header='Plot of Responses of '+implabel(i)
  graph(header=header,key=below,klabels=implabel,number=0, $
  window='OF_'+implabel(i)) neqn
  cards impblk(i,ieqn)
end do i

* Unlike in Example 10.3, the graphs show unscaled impulse responses. The
* impulse responses of logarithmic variables are percent changes. Since the
* US interest rate is nonlogarithmic, changes are percentage points.



* Lagrange Multiplier Test of the Matrix of Residuals
* ___________________________________________________


* SUR produces an efficiency gain only if the equations of the model contain
* different regressors (see above) and the residuals of the equations are
* correlated. Here, the second condition is tested.

* Breusch and Pagan (1980) propose a Lagrange multiplier test. The null
* hypothesis is that the residuals are contemporaneously uncorrelated across
* equations. Rejection of the null hypothesis suggests that SUR increases the
* efficiency of estimates.

* Smpl clears the sample command that was set in the preceding section.

smpl

declare rect corrmx(neqn,neqn)
ewise corrmx(i,j)=%sigma(i,j)/(%sigma(i,i)*%sigma(j,j))**0.5
display corrmx
```

```
 1.00000  0.21073 -0.24812  0.34696  0.30863  0.34404  0.02149 -0.13004  0.34389
 0.21073  1.00000 -0.05230 -0.02174 -0.12055 -0.08849 -0.24167 -0.43217  0.14344
-0.24812 -0.05230  1.00000  0.03480  0.02812 -0.05910 -0.15036 -0.04824 -0.31886
 0.34696 -0.02174  0.03480  1.00000  0.45011  0.01225  0.04864  0.17445  0.02043
 0.30863 -0.12055  0.02812  0.45011  1.00000  0.07531  0.12605 -0.17003  0.12993
 0.34404 -0.08849 -0.05910  0.01225  0.07531  1.00000  0.12330  0.10169  0.22437
 0.02149 -0.24167 -0.15036  0.04864  0.12605  0.12330  1.00000 -0.11386  0.09561
-0.13004 -0.43217 -0.04824  0.17445 -0.17003  0.10169 -0.11386  1.00000 -0.18804
 0.34389  0.14344 -0.31886  0.02043  0.12993  0.22437  0.09561 -0.18804  1.00000

declare rect corrsq(neqn,neqn)
ewise corrsq(i,j)=corrmx(i,j)**2

display bp=%nobs*(%sum(corrsq)-neqn)/2
     91.88468

declare integer dgf

display dgf=neqn*(neqn-1)/2
36

cdf chisqr bp dgf
Chi-Squared(36)=     91.884677 with Significance Level 0.00000088


* The null hypothesis that there is no correlation between the residuals
* across equations is rejected.



* Lagrange Multiplier Test for Serial Correlation
* _______________________________________________


* In this section the residuals of each equation are tested for serial
* correlation. Godfrey (1978) and Breusch (1978) propose a Lagrange multiplier
* test. The null hypothesis is that there is no serial correlation.

* See also Green (2000), p. 542.

* The following dofor loop produces graphs of residuals.

dofor i = USGDPEQRES USRINTEQRES AUSCPIEQRES NSWGSPEQRES VICGSPEQRES $
    QLDGSPEQRES SAGSPEQRES WAGSPEQRES AUSM1EQRES
    graph(header=%l(i)) 1
    # i
end dofor i

* The LM test is implemented by regressing the residuals of each equation
* on the regressors and lagged residuals of that equation. Two lags of the
* residuals are included in the test. In all equations the null hypothesis
* that the coefficients on the lagged residuals are zero cannot be rejected.
* Therefore, the joint hypothesis that there is no first and second order
* serial correlation is accepted.

linreg(noprint) USGDPEQRES
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} USGDPEQRES{1 to nlags}
exclude
# USGDPEQRES{1 to nlags}
```

```
Null Hypothesis : The Following Coefficients Are Zero
USGDPEQRES       Lag(s) 1 to 2
F(2,55)=      2.26661 with Significance Level 0.11326330

linreg(noprint) USRINTEQRES
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} USRINTEQRES{1 to nlags}
exclude
# USRINTEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
USRINTEQRES      Lag(s) 1 to 2
F(2,55)=      0.32771 with Significance Level 0.72197237

linreg(noprint) AUSCPIEQRES
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWGSP{1 to nlags} CLNVICGSP{1 to nlags} CLNQLDGSP{1 to nlags} $
  CLNSAGSP{1 to nlags} CLNWAGSP{1 to nlags} CLNAUSM1{1 to nlags} $
  AUSCPIEQRES{1 to nlags}
exclude
# AUSCPIEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
AUSCPIEQRES      Lag(s) 1 to 2
F(2,41)=      2.17271 with Significance Level 0.12680441
linreg(noprint) NSWGSPEQRES
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWGSP{1 to nlags} CLNVICGSP{1 to nlags} CLNQLDGSP{1 to nlags} $
  CLNSAGSP{1 to nlags} CLNWAGSP{1 to nlags} CLNAUSM1{1 to nlags} $
  NSWGSPEQRES{1 to nlags}
exclude
# NSWGSPEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
NSWGSPEQRES      Lag(s) 1 to 2
F(2,41)=      0.45402 with Significance Level 0.63822749

linreg(noprint) VICGSPEQRES
# CONSTANT CLNUSGDP{1 to nlags+1} USRINT{1 to nlags+1} CLNAUSCPI{1 to nlags+1} $
  CLNNSWGSP{1 to nlags+1} CLNVICGSP{1 to nlags+1} CLNQLDGSP{1 to nlags+1} $
  CLNSAGSP{1 to nlags+1} CLNWAGSP{1 to nlags+1} CLNAUSM1{1 to nlags+1} $
  VICGSPEQRES{1 to nlags}
exclude
# VICGSPEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
VICGSPEQRES      Lag(s) 1 to 2
F(2,32)=      0.17654 with Significance Level 0.83897424

linreg(noprint) QLDGSPEQRES
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWGSP{1 to nlags} CLNVICGSP{1 to nlags} CLNQLDGSP{1 to nlags} $
  CLNSAGSP{1 to nlags} CLNWAGSP{1 to nlags} CLNAUSM1{1 to nlags} $
  QLDGSPEQRES{1 to nlags}
exclude
# QLDGSPEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
QLDGSPEQRES      Lag(s) 1 to 2
F(2,41)=      0.72504 with Significance Level 0.49040870
```

```
linreg(noprint) SAGSPEQRES
# CONSTANT CLNUSGDP{1 to nlags+1} USRINT{1 to nlags+1} CLNAUSCPI{1 to nlags+1} $
  CLNNSWGSP{1 to nlags+1} CLNVICGSP{1 to nlags+1} CLNQLDGSP{1 to nlags+1} $
  CLNSAGSP{1 to nlags+1} CLNWAGSP{1 to nlags+1} CLNAUSM1{1 to nlags+1} $
  SAGSPEQRES{1 to nlags}
exclude
# SAGSPEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
SAGSPEQRES       Lag(s) 1 to 2
F(2,32)=      0.42463 with Significance Level 0.65764503

linreg(noprint) WAGSPEQRES
# CONSTANT CLNUSGDP{1 to nlags+1} USRINT{1 to nlags+1} CLNAUSCPI{1 to nlags+1} $
  CLNNSWGSP{1 to nlags+1} CLNVICGSP{1 to nlags+1} CLNQLDGSP{1 to nlags+1} $
  CLNSAGSP{1 to nlags+1} CLNWAGSP{1 to nlags+1} CLNAUSM1{1 to nlags+1} $
  WAGSPEQRES{1 to nlags}
exclude
# WAGSPEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
WAGSPEQRES       Lag(s) 1 to 2
F(2,32)=      0.91045 with Significance Level 0.41251349

linreg(noprint) AUSM1EQRES
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWGSP{1 to nlags} CLNVICGSP{1 to nlags} CLNQLDGSP{1 to nlags} $
  CLNSAGSP{1 to nlags} CLNWAGSP{1 to nlags} CLNAUSM1{1 to nlags} $
  AUSM1EQRES{1 to nlags}
exclude
# AUSM1EQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
AUSM1EQRES       Lag(s) 1 to 2
F(2,41)=      1.43261 with Significance Level 0.25038084


* Lag Length
* __________


* The Akaike (ACI) and Schwartz Bayesian Information (BIC) criteria are
* calculated.

* In addition, a likelihood ratio test is used with a degree of freedom
* correction that was proposed by Sims (1980). First, four lags are tested
* against three, then three against two, and then two against one. For
* simplicity, a VAR model is used in which each equation includes the same
* regressors and lags.


* ACI and BIC Information Criteria
* ________________________________


* The following do loop computes the ACI and BIC Criteria for VAR models
* with four, three, two and one lag (Example 10.1, RATS User's Guide,
* Version V).
```

```
* Fix the time period so that the progressive elimination of lags does not
* affect the sample period.

smpl 1986:3 2002:1

do lags=1,4
  system
  variables CLNUSGDP USRINT CLNAUSCPI CLNNSWGSP CLNVICGSP CLNQLDGSP $
  CLNSAGSP CLNWAGSP CLNAUSM1
  lags 1 to lags
  DET CONSTANT
  end(system)
  estimate(noprint)
  compute BIC=0.5*%nobs*%logdet+neqn*(neqn*lags+2)*log(%nobs)
  compute AIC=0.5*%nobs*%logdet+neqn*(neqn*lags+2)*2
  if lags==1
     display @4 'LAGS' @20 'AIC' @35 'BIC'
     display @5 #### LAGS @20 ####.#### AIC @35 BIC
end do lags
   LAGS            AIC            BIC
       1           -2279.3726     -2067.2022     <----- Minimum
       2           -2190.2474     -1804.4831
       3           -2105.4904     -1546.1322
       4           -2039.5775     -1306.6254
* AIC and BIC suggest a model with one lag. However, the coefficient of 0.5
* is often not included in the expressions for AIC and BIC. Without multiplying
* by 0.5, AIC suggests two lags, while BIC still suggests one.



* Four Against Three Lags
* _______________________


system
variables CLNUSGDP USRINT CLNAUSCPI CLNNSWGSP CLNVICGSP CLNQLDGSP CLNSAGSP $
CLNWAGSP CLNAUSM1
lags 1 to 4
det CONSTANT
end(system)

estimate(noprint,resids=RESIDS3)
compute logdetu=%logdet

system
variables CLNUSGDP USRINT CLNAUSCPI CLNNSWGSP CLNVICGSP CLNQLDGSP CLNSAGSP $
CLNWAGSP CLNAUSM1
lags 1 to 3
det CONSTANT
end(system)

estimate(noprint,resids=RESIDS2)
compute logdetr=%logdet

cdf chisqr (%nobs-37)*(logdetr-logdetu) 81
Chi-Squared(81)=     79.309994 with Significance Level 0.53236404

* The null hypothesis that the lag length is three (and not four) cannot be
* rejected.
```

```
* Three Against Two Lags
* _____________________


system
variables CLNUSGDP USRINT CLNAUSCPI CLNNSWGSP CLNVICGSP CLNQLDGSP CLNSAGSP $
CLNWAGSP CLNAUSM1
lags 1 to 3
det CONSTANT
end(system)

estimate(noprint,resids=RESIDS3)
compute logdetu=%logdet

system
variables CLNUSGDP USRINT CLNAUSCPI CLNNSWGSP CLNVICGSP CLNQLDGSP CLNSAGSP $
CLNWAGSP CLNAUSM1
lags 1 to 2
det CONSTANT
end(system)

estimate(noprint,resids=RESIDS2)
compute logdetr=%logdet

cdf chisqr (%nobs-28)*(logdetr-logdetu) 81
Chi-Squared(81)=     85.825553 with Significance Level 0.33577997

* The null hypothesis that the lag length is two (and not three) cannot be
* rejected.



* Two Against One Lag
* ___________________


system
variables CLNUSGDP USRINT CLNAUSCPI CLNNSWGSP CLNVICGSP CLNQLDGSP CLNSAGSP $
CLNWAGSP CLNAUSM1
lags 1 to 2
det CONSTANT
end(system)

estimate(noprint,resids=RESIDS3)
compute logdetu=%logdet

system
variables CLNUSGDP USRINT CLNAUSCPI CLNNSWGSP CLNVICGSP CLNQLDGSP CLNSAGSP $
CLNWAGSP CLNAUSM1
lags 1 to 1
det CONSTANT
end(system)

estimate(noprint,resids=RESIDS2)
compute logdetr=%logdet

cdf chisqr (%nobs-19)*(logdetr-logdetu) 81
Chi-Squared(81)=    101.793421 with Significance Level 0.05901860
```

```
* The null hypothesis that there is only one lag is rejected, suggesting a
* model with two lags.



* Four Against Two Lags
* _____________________


* Reducing the lag length sequentially from four to two suggests a model with
* two lags. But this does not necessarily imply that dropping lags four and
* three in one go does also support the hypothesis that there are only two
* lags. Here, two against four lags are tested.

system
variables CLNUSGDP USRINT CLNAUSCPI CLNNSWGSP CLNVICGSP CLNQLDGSP CLNSAGSP $
CLNWAGSP CLNAUSM1
lags 1 to 4
det CONSTANT
end(system)

estimate(noprint,resids=RESIDS3)
compute logdetu=%logdet

system
variables CLNUSGDP USRINT CLNAUSCPI CLNNSWGSP CLNVICGSP CLNQLDGSP CLNSAGSP $
CLNWAGSP CLNAUSM1
lags 1 to 2
det CONSTANT
end(system)

estimate(noprint,resids=RESIDS2)
compute logdetr=%logdet

cdf chisqr (%nobs-37)*(logdetr-logdetu) 162
Chi-Squared(162)=    143.066119 with Significance Level 0.85508242

* The null hypothesis of two lags cannot be rejected.



* 1.3. Trend Term
* _______________


* In this section each equation contains a trend term, except for the
* equation with the US interest rate as dependent variable.

* Section 1.2 includes detailed comments on the RATS program and econometric
* techniques. These comments are not repeated here.

* Use clear program in the file menu.

cal 1984 3 4
allocate 2002:1
open data
data(format=rats) 1984:3 2002:1 NSWGSP VICGSP QLDGSP SAGSP WAGSP AUSCPI $
   AUSM1 USCPI USINT USGDP

* Datafile: STATEGDPQ.rat
```

```
* Data Transformations
* ___________________


dofor i = NSWGSP VICGSP QLDGSP SAGSP WAGSP AUSCPI AUSM1 USCPI USGDP
   compute [label] logs = 'ln'+%l(i)
   set %s(logs) = log(i{0})
end dofor i

set USINFL = (LNUSCPI - LNUSCPI{4})*100
set USRINT = USINT - USINFL
set TREND = t



* SUR Estimation
* ______________


compute  neqn   = 9
compute  nlags  = 2

equation usgdpeq LNUSGDP
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags}
equation usrinteq USRINT
# CONSTANT LNUSGDP{1 to nlags} USRINT{1 to nlags}
equation auscpieq LNAUSCPI
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWGSP{1 to nlags} LNVICGSP{1 to nlags} LNQLDGSP{1 to nlags} $
  LNSAGSP{1 to nlags} LNWAGSP{1 to nlags} LNAUSM1{1 to nlags}
equation nswgspeq LNNSWGSP
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWGSP{1 to nlags} LNVICGSP{1 to nlags} LNQLDGSP{1 to nlags} $
  LNSAGSP{1 to nlags} LNWAGSP{1 to nlags} LNAUSM1{1 to nlags}
equation vicgspeq LNVICGSP
# CONSTANT TREND LNUSGDP{1 to nlags+1} USRINT{1 to nlags+1} $
  LNAUSCPI{1 to nlags+1} LNNSWGSP{1 to nlags+1} LNVICGSP{1 to nlags+1} $
  LNQLDGSP{1 to nlags+1} LNSAGSP{1 to nlags+1} LNWAGSP{1 to nlags+1} $
  LNAUSM1{1 to nlags+1}
equation qldgspeq LNQLDGSP
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWGSP{1 to nlags} LNVICGSP{1 to nlags} LNQLDGSP{1 to nlags} $
  LNSAGSP{1 to nlags} LNWAGSP{1 to nlags} LNAUSM1{1 to nlags}
equation sagspeq LNSAGSP
# CONSTANT TREND LNUSGDP{1 to nlags+1} USRINT{1 to nlags+1} $
  LNAUSCPI{1 to nlags+1} LNNSWGSP{1 to nlags+1} LNVICGSP{1 to nlags+1} $
  LNQLDGSP{1 to nlags+1} LNSAGSP{1 to nlags} LNWAGSP{1 to nlags+1} $
  LNAUSM1{1 to nlags+1}
equation wagspeq LNWAGSP
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWGSP{1 to nlags} LNVICGSP{1 to nlags} LNQLDGSP{1 to nlags} $
  LNSAGSP{1 to nlags} LNWAGSP{1 to nlags} LNAUSM1{1 to nlags}
equation ausm1eq LNAUSM1
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWGSP{1 to nlags} LNVICGSP{1 to nlags} LNQLDGSP{1 to nlags} $
  LNSAGSP{1 to nlags} LNWAGSP{1 to nlags} LNAUSM1{1 to nlags}
```

```
SUR(noprint) neqn
# usgdpeq USGDPEQRES
# usrinteq USRINTEQRES
# auscpieq AUSCPIEQRES
# nswgspeq NSWGSPEQRES
# vicgspeq VICGSPEQRES
# qldgspeq QLDGSPEQRES
# sagspeq SAGSPEQRES
# wagspeq WAGSPEQRES
# ausm1eq AUSM1EQRES


Covariance\Correlation Matrix of Residuals
              LNUSGDP        USRINT         LNAUSCPI       LNNSWGSP
LNUSGDP    0.00002465168  0.2132892034  -0.1540654333   0.4442612387
USRINT     0.00046165846  0.19004538033  0.0247293043   0.0968412319
LNAUSCPI  -0.00000388482  0.00005474979  0.00002579193  0.0204303973
LNNSWGSP   0.00001564878  0.00029950753  0.00000073610  0.00005033123
LNVICGSP   0.00001721440 -0.00033336689  0.00000223261  0.00002501162
LNQLDGSP   0.00001300156 -0.00047777979 -0.00000102183 -0.00000110589
LNSAGSP   -0.00000122594 -0.00070672598 -0.00000558936 -0.00000031393
LNWAGSP   -0.00000686965 -0.00123347532  0.00000363131  0.00000802629
LNAUSM1    0.00002720861  0.00066680094 -0.00002495472  0.00001657716


             LNVICGSP       LNQLDGSP        LNSAGSP         LNWAGSP
LNUSGDP     0.4178123191   0.2951383527  -0.0253053537  -0.1168995373
USRINT     -0.0921523462  -0.1235243287  -0.1661457382  -0.2390579322
LNAUSCPI    0.0529765616  -0.0226771408  -0.1127942030   0.0604119136
LNNSWGSP    0.4248499257  -0.0175689397  -0.0045349680   0.0955866785
LNVICGSP   0.00006886124   0.1100804450   0.0376720303  -0.2025058694
LNQLDGSP   0.00000810484  0.00007872148   0.1068941287   0.0209000050
LNSAGSP    0.00000305028  0.00000925409  0.00009520645  -0.1300047013
LNWAGSP   -0.00001988949  0.00000219478 -0.00001501381   0.00014008683
LNAUSM1    0.00002117094  0.00002385327  0.00000642471  -0.00005419783


              LNAUSM1
LNUSGDP     0.3683954390
USRINT      0.1028249776
LNAUSCPI   -0.3303253017
LNNSWGSP    0.1570805931
LNVICGSP    0.1715078074
LNQLDGSP    0.1807308779
LNSAGSP     0.0442640864
LNWAGSP    -0.3078324005
LNAUSM1    0.00022127780


* Impulse Responses
* _________________


declare rect[series] impblk(neqn,neqn)
declare vect[series] noscaled(neqn)
declare vect[strings] implabel(neqn)
```

```
compute implabel=|| $
  'USRGDP',$
  'USRINT',$
  'AUSCPI',$
  'NSWGSP',$
  'VICGSP',$
  'QLDGSP',$
  'SAGSP',$
  'WAGSP',$
  'AUSM1'||

compute  nsteps = 24
list ieqn = 1 to neqn
smpl 1 nsteps

impulse(results=impblk,noprint) neqn nsteps * %sigma
# usgdpeq
# usrinteq
# auscpieq
# nswgspeq
# vicgspeq
# qldgspeq
# sagspeq
# wagspeq
# ausm1eq

do i=1,neqn
  compute header='Plot of Responses to '+implabel(i)
  do j=1,neqn
     set noscaled(j) = (impblk(j,i))*100
  end do j
  graph(header=header,key=below,klabels=implabel,number=0, $
  window='TO_'+implabel(i),min=-0.4,max=0.8) neqn
  cards noscaled(ieqn)
end do i

do i=1,neqn
  compute header='Plot of Responses of '+implabel(i)
  graph(header=header,key=below,klabels=implabel,number=0, $
  window='OF_'+implabel(i)) neqn
  cards impblk(i,ieqn)
end do i



* Lagrange Multiplier Test of the Matrix of Residuals
* ___________________________________________________


* The null hypothesis is that the residuals are uncorrelated across equations.

smpl

declare rect corrmx(neqn,neqn)
ewise corrmx(i,j)=%sigma(i,j)/(%sigma(i,i)*%sigma(j,j))**0.5
```

```
display corrmx

 1.00000  0.21329 -0.15407  0.44426  0.41781  0.29514 -0.02531 -0.11690  0.36840
 0.21329  1.00000  0.02473  0.09684 -0.09215 -0.12352 -0.16615 -0.23906  0.10282
-0.15407  0.02473  1.00000  0.02043  0.05298 -0.02268 -0.11279  0.06041 -0.33033
 0.44426  0.09684  0.02043  1.00000  0.42485 -0.01757 -0.00453  0.09559  0.15708
 0.41781 -0.09215  0.05298  0.42485  1.00000  0.11008  0.03767 -0.20251  0.17151
 0.29514 -0.12352 -0.02268 -0.01757  0.11008  1.00000  0.10689  0.02090  0.18073
-0.02531 -0.16615 -0.11279 -0.00453  0.03767  0.10689  1.00000 -0.13000  0.04426
-0.11690 -0.23906  0.06041  0.09559 -0.20251  0.02090 -0.13000  1.00000 -0.30783
 0.36840  0.10282 -0.33033  0.15708  0.17151  0.18073  0.04426 -0.30783  1.00000

declare rect corrsq(neqn,neqn)
ewise corrsq(i,j)=corrmx(i,j)**2

display bp=%nobs*(%sum(corrsq)-neqn)/2
     89.17306

declare integer dgf

display dgf=neqn*(neqn-1)/2
36

cdf chisqr bp dgf
Chi-Squared(36)=     89.173055 with Significance Level 0.00000210



* Lagrange Multiplier Test for Serial Correlation
* _______________________________________________


* The null hypothesis is that there is no serial correlation.

dofor i = USGDPEQRES USRINTEQRES AUSCPIEQRES NSWGSPEQRES VICGSPEQRES $
    QLDGSPEQRES SAGSPEQRES WAGSPEQRES AUSM1EQRES
    graph(header=%l(i)) 1
    # i
end dofor i

linreg(noprint) USGDPEQRES
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} USGDPEQRES{1 to nlags}
exclude
# USGDPEQRES{1 to NLAGS}

Null Hypothesis : The Following Coefficients Are Zero
USGDPEQRES       Lag(s) 1 to 2
F(2,54)=      1.88878 with Significance Level 0.16111326

linreg(noprint) USRINTEQRES
# CONSTANT LNUSGDP{1 to nlags} USRINT{1 to nlags} USRINTEQRES{1 to nlags}
exclude
# USRINTEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
USRINTEQRES      Lag(s) 1 to 2
F(2,55)=      0.51795 with Significance Level 0.59861672
```

```
linreg(noprint) AUSCPIEQRES
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWGSP{1 to nlags} LNVICGSP{1 to nlags} LNQLDGSP{1 to nlags} $
  LNSAGSP{1 to nlags} LNWAGSP{1 to nlags} LNAUSM1{1 to nlags} $
  AUSCPIEQRES{1 to nlags}
exclude
# AUSCPIEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
AUSCPIEQRES      Lag(s) 1 to 2
F(2,40)=      1.18409 with Significance Level 0.31652159

linreg(noprint) NSWGSPEQRES
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWGSP{1 to nlags} LNVICGSP{1 to nlags} LNQLDGSP{1 to nlags} $
  LNSAGSP{1 to nlags} LNWAGSP{1 to nlags} LNAUSM1{1 to nlags} $
  NSWGSPEQRES{1 to nlags}
exclude
# NSWGSPEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
NSWGSPEQRES      Lag(s) 1 to 2
F(2,40)=      0.67296 with Significance Level 0.51587647

linreg(noprint) VICGSPEQRES
# CONSTANT TREND LNUSGDP{1 to nlags+1} USRINT{1 to nlags+1} LNAUSCPI{1 to
nlags+1} $
  LNNSWGSP{1 to nlags+1} LNVICGSP{1 to nlags+1} LNQLDGSP{1 to nlags+1} $
  LNSAGSP{1 to nlags+1} LNWAGSP{1 to nlags+1} LNAUSM1{1 to nlags+1} $
  VICGSPEQRES{1 to nlags+1}
exclude
# VICGSPEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
VICGSPEQRES      Lag(s) 1 to 2
F(2,29)=      1.51747 with Significance Level 0.23616925

linreg(noprint) QLDGSPEQRES
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWGSP{1 to nlags} LNVICGSP{1 to nlags} LNQLDGSP{1 to nlags} $
  LNSAGSP{1 to nlags} LNWAGSP{1 to nlags} LNAUSM1{1 to nlags} $
  QLDGSPEQRES{1 to nlags}
exclude
# QLDGSPEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
QLDGSPEQRES      Lag(s) 1 to 2
F(2,40)=      0.52432 with Significance Level 0.59596846

linreg(noprint) SAGSPEQRES
# CONSTANT TREND LNUSGDP{1 to nlags+1} USRINT{1 to nlags+1} LNAUSCPI{1 to
nlags+1} $
  LNNSWGSP{1 to nlags+1} LNVICGSP{1 to nlags+1} LNQLDGSP{1 to nlags+1} $
  LNSAGSP{1 to nlags+1} LNWAGSP{1 to nlags+1} LNAUSM1{1 to nlags+1} $
  SAGSPEQRES{1 to nlags+1}
exclude
# SAGSPEQRES{1 to nlags}
```

```
Null Hypothesis : The Following Coefficients Are Zero
SAGSPEQRES       Lag(s) 1 to 2
F(2,29)=      0.02874 with Significance Level 0.97170050

linreg(noprint) WAGSPEQRES
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWGSP{1 to nlags} LNVICGSP{1 to nlags} LNQLDGSP{1 to nlags} $
  LNSAGSP{1 to nlags} LNWAGSP{1 to nlags} LNAUSM1{1 to nlags} $
  WAGSPEQRES{1 to nlags}
exclude
# WAGSPEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
WAGSPEQRES       Lag(s) 1 to 2
F(2,40)=      1.50909 with Significance Level 0.23343232

linreg(noprint) AUSM1EQRES
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWGSP{1 to nlags} LNVICGSP{1 to nlags} LNQLDGSP{1 to nlags} $
  LNSAGSP{1 to nlags} LNWAGSP{1 to nlags} LNAUSM1{1 to nlags} $
  AUSM1EQRES{1 to nlags}

exclude
# AUSM1EQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
AUSM1EQRES       Lag(s) 1 to 2
F(2,40)=      1.98177 with Significance Level 0.15112923



* Lag Length
* __________


* ACI and BIC Information Criteria
* __________________________________


smpl 1986:3 2002:1

do lags=1,4
  system
  variables LNUSGDP USRINT LNAUSCPI LNNSWGSP LNVICGSP LNQLDGSP LNSAGSP $
  LNWAGSP LNAUSM1
  lags 1 to lags
  DET CONSTANT TREND
  end(system)
  estimate(noprint)
  compute BIC=0.5*%nobs*%logdet+neqn*(neqn*lags+2)*log(%nobs)
  compute AIC=0.5*%nobs*%logdet+neqn*(neqn*lags+2)*2
  if lags==1
     display @4 'LAGS' @20 'AIC' @35 'BIC'
     display @5 #### LAGS @20 ####.#### AIC @35 BIC
end do lags
   LAGS            AIC            BIC
       1           -2255.6379     -2043.4676   <-------- Minimum
       2           -2189.1273     -1803.3630
       3           -2096.7359     -1537.3777
       4           -2062.8785     -1329.9264
```

```
* Four Against Three Lags
* _______________________


* Likelihood ratio test with degrees of freedom correction (Sims 1980).

system
variables LNUSGDP USRINT LNAUSCPI LNNSWGSP LNVICGSP LNQLDGSP LNSAGSP $
LNWAGSP LNAUSM1
lags 1 to 4
det CONSTANT TREND
end(system)

estimate(noprint,resids=RESIDS3)
compute logdetu=%logdet

system
variables LNUSGDP USRINT LNAUSCPI LNNSWGSP LNVICGSP LNQLDGSP LNSAGSP $
LNWAGSP LNAUSM1
lags 1 to 3
det CONSTANT TREND
end(system)

estimate(noprint,resids=RESIDS2)
compute logdetr=%logdet

cdf chisqr (%nobs-38)*(logdetr-logdetu) 81
Chi-Squared(81)=    101.700487 with Significance Level 0.05976029

* The null hypothesis that the lag length is three (and not four)
* is rejected.



* Three Against Two Lags
* ______________________


system
variables LNUSGDP USRINT LNAUSCPI LNNSWGSP LNVICGSP LNQLDGSP LNSAGSP $
LNWAGSP LNAUSM1
lags 1 to 3
det CONSTANT TREND
end(system)

estimate(noprint,resids=RESIDS3)
compute logdetu=%logdet

system
variables LNUSGDP USRINT LNAUSCPI LNNSWGSP LNVICGSP LNQLDGSP LNSAGSP $
LNWAGSP LNAUSM1
lags 1 to 2
det CONSTANT TREND
end(system)

estimate(noprint,resids=RESIDS2)
compute logdetr=%logdet

cdf chisqr (%nobs-29)*(logdetr-logdetu) 81
Chi-Squared(81)=     75.133108 with Significance Level 0.66269850
```

```
* The null hypothesis that the lag length is two (and not three) cannot be
* rejected.


* Two Against One Lag
* ___________________

system
variables LNUSGDP USRINT LNAUSCPI LNNSWGSP LNVICGSP LNQLDGSP LNSAGSP $
LNWAGSP LNAUSM1
lags 1 to 2
det CONSTANT TREND
end(system)

estimate(noprint,resids=RESIDS3)
compute logdetu=%logdet
system
variables LNUSGDP USRINT LNAUSCPI LNNSWGSP LNVICGSP LNQLDGSP LNSAGSP $
LNWAGSP LNAUSM1
lags 1 to 1
det CONSTANT TREND
end(system)

estimate(noprint,resids=RESIDS2)
compute logdetr=%logdet

cdf chisqr (%nobs-20)*(logdetr-logdetu) 81
Chi-Squared(81)=    130.350585 with Significance Level 0.00042132

* The null hypothesis that there is only one lag can be rejected.


* Four Against Two Lags
* _____________________

system
variables LNUSGDP USRINT LNAUSCPI LNNSWGSP LNVICGSP LNQLDGSP LNSAGSP $
LNWAGSP LNAUSM1
lags 1 to 4
det CONSTANT TREND
end(system)

estimate(noprint,resids=RESIDS3)
compute logdetu=%logdet

system
variables LNUSGDP USRINT LNAUSCPI LNNSWGSP LNVICGSP LNQLDGSP LNSAGSP $
LNWAGSP LNAUSM1
lags 1 to 2
det CONSTANT TREND
end(system)

estimate(noprint,resids=RESIDS2)
compute logdetr=%logdet

cdf chisqr (%nobs-38)*(logdetr-logdetu) 162
Chi-Squared(162)=    156.945419 with Significance Level 0.59740650

* The null hypothesis of two lags cannot be rejected.
```

```
* 2. State Final Demand
* ____________________


* Sections 1.1. and 1.2 contain detailed comments on the RATS program and
* econometric techniques. These comments are not repeated here.

* Use clear program in the file menu.



* 2.1. Correlations
* ________________


cal 1985 3 4
all 0 2002:1
open data
data(format=rats) 1985:3 2002:1 NSWSFD VICSFD QLDSFD SASFD WASFD TASSFD $
   NTSFD ACTSFD

* Datafile: STATEGDPQ.RAT



* Data Transformations
* ___________________


dofor i = NSWSFD VICSFD QLDSFD SASFD WASFD TASSFD NTSFD ACTSFD
   compute [label] logs = 'dln'+%l(i)
   set %s(logs) = log(i{0})-log(i{4})
end dofor i



* Correlation Matrix of State Final Demands (Growth Rates)
* ________________________________________________________


table / DLNNSWSFD DLNVICSFD DLNQLDSFD DLNSASFD DLNWASFD DLNTASSFD DLNNTSFD $
   DLNACTSFD

Series              Obs       Mean        Std Error      Minimum       Maximum
DLNNSWSFD             63  0.0297534296  0.0267869984 -0.0284389394  0.0808560827
DLNVICSFD             63  0.0298227775  0.0327180456 -0.0679968384  0.0818849679
DLNQLDSFD             63  0.0398434647  0.0298203705 -0.0311643584  0.1116027596
DLNSASFD              63  0.0239337449  0.0277423860 -0.0261159507  0.0852369759
DLNWASFD              63  0.0336200903  0.0436259899 -0.0643634990  0.1100436702
DLNTASSFD             63  0.0172684949  0.0317638725 -0.0725169692  0.0985660222
DLNNTSFD              63  0.0266530405  0.0805047382 -0.1981207191  0.2985465127
DLNACTSFD             63  0.0409979855  0.0514388761 -0.1195832162  0.2236067645

cmom(corr,matrix=cormatrix,print) 1986:3 2002:1
# DLNNSWSFD DLNVICSFD DLNQLDSFD DLNSASFD DLNWASFD DLNTASSFD DLNNTSFD DLNACTSFD
```

```
Correlation Matrix
Quarterly Data From 1986:03 To 2002:01
              DLNNSWSFD      DLNVICSFD      DLNQLDSFD      DLNSASFD
DLNNSWSFD  1.00000000000  0.60968055753  0.53772272484  0.53642491305
DLNVICSFD  0.60968055753  1.00000000000  0.65961553114  0.42211372087
DLNQLDSFD  0.53772272484  0.65961553114  1.00000000000  0.40319273600
DLNSASFD   0.53642491305  0.42211372087  0.40319273600  1.00000000000
DLNWASFD   0.35891551241  0.53393546972  0.49221626236  0.33787593131
DLNTASSFD  0.31508827262  0.54608288571  0.49078977790  0.48594246258
DLNNTSFD   0.22184302972  0.29986975483  0.27500567275  0.21980915176
DLNACTSFD  0.15311117633  0.11907291376  0.25189076142  0.11429891124


              DLNWASFD       DLNTASSFD      DLNNTSFD       DLNACTSFD
DLNNSWSFD  0.35891551241  0.31508827262  0.22184302972  0.15311117633
DLNVICSFD  0.53393546972  0.54608288571  0.29986975483  0.11907291376
DLNQLDSFD  0.49221626236  0.49078977790  0.27500567275  0.25189076142
DLNSASFD   0.33787593131  0.48594246258  0.21980915176  0.11429891124
DLNWASFD   1.00000000000  0.32629653514  0.23739687411 -0.05287268791
DLNTASSFD  0.32629653514  1.00000000000  0.28974650179 -0.13732381466
DLNNTSFD   0.23739687411  0.28974650179  1.00000000000 -0.23778038604
DLNACTSFD -0.05287268791 -0.13732381466 -0.23778038604  1.00000000000


* Correlations Between State Final Demand and Final Demand Outside of a State
* ___________________________________________________________________________


set AUSFD = NSWSFD+VICSFD+QLDSFD+SASFD+WASFD+TASSFD+NTSFD+ACTSFD

dofor i = NSWSFD VICSFD QLDSFD SASFD WASFD TASSFD NTSFD ACTSFD
   compute [label] adjust = 'ausadj'+%l(i)
   set %s(adjust) = log(AUSFD{0}-i{0})-log(AUSFD{4}-i{4})
end dofor i

cross DLNNSWSFD AUSADJNSWSFD 1986:3 2002:1 0 0
Cross Correlations of Series DLNNSWSFD and AUSADJNSWSFD
Quarterly Data From 1986:03 To 2002:01
     0: 0.64785096
cross DLNVICSFD AUSADJVICSFD 1986:3 2002:1 0 0
Cross Correlations of Series DLNVICSFD and AUSADJVICSFD
Quarterly Data From 1986:03 To 2002:01
     0: 0.75002046

cross DLNQLDSFD AUSADJQLDSFD 1986:3 2002:1 0 0
Cross Correlations of Series DLNQLDSFD and AUSADJQLDSFD
Quarterly Data From 1986:03 To 2002:01
     0: 0.70427518

cross DLNSASFD AUSADJSASFD 1986:3 2002:1 0 0
Cross Correlations of Series DLNSASFD and AUSADJSASFD
Quarterly Data From 1986:03 To 2002:01
     0: 0.55334388

cross DLNWASFD AUSADJWASFD 1986:3 2002:1 0 0
Cross Correlations of Series DLNWASFD and AUSADJWASFD
Quarterly Data From 1986:03 To 2002:01
     0: 0.51673323
```

```
cross DLNTASSFD AUSADJTASSFD 1986:3 2002:1 0 0
Cross Correlations of Series DLNTASSFD and AUSADJTASSFD
Quarterly Data From 1986:03 To 2002:01
     0: 0.51931815

cross DLNNTSFD AUSADJNTSFD 1986:3 2002:1 0 0
Cross Correlations of Series DLNNTSFD and AUSADJNTSFD
Quarterly Data From 1986:03 To 2002:01
     0: 0.30354129
cross DLNACTSFD AUSADJACTSFD 1986:3 2002:1 0 0
Cross Correlations of Series DLNACTSFD and AUSADJACTSFD
Quarterly Data From 1986:03 To 2002:01
     0: 0.13894430



* 2.2. HP-Filter
* ______________


* In this section variables are detrended with the Hodrick-Prescott Filter,
* except for the US interest rate.

* Use clear program in the file menu.

cal 1984 3 4
allocate 2002:1
open data
data(format=rats) 1984:3 2002:1 NSWSFD VICSFD QLDSFD SASFD WASFD AUSCPI $
    AUSM1 USCPI USINT USGDP

* Datafile: STATEGDPQ.rat



* Data Transformations
* ____________________


dofor i = NSWSFD VICSFD QLDSFD SASFD WASFD AUSCPI AUSM1 USCPI USGDP
   compute [label] logs = 'ln'+%l(i)
   set %s(logs) = log(i{0})
end dofor i

set USINFL = (LNUSCPI - LNUSCPI{4})*100
set USRINT = USINT - USINFL
set TREND = T

source(noecho) hpfilter.src

dofor j = LNNSWSFD LNVICSFD LNQLDSFD LNSASFD LNWASFD LNAUSCPI LNAUSM1 $
   LNUSCPI LNUSGDP
   compute [label] growth = 'G'+%l(j)
   @hpfilter j / %s(growth)
   compute [label] cycle = 'C'+%l(j)
   set %s(cycle) = j{0} - %s(growth)
*   graph(header=%l(j)) 2
*   # j
*   # %s(growth)
end dofor j
```

```
dofor k = CLNNSWSFD CLNVICSFD CLNQLDSFD CLNSASFD CLNWASFD CLNAUSCPI CLNAUSM1 $
   CLNUSCPI CLNUSGDP
   graph(header=%l(k)) 1
   # k
end dofor k



* SUR Estimation
* ______________


compute neqn   = 9
compute nlags  = 1

equation usgdpeq CLNUSGDP
# CONSTANT CLNUSGDP{1 to nlags+1} USRINT{1 to nlags+1}
equation usrinteq USRINT
# CONSTANT CLNUSGDP{1 to nlags+1} USRINT{1 to nlags+1}
equation auscpieq CLNAUSCPI
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWSFD{1 to nlags} CLNVICSFD{1 to nlags} CLNQLDSFD{1 to nlags} $
  CLNSASFD{1 to nlags} CLNWASFD{1 to nlags} CLNAUSM1{1 to nlags}
equation nswsfdeq CLNNSWSFD
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWSFD{1 to nlags} CLNVICSFD{1 to nlags} CLNQLDSFD{1 to nlags} $
  CLNSASFD{1 to nlags} CLNWASFD{1 to nlags} CLNAUSM1{1 to nlags}
equation vicsfdeq CLNVICSFD
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWSFD{1 to nlags} CLNVICSFD{1 to nlags} CLNQLDSFD{1 to nlags} $
  CLNSASFD{1 to nlags} CLNWASFD{1 to nlags} CLNAUSM1{1 to nlags}
equation qldsfdeq CLNQLDSFD
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWSFD{1 to nlags} CLNVICSFD{1 to nlags} CLNQLDSFD{1 to nlags} $
  CLNSASFD{1 to nlags} CLNWASFD{1 to nlags} CLNAUSM1{1 to nlags}
equation sasfdeq CLNSASFD
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWSFD{1 to nlags} CLNVICSFD{1 to nlags} CLNQLDSFD{1 to nlags} $
  CLNSASFD{1 to nlags} CLNWASFD{1 to nlags} CLNAUSM1{1 to nlags}
equation wasfdeq CLNWASFD
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWSFD{1 to nlags} CLNVICSFD{1 to nlags} CLNQLDSFD{1 to nlags} $
  CLNSASFD{1 to nlags} CLNWASFD{1 to nlags} CLNAUSM1{1 to nlags}
equation ausm1eq CLNAUSM1
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWSFD{1 to nlags} CLNVICSFD{1 to nlags} CLNQLDSFD{1 to nlags} $
  CLNSASFD{1 to nlags} CLNWASFD{1 to nlags} CLNAUSM1{1 to nlags}

sur(noprint) neqn
# usgdpeq USGDPEQRES
# usrinteq USRINTEQRES
# auscpieq AUSCPIEQRES
# nswsfdeq NSWSFDEQRES
# vicsfdeq VICSFDEQRES
# qldsfdeq QLDSFDEQRES
# sasfdeq SASFDEQRES
# wasfdeq WASFDEQRES
# ausm1eq AUSM1EQRES
```

```
Covariance\Correlation Matrix of Residuals
              CLNUSGDP        USRINT        CLNAUSCPI      CLNNSWSFD
CLNUSGDP   0.00002094432   0.2085896663  -0.3603712166   0.3579521127
USRINT     0.00042188040  0.19531102937  -0.1111589569   0.1336346503
CLNAUSCPI -0.00000882573 -0.00026289063  0.00002863746  -0.0767701653
CLNNSWSFD  0.00001659016  0.00059810158 -0.00000416056  0.00010256164
CLNVICSFD  0.00003333755  0.00048977330 -0.00001856714  0.00006097427
CLNQLDSFD  0.00000641832 -0.00108638024 -0.00001927066  0.00003626791
CLNSASFD  -0.00000492663  0.00133908643 -0.00000985914  0.00005646818
CLNWASFD   0.00002320702  0.00079443096 -0.00002704801  0.00004627575
CLNAUSM1   0.00000827614  0.00071222623 -0.00000918405  0.00000960474


              CLNVICSFD      CLNQLDSFD       CLNSASFD       CLNWASFD
CLNUSGDP    0.5892258827   0.1183205490  -0.0798579263   0.3347945987
USRINT      0.0896423075  -0.2073913141   0.2247743597   0.1186820682
CLNAUSCPI  -0.2806461925  -0.3038094843  -0.1366699897  -0.3337032248
CLNNSWSFD   0.4870072282   0.3021358030   0.4136307694   0.3016847161
CLNVICSFD  0.00015284013   0.4766061414   0.1731389856   0.4184144632
CLNQLDSFD  0.00006984032  0.00014049337   0.1509034382   0.1194853570
CLNSASFD   0.00002885440  0.00002411157  0.00018171757   0.1776041394
CLNWASFD   0.00007834893  0.00002145113  0.00003626262  0.00022941158
CLNAUSM1   0.00003190049  0.00000791775 -0.00003906431  0.00008237766


              CLNAUSM1
CLNUSGDP    0.1201854912
USRINT      0.1071055893
CLNAUSCPI  -0.1140576660
CLNNSWSFD   0.0630304999
CLNVICSFD   0.1714889556
CLNQLDSFD   0.0443947365
CLNSASFD   -0.1925924412
CLNWASFD    0.3614592644
CLNAUSM1   0.00022640441



* Impulse Responses
* _________________


declare rect[series] impblk(neqn,neqn)
declare vect[series] noscaled(neqn)
declare vect[strings] implabel(neqn)

compute implabel=|| $
   'USRGDP',$
   'USRINT',$
   'AUSCPI',$
   'NSWSFD',$
   'VICSFD',$
   'QLDSFD',$
   'SASFD',$
   'WASFD',$
   'AUSM1'||

compute  nsteps = 24
list ieqn = 1 to neqn
smpl 1 nsteps
```

```
impulse(results=impblk,noprint) neqn nsteps * %sigma
# usgdpeq
# usrinteq
# auscpieq
# nswsfdeq
# vicsfdeq
# qldsfdeq
# sasfdeq
# wasfdeq
# ausm1eq

do i=1,neqn
  compute header='Plot of Responses to '+implabel(i)
  do j=1,neqn
     set noscaled(j) = (impblk(j,i))*100
  end do j
  graph(header=header,key=below,klabels=implabel,number=0, $
  window='TO_'+implabel(i),min=-0.4,max=0.8) neqn
  cards noscaled(ieqn)
end do i

do i=1,neqn
  compute header='Plot of Responses of '+implabel(i)
  graph(header=header,key=below,klabels=implabel,number=0, $
  window='OF_'+implabel(i)) neqn
  cards impblk(i,ieqn)
end do i



* Lagrange Multiplier Test of the Matrix of Residuals
* ___________________________________________________


* The null hypothesis is that the residuals are uncorrelated across equations.

smpl

declare rect corrmx(neqn,neqn)
ewise corrmx(i,j)=%sigma(i,j)/(%sigma(i,i)*%sigma(j,j))**0.5

display corrmx
 1.00000  0.20859 -0.36037  0.35795  0.58923  0.11832 -0.07986  0.33479  0.12019
 0.20859  1.00000 -0.11116  0.13363  0.08964 -0.20739  0.22477  0.11868  0.10711
-0.36037 -0.11116  1.00000 -0.07677 -0.28065 -0.30381 -0.13667 -0.33370 -0.11406
 0.35795  0.13363 -0.07677  1.00000  0.48701  0.30214  0.41363  0.30168  0.06303
 0.58923  0.08964 -0.28065  0.48701  1.00000  0.47661  0.17314  0.41841  0.17149
 0.11832 -0.20739 -0.30381  0.30214  0.47661  1.00000  0.15090  0.11949  0.04439
-0.07986  0.22477 -0.13667  0.41363  0.17314  0.15090  1.00000  0.17760 -0.19259
 0.33479  0.11868 -0.33370  0.30168  0.41841  0.11949  0.17760  1.00000  0.36146
 0.12019  0.10711 -0.11406  0.06303  0.17149  0.04439 -0.19259  0.36146  1.00000

declare rect corrsq(neqn,neqn)
ewise corrsq(i,j)=corrmx(i,j)**2

display bp=%nobs*(%sum(corrsq)-neqn)/2
    166.88118

declare integer dgf
```

```
display dgf=neqn*(neqn-1)/2
36

cdf chisqr bp dgf
Chi-Squared(36)=    166.881180 with Significance Level 0.00000000



* Lagrange Multiplier Test for Serial Correlation
* _______________________________________________


* The null hypothesis is that there is no serial correlation.

dofor i = USGDPEQRES USRINTEQRES AUSCPIEQRES NSWSFDEQRES VICSFDEQRES $
    QLDSFDEQRES SASFDEQRES WASFDEQRES AUSM1EQRES
    graph(header=%l(i)) 1
    # i
end dofor i

linreg(noprint) USGDPEQRES
# CONSTANT CLNUSGDP{1 to nlags+1} USRINT{1 to nlags+1} USGDPEQRES{1 to nlags+1}
exclude
# USGDPEQRES{1 to nlags+1}

Null Hypothesis : The Following Coefficients Are Zero
USGDPEQRES       Lag(s) 1 to 2
F(2,56)=      2.25009 with Significance Level 0.11483590

linreg(noprint) USRINTEQRES
# CONSTANT CLNUSGDP{1 to nlags+1} USRINT{1 to nlags+1} USRINTEQRES{1 to nlags+1}
exclude
# USRINTEQRES{1 to nlags+1}

Null Hypothesis : The Following Coefficients Are Zero
USRINTEQRES      Lag(s) 1 to 2
F(2,56)=      0.28054 with Significance Level 0.75643424

linreg(noprint) AUSCPIEQRES
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWSFD{1 to nlags} CLNVICSFD{1 to nlags} CLNQLDSFD{1 to nlags} $
  CLNSASFD{1 to nlags} CLNWASFD{1 to nlags} CLNAUSM1{1 to nlags} $
  AUSCPIEQRES{1 to nlags+1}
exclude
# AUSCPIEQRES{1 to nlags+1}

Null Hypothesis : The Following Coefficients Are Zero
AUSCPIEQRES      Lag(s) 1 to 2
F(2,51)=      0.58714 with Significance Level 0.55963040

linreg(noprint) NSWSFDEQRES
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWSFD{1 to nlags} CLNVICSFD{1 to nlags} CLNQLDSFD{1 to nlags} $
  CLNSASFD{1 to nlags} CLNWASFD{1 to nlags} CLNAUSM1{1 to nlags} $
  NSWSFDEQRES{1 to nlags+1}
exclude
# NSWSFDEQRES{1 to nlags+1}
```

```
Null Hypothesis : The Following Coefficients Are Zero
NSWSFDEQRES      Lag(s) 1 to 2
F(2,51)=      0.19521 with Significance Level 0.82327530

linreg(noprint) VICSFDEQRES
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWSFD{1 to nlags} CLNVICSFD{1 to nlags} CLNQLDSFD{1 to nlags} $
  CLNSASFD{1 to nlags} CLNWASFD{1 to nlags} CLNAUSM1{1 to nlags} $
  VICSFDEQRES{1 to nlags+1}
exclude
# VICSFDEQRES{1 to nlags+1}

Null Hypothesis : The Following Coefficients Are Zero
VICSFDEQRES      Lag(s) 1 to 2
F(2,51)=      0.85729 with Significance Level 0.43033463

linreg(noprint) QLDSFDEQRES
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWSFD{1 to nlags} CLNVICSFD{1 to nlags} CLNQLDSFD{1 to nlags} $
  CLNSASFD{1 to nlags} CLNWASFD{1 to nlags} CLNAUSM1{1 to nlags} $
  QLDSFDEQRES{1 to nlags+1}
exclude
# QLDSFDEQRES{1 to nlags+1}

Null Hypothesis : The Following Coefficients Are Zero
QLDSFDEQRES      Lag(s) 1 to 2
F(2,51)=      0.06260 with Significance Level 0.93939015

linreg(noprint) SASFDEQRES
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWSFD{1 to nlags} CLNVICSFD{1 to nlags} CLNQLDSFD{1 to nlags} $
  CLNSASFD{1 to nlags} CLNWASFD{1 to nlags} CLNAUSM1{1 to nlags} $
  SASFDEQRES{1 to nlags+1}
exclude
# SASFDEQRES{1 to nlags+1}

Null Hypothesis : The Following Coefficients Are Zero
SASFDEQRES       Lag(s) 1 to 2
F(2,51)=      0.14714 with Significance Level 0.86353949

linreg(noprint) WASFDEQRES
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWSFD{1 to nlags} CLNVICSFD{1 to nlags} CLNQLDSFD{1 to nlags} $
  CLNSASFD{1 to nlags} CLNWASFD{1 to nlags} CLNAUSM1{1 to nlags} $
  WASFDEQRES{1 to nlags+1}
exclude
# WASFDEQRES{1 to nlags+1}

Null Hypothesis : The Following Coefficients Are Zero
WASFDEQRES       Lag(s) 1 to 2
F(2,51)=      0.51216 with Significance Level 0.60224955

linreg(noprint) AUSM1EQRES
# CONSTANT CLNUSGDP{1 to nlags} USRINT{1 to nlags} CLNAUSCPI{1 to nlags} $
  CLNNSWSFD{1 to nlags} CLNVICSFD{1 to nlags} CLNQLDSFD{1 to nlags} $
  CLNSASFD{1 to nlags} CLNWASFD{1 to nlags} CLNAUSM1{1 to nlags} $
  AUSM1EQRES{1 to nlags+1}
exclude
# AUSM1EQRES{1 to nlags+1}
```

```
Null Hypothesis : The Following Coefficients Are Zero
AUSM1EQRES       Lag(s) 1 to 2
F(2,51)=      0.06541 with Significance Level 0.93676244



* Lag Length
* __________


* AIC and BIC Information Criteria
* ________________________________


smpl 1986:3 2002:1

do lags=1,4
  system
  variables CLNUSGDP USRINT CLNAUSCPI CLNNSWSFD CLNVICSFD CLNQLDSFD $
  CLNSASFD CLNWASFD CLNAUSM1
  lags 1 to lags
  DET CONSTANT
  end(system)
  estimate(noprint)
  compute BIC=0.5*%nobs*%logdet+neqn*(neqn*lags+2)*log(%nobs)
  compute AIC=0.5*%nobs*%logdet+neqn*(neqn*lags+2)*2
  if lags==1
     display @4 'LAGS' @20 'AIC' @35 'BIC'
     display @5 #### LAGS @20 ####.#### AIC @35 BIC
end do lags
   LAGS            AIC            BIC
       1           -2256.5458     -2044.3754     <----- Minimum
       2           -2148.4263     -1762.6620
       3           -2067.8782     -1508.5200
       4           -1986.6375     -1253.6854



* Four Against Three Lags
* _______________________


system
variables CLNUSGDP USRINT CLNAUSCPI CLNNSWSFD CLNVICSFD CLNQLDSFD CLNSASFD $
CLNWASFD CLNAUSM1
lags 1 to 4
det CONSTANT
end(system)

estimate(noprint,resids=RESIDS3)
compute logdetu=%logdet

system
variables CLNUSGDP USRINT CLNAUSCPI CLNNSWSFD CLNVICSFD CLNQLDSFD CLNSASFD $
CLNWASFD CLNAUSM1
lags 1 to 3
det CONSTANT
end(system)

estimate(noprint,resids=RESIDS2)
```

```
compute logdetr=%logdet

cdf chisqr (%nobs-37)*(logdetr-logdetu) 81
Chi-Squared(81)=     66.658454 with Significance Level 0.87449509


* The null hypothesis that the lag length is three (and not four) cannot be
* rejected.



* Three Against Two Lags
* ______________________


system
variables CLNUSGDP USRINT CLNAUSCPI CLNNSWSFD CLNVICSFD CLNQLDSFD CLNSASFD $
CLNWASFD CLNAUSM1
lags 1 to 3
det CONSTANT
end(system)

estimate(noprint,resids=RESIDS3)
compute logdetu=%logdet

system
variables CLNUSGDP USRINT CLNAUSCPI CLNNSWSFD CLNVICSFD CLNQLDSFD CLNSASFD $
CLNWASFD CLNAUSM1
lags 1 to 2
det CONSTANT
end(system)

estimate(noprint,resids=RESIDS2)
compute logdetr=%logdet

cdf chisqr (%nobs-28)*(logdetr-logdetu) 81
Chi-Squared(81)=     90.502152 with Significance Level 0.22031477

* The null hypothesis that the lag length is two (and not three) cannot be
* rejected.



* Two Against One Lag
* ___________________


system
variables CLNUSGDP USRINT CLNAUSCPI CLNNSWSFD CLNVICSFD CLNQLDSFD CLNSASFD $
CLNWASFD CLNAUSM1
lags 1 to 2
det CONSTANT
end(system)

estimate(noprint,resids=RESIDS3)
compute logdetu=%logdet

system
variables CLNUSGDP USRINT CLNAUSCPI CLNNSWSFD CLNVICSFD CLNQLDSFD CLNSASFD $
CLNWASFD CLNAUSM1
```

```
lags 1 to 1
det CONSTANT
end(system)

estimate(noprint,resids=RESIDS2)
compute logdetr=%logdet
cdf chisqr (%nobs-19)*(logdetr-logdetu) 81
Chi-Squared(81)=     75.261684 with Significance Level 0.65881443

* The null hypothesis of one lag cannot be rejected.



* Four Against One Lag
* ____________________


system
variables CLNUSGDP USRINT CLNAUSCPI CLNNSWSFD CLNVICSFD CLNQLDSFD CLNSASFD $
CLNWASFD CLNAUSM1
lags 1 to 4
det CONSTANT
end(system)

estimate(noprint,resids=RESIDS3)
compute logdetu=%logdet

system
variables CLNUSGDP USRINT CLNAUSCPI CLNNSWSFD CLNVICSFD CLNQLDSFD CLNSASFD $
CLNWASFD CLNAUSM1
lags 1 to 1
det CONSTANT
end(system)

estimate(noprint,resids=RESIDS2)
compute logdetr=%logdet

cdf chisqr (%nobs-37)*(logdetr-logdetu) 243
Chi-Squared(243)=    178.361437 with Significance Level 0.99933814

* The null hypothesis of one lag cannot be rejected.



* 2.3. Trend Term
* _______________


* In this section each equation contains a trend term, except for the
* equation with the US interest rate as dependent variable.

* Use clear program in the file menu.

cal 1984 3 4
allocate 2002:1
open data
data(format=rats) 1984:3 2002:1 NSWSFD VICSFD QLDSFD SASFD WASFD AUSCPI $
AUSM1 USCPI USINT USGDP

* Datafile: STATEGDPQ.rat
```

```
* Data Transformations
* ____________________


dofor i = NSWSFD VICSFD QLDSFD SASFD WASFD AUSCPI AUSM1 USCPI USGDP
   compute [label] logs = 'ln'+%l(i)
   set %s(logs) = log(i{0})
end dofor i


set USINFL = (LNUSCPI - LNUSCPI{4})*100
set USRINT = USINT - USINFL

set TREND = t



* SUR Estimation
* ______________


compute  neqn   = 9
compute  nlags  = 2

equation usgdpeq LNUSGDP
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags}
equation usrinteq USRINT
# CONSTANT LNUSGDP{1 to nlags} USRINT{1 to nlags}
equation auscpieq LNAUSCPI
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWSFD{1 to nlags} LNVICSFD{1 to nlags} LNQLDSFD{1 to nlags} $
  LNSASFD{1 to nlags} LNWASFD{1 to nlags} LNAUSM1{1 to nlags}
equation nswsfdeq LNNSWSFD
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWSFD{1 to nlags} LNVICSFD{1 to nlags} LNQLDSFD{1 to nlags} $
  LNSASFD{1 to nlags} LNWASFD{1 to nlags} LNAUSM1{1 to nlags}
equation vicsfdeq LNVICSFD
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWSFD{1 to nlags} LNVICSFD{1 to nlags} LNQLDSFD{1 to nlags} $
  LNSASFD{1 to nlags} LNWASFD{1 to nlags} LNAUSM1{1 to nlags}
equation qldsfdeq LNQLDSFD
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWSFD{1 to nlags} LNVICSFD{1 to nlags} LNQLDSFD{1 to nlags} $
  LNSASFD{1 to nlags} LNWASFD{1 to nlags} LNAUSM1{1 to nlags}
equation sasfdeq LNSASFD
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWSFD{1 to nlags} LNVICSFD{1 to nlags} LNQLDSFD{1 to nlags} $
  LNSASFD{1 to nlags} LNWASFD{1 to nlags} LNAUSM1{1 to nlags}
equation wasfdeq LNWASFD
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWSFD{1 to nlags} LNVICSFD{1 to nlags} LNQLDSFD{1 to nlags} $
  LNSASFD{1 to nlags} LNWASFD{1 to nlags} LNAUSM1{1 to nlags}
equation ausm1eq LNAUSM1
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWSFD{1 to nlags} LNVICSFD{1 to nlags} LNQLDSFD{1 to nlags} $
  LNSASFD{1 to nlags} LNWASFD{1 to nlags} LNAUSM1{1 to nlags}
```

```
SUR(noprint) neqn
# usgdpeq USGDPEQRES
# usrinteq USRINTEQRES
# auscpieq AUSCPIEQRES
# nswsfdeq NSWSFDEQRES
# vicsfdeq VICSFDEQRES
# qldsfdeq QLDSFDEQRES
# sasfdeq SASFDEQRES
# wasfdeq WASFDEQRES
# ausm1eq AUSM1EQRES


Covariance\Correlation Matrix of Residuals
              LNUSGDP        USRINT        LNAUSCPI       LNNSWSFD
LNUSGDP   0.00002429435   0.2149846426  -0.3487168693   0.3515765642
USRINT    0.00045999238  0.18844344916  -0.0648954343   0.2429534221
LNAUSCPI -0.00000879288 -0.00014411529  0.00002617042  -0.0106143681
LNNSWSFD  0.00001681094  0.00102313502 -0.00000052677  0.00009411066
LNVICSFD  0.00003503851  0.00177640763 -0.00002229125  0.00004967520
LNQLDSFD  0.00001292231 -0.00056837318 -0.00002046135  0.00003081736
LNSASFD  -0.00000153188  0.00192648422 -0.00001185778  0.00004695952
LNWASFD   0.00002979522  0.00177065846 -0.00002694624  0.00004029225
LNAUSM1   0.00001233429  0.00098047410 -0.00000924527  0.00001514652


             LNVICSFD       LNQLDSFD        LNSASFD        LNWASFD
LNUSGDP    0.5688643930   0.2382163296  -0.0246420154   0.3978718383
USRINT     0.3274672617  -0.1189671599   0.3518670029   0.2684686128
LNAUSCPI  -0.3486943101  -0.3634234372  -0.1837814827  -0.3466906119
LNNSWSFD   0.4097660697   0.2886424024   0.3838025169   0.2733703101
LNVICSFD  0.00015615951   0.4185427106   0.2051171931   0.4357449258
LNQLDSFD  0.00005756254  0.00012112448   0.0707395661   0.1252594040
LNSASFD   0.00003232829  0.00000981917  0.00015907165   0.2384738223
LNWASFD   0.00008273082  0.00002094484  0.00004569702  0.00023083492
LNAUSM1   0.00004276810  0.00000547402 -0.00002326946  0.00005878821


              LNAUSM1
LNUSGDP    0.1922512586
USRINT     0.1735215404
LNAUSCPI  -0.1388423822
LNNSWSFD   0.1199502445
LNVICSFD   0.2629320369
LNQLDSFD   0.0382118436
LNSASFD   -0.1417417346
LNWASFD    0.2972673693
LNAUSM1   0.00016942770



* Impulse Responses
* _________________


declare rect[series] impblk(neqn,neqn)
declare vect[series] noscaled(neqn)
declare vect[strings] implabel(neqn)
```

```
compute implabel=|| $
  'USRGDP',$
  'USRINT',$
  'AUSCPI',$
  'NSWSFD',$
  'VICSFD',$
  'QLDSFD',$
  'SASFD',$
  'WASFD',$
  'AUSM1'||

compute  nsteps = 24
list ieqn = 1 to neqn
smpl 1 nsteps
impulse(results=impblk,noprint) neqn nsteps * %sigma
# usgdpeq
# usrinteq
# auscpieq
# nswsfdeq
# vicsfdeq
# qldsfdeq
# sasfdeq
# wasfdeq
# ausm1eq

do i=1,neqn
  compute header='Plot of Responses to '+implabel(i)
  do j=1,neqn
     set noscaled(j) = (impblk(j,i))*100
  end do j
  graph(header=header,key=below,klabels=implabel,number=0, $
  window='TO_'+implabel(i),min=-0.4,max=0.8) neqn
  cards noscaled(ieqn)
end do i

do i=1,neqn
  compute header='Plot of Responses of '+implabel(i)
  graph(header=header,key=below,klabels=implabel,number=0, $
  window='OF_'+implabel(i)) neqn
  cards impblk(i,ieqn)
end do i



* Lagrange Multiplier Test of the Matrix of Residuals
* ___________________________________________________


* The null hypothesis is that the residuals are uncorrelated across equations.

smpl

declare rect corrmx(neqn,neqn)
ewise corrmx(i,j)=%sigma(i,j)/(%sigma(i,i)*%sigma(j,j))**0.5
```

```
display corrmx

 1.00000  0.21498 -0.34872  0.35158  0.56886  0.23822 -0.02464  0.39787  0.19225
 0.21498  1.00000 -0.06490  0.24295  0.32747 -0.11897  0.35187  0.26847  0.17352
-0.34872 -0.06490  1.00000 -0.01061 -0.34869 -0.36342 -0.18378 -0.34669 -0.13884
 0.35158  0.24295 -0.01061  1.00000  0.40977  0.28864  0.38380  0.27337  0.11995
 0.56886  0.32747 -0.34869  0.40977  1.00000  0.41854  0.20512  0.43574  0.26293
 0.23822 -0.11897 -0.36342  0.28864  0.41854  1.00000  0.07074  0.12526  0.03821
-0.02464  0.35187 -0.18378  0.38380  0.20512  0.07074  1.00000  0.23847 -0.14174
 0.39787  0.26847 -0.34669  0.27337  0.43574  0.12526  0.23847  1.00000  0.29727
 0.19225  0.17352 -0.13884  0.11995  0.26293  0.03821 -0.14174  0.29727  1.00000

declare rect corrsq(neqn,neqn)
ewise corrsq(i,j)=corrmx(i,j)**2

display bp=%nobs*(%sum(corrsq)-neqn)/2
    185.68445

declare integer dgf

display dgf=neqn*(neqn-1)/2
36

cdf chisqr bp dgf
Chi-Squared(36)=    185.684448 with Significance Level 0.00000000



* Lagrange Multiplier Test for Serial Correlation
* _______________________________________________


* The null hypothesis is that there is no serial correlation.

dofor i = USGDPEQRES USRINTEQRES AUSCPIEQRES NSWSFDEQRES VICSFDEQRES $
    QLDSFDEQRES SASFDEQRES WASFDEQRES AUSM1EQRES
    graph(header=%l(i)) 1
    # i
end dofor i

linreg(noprint) USGDPEQRES
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} USGDPEQRES{1 to nlags}
exclude
# USGDPEQRES{1 to NLAGS}

Null Hypothesis : The Following Coefficients Are Zero
USGDPEQRES       Lag(s) 1 to 2
F(2,55)=      1.91281 with Significance Level 0.15735947

linreg(noprint) USRINTEQRES
# CONSTANT LNUSGDP{1 to nlags} USRINT{1 to nlags} USRINTEQRES{1 to nlags}
exclude
# USRINTEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
USRINTEQRES      Lag(s) 1 to 2
F(2,56)=      0.55753 with Significance Level 0.57576633
```

```
linreg(noprint) AUSCPIEQRES
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWSFD{1 to nlags} LNVICSFD{1 to nlags} LNQLDSFD{1 to nlags} $
  LNSASFD{1 to nlags} LNWASFD{1 to nlags} LNAUSM1{1 to nlags} $
  AUSCPIEQRES{1 to nlags}
exclude
# AUSCPIEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
AUSCPIEQRES      Lag(s) 1 to 2
F(2,41)=      1.34160 with Significance Level 0.27266141

linreg(noprint) NSWSFDEQRES
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWSFD{1 to nlags} LNVICSFD{1 to nlags} LNQLDSFD{1 to nlags} $
  LNSASFD{1 to nlags} LNWASFD{1 to nlags} LNAUSM1{1 to nlags} $
  NSWSFDEQRES{1 to nlags}
exclude
# NSWSFDEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
NSWSFDEQRES      Lag(s) 1 to 2
F(2,41)=      0.31802 with Significance Level 0.72936603

linreg(noprint) VICSFDEQRES
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWSFD{1 to nlags} LNVICSFD{1 to nlags} LNQLDSFD{1 to nlags} $
  LNSASFD{1 to nlags} LNWASFD{1 to nlags} LNAUSM1{1 to nlags} $
  VICSFDEQRES{1 to nlags}
exclude
# VICSFDEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
VICSFDEQRES      Lag(s) 1 to 2
F(2,41)=      1.05436 with Significance Level 0.35767028

linreg(noprint) QLDSFDEQRES
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWSFD{1 to nlags} LNVICSFD{1 to nlags} LNQLDSFD{1 to nlags} $
  LNSASFD{1 to nlags} LNWASFD{1 to nlags} LNAUSM1{1 to nlags} $
  QLDSFDEQRES{1 to nlags}
exclude
# QLDSFDEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
QLDSFDEQRES      Lag(s) 1 to 2
F(2,41)=      0.11908 with Significance Level 0.88804493

linreg(noprint) SASFDEQRES
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWSFD{1 to nlags} LNVICSFD{1 to nlags} LNQLDSFD{1 to nlags} $
  LNSASFD{1 to nlags} LNWASFD{1 to nlags} LNAUSM1{1 to nlags} $
  SASFDEQRES{1 to nlags}
exclude
# SASFDEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
SASFDEQRES       Lag(s) 1 to 2
F(2,41)=      0.45194 with Significance Level 0.63952165
```

```
linreg(noprint) WASFDEQRES
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWSFD{1 to nlags} LNVICSFD{1 to nlags} LNQLDSFD{1 to nlags} $
  LNSASFD{1 to nlags} LNWASFD{1 to nlags} LNAUSM1{1 to nlags} $
  WASFDEQRES{1 to nlags}
exclude
# WASFDEQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
WASFDEQRES       Lag(s) 1 to 2
F(2,41)=      1.55209 with Significance Level 0.22399362

linreg(noprint) AUSM1EQRES
# CONSTANT TREND LNUSGDP{1 to nlags} USRINT{1 to nlags} LNAUSCPI{1 to nlags} $
  LNNSWSFD{1 to nlags} LNVICSFD{1 to nlags} LNQLDSFD{1 to nlags} $
  LNSASFD{1 to nlags} LNWASFD{1 to nlags} LNAUSM1{1 to nlags} $
  AUSM1EQRES{1 to nlags}
exclude
# AUSM1EQRES{1 to nlags}

Null Hypothesis : The Following Coefficients Are Zero
AUSM1EQRES       Lag(s) 1 to 2
F(2,41)=      2.26273 with Significance Level 0.11691091



* Lag Length
* __________


* AIC and BIC Information Criteria
* ________________________________


smpl 1986:3 2002:1

do lags=1,4
  system
  variables LNUSGDP USRINT LNAUSCPI LNNSWSFD LNVICSFD LNQLDSFD LNSASFD $
  LNWASFD LNAUSM1
  lags 1 to lags
  DET CONSTANT TREND
  end(system)
  estimate(noprint)
  compute BIC=0.5*%nobs*%logdet+neqn*(neqn*lags+2)*log(%nobs)
  compute AIC=0.5*%nobs*%logdet+neqn*(neqn*lags+2)*2
  if lags==1
     display @4 'LAGS' @20 'AIC' @35 'BIC'
     display @5 #### LAGS @20 ####.#### AIC @35 BIC
end do lags
   LAGS            AIC            BIC
       1           -2229.6732     -2017.5029    <------ Minimum
       2           -2139.0087     -1753.2444
       3           -2062.5362     -1503.1780
       4           -2007.0637     -1274.1117
```

```
* Four Against Three Lags
* _______________________

system
variables LNUSGDP USRINT LNAUSCPI LNNSWSFD LNVICSFD LNQLDSFD LNSASFD $
LNWASFD LNAUSM1
lags 1 to 4
det CONSTANT TREND
end(system)

estimate(noprint,resids=RESIDS3)
compute logdetu=%logdet

system
variables LNUSGDP USRINT LNAUSCPI LNNSWSFD LNVICSFD LNQLDSFD LNSASFD $
LNWASFD LNAUSM1
lags 1 to 3
det CONSTANT TREND
end(system)

estimate(noprint,resids=RESIDS2)
compute logdetr=%logdet
cdf chisqr (%nobs-38)*(logdetr-logdetu) 81
Chi-Squared(81)=     84.545680 with Significance Level 0.37189750

* The null hypothesis that the lag length is three (and not four) cannot be
* rejected.



* Three Against Two Lags
* ______________________

system
variables LNUSGDP USRINT LNAUSCPI LNNSWSFD LNVICSFD LNQLDSFD LNSASFD $
LNWASFD LNAUSM1
lags 1 to 3
det CONSTANT TREND
end(system)

estimate(noprint,resids=RESIDS3)
compute logdetu=%logdet

system
variables LNUSGDP USRINT LNAUSCPI LNNSWSFD LNVICSFD LNQLDSFD LNSASFD $
LNWASFD LNAUSM1
lags 1 to 2
det CONSTANT TREND
end(system)

estimate(noprint,resids=RESIDS2)
compute logdetr=%logdet

cdf chisqr (%nobs-29)*(logdetr-logdetu) 81
Chi-Squared(81)=     92.315417 with Significance Level 0.18338818

* The null hypothesis that the lag length is two (and not three) cannot be
* rejected.
```

```
* Two Against One Lag
* __________________


system
variables LNUSGDP USRINT LNAUSCPI LNNSWSFD LNVICSFD LNQLDSFD LNSASFD $
LNWASFD LNAUSM1
lags 1 to 2
det CONSTANT TREND
end(system)

estimate(noprint,resids=RESIDS3)
compute logdetu=%logdet

system
variables LNUSGDP USRINT LNAUSCPI LNNSWSFD LNVICSFD LNQLDSFD LNSASFD $
LNWASFD LNAUSM1
lags 1 to 1
det CONSTANT TREND
end(system)

estimate(noprint,resids=RESIDS2)
compute logdetr=%logdet

cdf chisqr (%nobs-20)*(logdetr-logdetu) 81
Chi-Squared(81)=     97.378494 with Significance Level 0.10371840

* The null hypothesis that there is only one lag is rejected.



* Four Against Two Lags
* ____________________


system
variables LNUSGDP USRINT LNAUSCPI LNNSWSFD LNVICSFD LNQLDSFD LNSASFD $
LNWASFD LNAUSM1
lags 1 to 4
det CONSTANT TREND
end(system)

estimate(noprint,resids=RESIDS3)
compute logdetu=%logdet

system
variables LNUSGDP USRINT LNAUSCPI LNNSWSFD LNVICSFD LNQLDSFD LNSASFD $
LNWASFD LNAUSM1
lags 1 to 2
det CONSTANT TREND
end(system)

estimate(noprint,resids=RESIDS2)
compute logdetr=%logdet

cdf chisqr (%nobs-38)*(logdetr-logdetu) 162
Chi-Squared(162)=    152.424663 with Significance Level 0.69342684

* The null hypothesis of two lags cannot be rejected.
```

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