Labor Market Flexibility and Structural Shocks: An International Perspective

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Abstract

We rank Chile in terms of labor market flexibility among a group that includes both OECD and emerging economies. To do that, we build an indicator of labor-market flexibility which allows international comparisons. Such indicator aims to capture the cyclical features of the labor market and is obtained by estimating a structural VAR (SVAR). The SVAR is identified using long-run restrictions, which are based on a simple open-economy model with labor-market rigidity. The estimation provides a direct measure of unemployment persistence in the presence of macro shocks. We formally test how close to the OECD institutional ranking is our labor market index and other rankings taken from the literature. It is worth to emphazise that since we build a ranking, instead of absolute, we refer here to relative flexibility. We found that Korea, HongKong, Chile, US and Mexico are the most flexible economies. At the other end our index indicates that Germany, Sweden, Spain and Colombia are the most rigid labor markets.

JEL classification: C32, E24, J5

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1 Introduction

As a contribution to the permanent local debate about the relative flexibility of the labor market, this article ranks Chile among a group of OECD and emerging economies by deriving and computing a labor-market-rigidity index. Rigidity is defined hereon as the persistence of unemployment over its natural level once the economy is hit by a structural shock. In this sense we do not deal with the kind of rigidity that would explain differences in the natural rate of unemployment among countries, even though they may be related.

We first build a small model which will guide our empirical approach very much in the spirit of Dolado and Jimeno (1997), and Balmaseda, Dolado and Lopez-Salido (2000), who associate labor-market rigidity with the persistence of unemployment in the presence of macro shocks. Indeed, their international evidence reveals a clear relation between some institutional measures of labor market rigidity and the macro dynamics. However, given that our main target is to rank Chile in terms of labor market rigidity, we naturally think of a model for an emerging open economy, frequently affected by large movements in the terms of trade, besides other supply and demand forces. In that sense, our model differs from the closed economy setup used by the authors mentioned above.

The model below assumes that wages are set in a bargaining framework, where insiders and outsiders interact, as was put forward by Blanchard and Summers (1986) and Blanchard (1991). This setting is used to introduce rigidity in the labor market, that prevents nominal wages from adjusting rapidly to equilibrium and leading to partial hysteresis of the unemployment rate.[1] Otherwise the model is fairly standard including a production function, a labor supply equation, a pricing equation, an aggregate demand -which is determined jointly by the IS and LM curves-, and some driving forces. Here, there is also a role for the uncovered interest-rate parity and the real exchange rate, where the latter depends on productivity and the terms of trade.

In the model, unemployment should be zero over the very long run, which is compatible with a vertical aggregate supply and the natural rate of unemployment having no trend. For instance, an increase in productivity should lead to a proportional increase in labor demand and the labor cost (producer real wage) with no change in unemployment. All shocks could have an impact on unemployment in the short run, though.[2] On the other hand, as in Balmaseda et al. (2000), the model should also be able to characterize the response of the real wage to supply and demand shocks.

Since the labor market indicator needs to be comparable across countries, it should depend exclusively on labor market rigidity. However, some of the rigidity indexes found in the related literature also depend on the elasticity of labor supply to real wages. Furthermore, an open economy version of those indexes would also depend on the share of tradable goods consumed in the economy. Hence our labor market index is different from others because it does depend exclusively on the coefficient of the model associated with labor market rigidity in the wage equation. The indicator measures the half life of unemployment after the economy is hit by a shock, which is compatible with the cyclical rigidity we are concerned with in this article. The

[1]In fact, this setting is compatible with any sort of institutional arrangement that could lead to nominal wage rigidity.

[2]Actually, the short-run effect of a productivity shock on unemployment depends on, among other things, the kind of structural changes it generates and the job skills demanded (Blanchard and Katz, 1997).

longer it takes for unemployment to vanish after a shock, the more rigid the country will be ranked, no matter what its average unemployment rate is.

Indeed, the empirical strategy allows us to compute the direct measure of persistence to assess the actual performance of labor markets. We use a structural VAR approach, with the long-run restriction identification strategy developed by Blanchard and Quah (1989). The VAR allows us to study the dynamics of the real wage, the real exchange rate, output and unemployment in a sample of both OECD countries and emerging markets. The model helps us to impose the long-run restrictions and interpret the shocks in the VAR. With the purpose of analyzing unemployment persistence, besides productivity, labor-force and a demand shock, we will identify a terms-of-trade shock, because it has a significant impact on an open economy. Since we intend to characterize labor market rigidity, we focus on the impulse response functions of unemployment after the economy is struck by the structural shocks.

Finally, we formally test how close to an OECD institutional ranking, stand our index and other rankings found in previous studies which try to quantitatively characterize labor market institutions as in Layard, Nickell and Jackman,1991 (LNJ), Vinals and Jimeno (1996), Balmaseda, Dolado and López-Salido (2000).

The second section of this article presents the model. The third one describes the empirical strategy and main results. The fourth section assesses the labor market index and the last part of the paper concludes.

2 The Model

2.1 The basic framework

2.1.1 Aggregate supply and demand

The economy is characterized by the supply of a domestic good by firms, which hire labor as the only factor of production. The technology is assumed to be of constant returns. Aggregate supply is then given by

$$y = n + x \tag{1}$$

where x is the productivity of labor, and n is aggregate employment (all variables in natural logs, from now on). Consumption is divided into the domestic good and an imported good. To obtain the aggregate demand, we use the traditional IS-LM analysis for an open economy. Saving-investment equilibrium is given by

$$y = -ar + \eta_z z + \eta_x x + q + \tau \tag{2}$$

where r is expected real interest rate, z is the relative price of domestic to foreign good (terms of trade), q is the real exchange rate and τ is a labor force shock.

Money market equilibrium is described by

$$m - p = -bi + y \tag{3}$$

where i is the nominal interest rate. Given perfect capital mobility, nominal interest rates on bonds are set at the beginning of each period at

$$i = \widetilde{i} + E\left[s_{+1}\right] - s \tag{4}$$

where $\widetilde{i}$ is the external interest rate. For simplicity, external real interest rate and inflation are normalized to zero, so depreciation expectations equal expected inflation. Expected real interest rates, on the other hand, are given by real international arbitrage condition,

$$r = E\left[q_{+1} - q\right] \tag{5}$$

Replacing this relation in 2 gives

$$y = -aE\left[q_{+1} - q\right] + q + \eta_z z + \eta_x x + \tau \tag{6}$$

2.1.2 Prices and the exchange rate

The price level is a weighted average of internal and external prices. Domestic prices depend on nominal wages and productivity, through

$$p^P = w - x \tag{7}$$

The aggregate price level is then given by

$$p = \gamma p^P + (1 - \gamma)s \tag{8}$$

Where s is the nominal exchange rate, and γ is the imported fraction of aggregate consumption. In the long run, q depends on productivity and real demand conditions only, so

$$\overline{q} = -\phi_z z - \phi_x x \tag{9}$$

In the short run, however, nominal rigidities in prices can lead to temporary exchange rate misalignment. The contemporary exchange rate is then given by

$$q = s - p \tag{10}$$

2.1.3 Wage setting

In a similar spirit to labor market settings in precedent papers, such as Blanchard and Summers (1986), nominal wage bargaining is a function of union power. Unions set wages one period in advance trying to keep expected employment equal to last period's level, as opposed to the wage that clears the market. This is represented by the following wage setting condition;

$$w = \arg\{E[n/w] = \lambda n_{-1} + (1-\lambda)l_{-1}\} \tag{11}$$

Where l is the labor supply, which is modeled as a function of real wages, plus a labor supply shock,

$$l = c(w-p) + \tau \tag{12}$$

Thus, unemployment is

$$u = l - n \tag{13}$$

This basic framework therefore defines a long-run equilibrium level of real and nominal variables that depend on four exogenous shocks; namely productivity, terms of trade, labor supply and the quantity of money. Each variable is assumed to follow a random walk process given by

$$\begin{aligned} \Delta x &= \varepsilon_x \\ \Delta z &= \varepsilon_z \\ \Delta \tau &= \varepsilon_\tau \\ \Delta m &= \varepsilon_m \end{aligned} \tag{14}$$

where ε_x, ε_z, ε_τ and ε_m are all uncorrelated i.i.d. shocks. Starting from an initial equilibrium position, the purpose of the model is to highlight how labor market rigidities affect the convergence of the system to a new steady state. Once the economy is hit by any of the exogenous shocks, price rigidities originated in wage bargaining will cause temporary misalignment of the real exchange rate, which affect directly aggregate demand and unemployment.

2.2 Dynamics

2.2.1 The long run

In the long run, real variables such as real wages, output, the real exchange rate and employment depend on real determinants only, namely supply, terms-of-trade and labor-supply shocks, through the values of x, z and τ. Using 7, 10 and 9 in 8, we solve for long run workers' real wage (where an asterisk represents a long run value)

$$(w-p)^* = (1+\phi_x(1-\gamma)/\gamma)x + (\phi_z(1-\gamma)/\gamma)z \tag{15}$$

Using 15 in 12, and given $l = n$ in the long run, we get output's steady state value

$$y^* = (1+c(1+\phi_x(1-\gamma)/\gamma))x + (c\phi_z(1-\gamma)/\gamma)z + \tau \tag{16}$$

Nominal variables, therefore, adjust to 15 and 16, given the monetary stance, so that the price level in the long run is given by

$$p^* = m - y^* \tag{17}$$

Nominal wages and the exchange rate are finally obtained by substituting 17 in 15 and 10, respectively.

This specification of the shocks allows us to derive long-run identifying restrictions, by solving the model above and reducing it to a system of four equations. These are 7, 9, 16 and 13, relating real producer wages (labor cost), the real exchange rate, output and unemployment to the four exogenous shocks given by 15. In the long run, labor cost changes depend on productivity shocks only, the real exchange rate on productivity and terms-of- trade shocks, output depends on the first two plus labor-supply shocks, while unemployment responds only temporarily to all shocks, being zero in steady state. The long-run equilibrium, therefore, has no role for the nominal rigidity introduced by wage bargaining. This comes from the assumption that there is partial hysteresis ($\lambda < 1$). Otherwise, the system's equilibrium would be permanently ruled by the short run dynamics described in the next section.[3]

2.2.2 The short run

It is interesting to analyze the dynamics that starts when the system is hit by any of the four shocks, calling for an adjustment in nominal variables in order to reach the new steady state. Though the rigidity introduced in wage bargaining produces symmetric responses of output and employment below and above its long run level, we will focus only on situations that cause

[3] The consistency of the model in the long run also restrains the values of some parameters presented so far, mainly the values of η_x and η_z. In order for supply to equal demand with interest rates on their natural levels (zero under the assumptions), the response of labor supply to shocks on z and x has to be consistent with the response of the agregate demand. Therefore,

$$\eta_x = 1 + \phi_x + c(1+\phi_x(1-\gamma)/\gamma)$$

and

$$\eta_z = \phi_z(1 + c(1-\gamma)/\gamma)$$

temporal unemployment. That is, shocks that call for a downward nominal wage adjustment. For simplicity, we normalize each variable to zero in the initial state. The timing of the model is the following;

1- Unions and firms negotiate contracts at the beginning of the period. Since the economy starts at steady state equilibrium and all shocks have zero mean, wage is set at the previous period's level.

2- The economy is hit by any of the four shocks, which calls for a nominal downward wage adjustment to reach the new long run equilibrium. Since wages are fixed for the present period, prices adjust only partially, holding back aggregate demand through the real exchange rate channel, causing positive unemployment.[4]

3- At the end of the first period, wage is negotiated again, taking account of previous employment level (union′s objective) and labor supply.

Given wage stickiness originated in the nominal-wage bargaining process, prices follow a gradual adjustment path to their full-employment level. As the asset channel reacts without this delay, the real exchange rate departs from its long run level. Thus, output and employment are demand-determined in the short run. To solve for output and employment in the period of the shock, we need to find the value of s_{+1}, s and w. In a framework of rational expectations, these can be derived from a dynamic system characterized by 2 equations: The first is given by substituting 6 in 3, while the second relation is obtained through the wage setting equation 11 (See appendix 1 for details). The system is given by

$$A_2 S - A_2 w_{-1} = aE\left[w_{+1}\right] - A_1 E\left[w\right] - as_{+2} + A_1 E\left[s_{+1}\right] + x(1-\lambda)(\eta_x(1-c)-1)/\gamma + z(1-\lambda)\eta_z/\gamma \quad (18)$$

$$(1+B_1)S - a\gamma w_{-1} = B_1 E\left[s_{+1}\right] - a\gamma E\left[w\right] - x\eta_x - z\eta_z - \tau + m \quad (19)$$

where $A_1 = 1 + a + a\lambda$, $A_2 = a\lambda + \lambda - (1-\lambda)c(1-\gamma)/\gamma$, $B_1 = b + a\gamma$. Solving the system with the method of undetermined coefficients, we find the values of s and the first negotiated wage, w, in terms of the contemporary shocks,

$$s = \pi_1 x + \pi_2 z + \pi_3 \tau + \pi_4 m \quad (20)$$

$$w = K_1 x + K_2 z + K_3 \tau + K_4 m \quad (21)$$

The parameters are solved in appendix 1. Once s and w are known, s_{+1}can be obtained from 19. By replacing these values in 6, we solve for demand-determined output in the initial period, and therefore employment.

[4]Since wage is set at the beginning of the period, prices are actually given by

$$p = \gamma(w_{-1} - x) + (1-\gamma)s$$

$$\begin{aligned} y^d &= \varepsilon_x \left(-\pi_1 \gamma (\frac{a}{B_1} - 1) + K_1 \frac{ba}{B_1} + \gamma + \eta_x \frac{b}{B_1} \right) \\ &+ \varepsilon_z \left(-\pi_2 \gamma (\frac{a}{B_1} - 1) + K_2 \frac{ba}{B_1} + \eta_z \frac{b}{B_1} \right) \\ &+ \varepsilon_\tau \left(-\pi_3 \gamma (\frac{a}{B_1} - 1) + K_3 \frac{ba}{B_1} + \frac{b}{B_1} \right) \\ &+ \varepsilon_m \left(-\pi_4 \gamma (\frac{a}{B_1} - 1) + K_4 \frac{ba}{B_1} - 1 \right) - w_{-1} \frac{ba}{B_1} \end{aligned} \tag{22}$$

$$n = y^d - \varepsilon_x \tag{23}$$

Though this expression may seem complicated, the basic intuition of the model is quite simple. If as a result of a shock, the real exchange rate is *below* its long-run level -as a consequence of the nominal rigidities originated in the wage bargaining process- so will aggregate demand and employment. In contrast, labor supply will temporarily rise given higher real wages (which depend negatively on q[5]). The result is a sharp increase in unemployment. In subsequent periods, this unemployment is gradually reduced at a speed λ. In general, from 11, employment at any period can be expressed as

$$n_{+s} = \lambda^s n + (1-\lambda) l (1 + \lambda + \lambda^2 + ... + \lambda^{s-1}) \tag{24}$$

which depends negatively on λ, and approaches l as $s \to \infty$. Unemployment, on the other hand, is simply given by

$$u_{+s} = \lambda^s u \tag{25}$$

In order to illustrate how the model works, figure 1 shows the response of the economy to a negative terms of trade shock. Panel a) represents the comparative static analysis. Aggregate demand (AD, equation 6) has a negative slope in relation to current nominal wages, w_{-1}, while long-run aggregate supply depends only on real parameters x, z, and τ. The economy's steady state is reached when this two meet, with nominal wages and prices making the necessary adjustments. In the short run, however, output is demand-determined by the intersection of AD with the horizontal line w_{-1}, which keeps prices from adjusting as long as the nominal wage gap is open. When terms of trade fall, long-run aggregate supply declines, reflecting the response of labor to lower real wages. The fall in aggregate demand is larger, however, given the relatively low response of the real exchange rate. In fact, as appendix 1 shows, the initial effect on q of a fall in terms of trade is given by $-\gamma\pi_2$, which is smaller than the long run depreciation, given by ϕ_z. As wage negotiations lower the initial level of w in future periods, prices fall and the real exchange rate depreciates further to its long-run value, with unemployment converging gradually to zero. Moreover, the initial gap $\overline{q} - q$ depends positively on λ. Therefore, besides delaying the return of unemployment to its long-run level, a rigid labor market causes a higher initial level of unemployment. Figures 2 shows the corresponding situations for a productivity shock, a labor supply shock, and a monetary contraction.

[5] In fact, it is easy to show that $w_{-1} - p = x - q(1-\gamma)/\gamma$.

2.3 An index of labor market rigidity

In order to have a measure that captures the cyclical persistence of labor market, we need to build an index that satisfies two necessary conditions. First, it must be related to λ. Second, and less obvious, it must be related to λ *only*. This comes from the fact that two economies that share the same measure of labor rigidity may show quite different responses for output, wages and unemployment if they differ on other structural parameters introduced in the model, such as c (the response of labor supply to real wage), and/or γ (the relative importance of the tradable sector). A standard measure used in the literature is the wage rigidity index in LNJ and BDL, which computes the ratio of accumulated response of unemployment to the new long-run level of the real wage after the shock. This type of measure, though, is not appropriate in our current framework, as is shown in appendix 2. While the assumption of a constant value of c over a rather homogenous sample of OECD countries seems acceptable, it becomes quite less satisfactory as the sample extends to less developed countries. By the same token, assuming similar degrees of openness further deteriorates the power of the measure. Fortunately, our model allows us to construct a rather simple index that depends only on λ: the half life of unemployment after a shock, i.e., the number of periods unemployment takes to decrease to one half of its maximum value. Solving for unemployment in period s from 24, we get

$$l - n_{+s} = (l - n)\,\lambda^{s} \tag{26}$$

from which the half life, s^* can be inferred

$$s^* = \frac{\ln(1/2)}{\ln \lambda}$$

which depends positively and solely on the value of our measure of labor market rigidity.

2.3.1 Conceptual Implications of Different Rigidity Indicators

The purpose of this section is to deepen further the conceptual implications of measuring labor market rigidities with alternative indexes. In particular, we compare the variables contained in a traditional indicator, the Wage Rigidity Index, with our rigidity proxy, the half life of unemployment after the shocks.

The traditional wage rigidity index, first introduced in the literature with the work of Layard *et al.*, is defined as the reciprocal of the response of real wages to unemployment, estimated from a standard wage equation. In response to a productivity shock in period t, therefore, it would be computed as

$$RWR = \lim_{k \longrightarrow \infty} \frac{\sum_{0}^{\infty} \partial u_{t+k} / \partial \varepsilon_{x,t}}{\partial (w - p^{p})_{t+k} / \partial \varepsilon_{x,t}}$$

which is the accumulated effect in unemployment in period k in relation to the change in the level of real wages.

The problem of computing such an index in our framework can be understood by replacing these values with their theoretical expressions derived from our model. Recalling the long-run level of producer's real wage after a productivity shock, from equation 7

$$\Delta(w - p^p) = \varepsilon_x$$

The accumulated response of unemployment, in turn, can be obtained by computing unemployment at period s from 24;

$$u_{+s} = \lambda^s(l - n) = \lambda^s u$$

which, if summed to infinity and substituting n from 23 in 13, gives

$$\sum_0^\infty \partial u_{t+k}/\partial\varepsilon_{x,t} = \partial u/\partial\varepsilon_{x,t}(1 + \lambda + ...\lambda^k)$$

$$= \frac{\left[c(1 + (\pi_1 + 1)(1 - \gamma)) - \left(-\pi_1\gamma(\frac{a}{B_1} - 1) + K_1\frac{ba}{B_1} + \gamma - 1 + \eta_x\frac{b}{B_1}\right)\right]}{1 - \lambda}$$

This expression depends positively on union's market power, λ, but unfortunately also on other structural parameters of the economy. Intuitively, unemployment in two economies with the same labor market rigidity would behave quite differently at the face of an increase in productivity depending on the elasticity of labor supply to real labor wages. Therefore, measuring labor market rigidity across economies that for some reason differ substantially in some of the parameters above would probably render questionable results.

3 The Empirical Strategy

Since the purpose of the paper is to measure unemployment persistence in the presence of shocks, we use the SVAR methodology. In particular, we follow Balmaseda et al. identifying the VAR with long-run restrictions as in Blanchard and Quah (1989) and Clarida and Galí (1995). These authors assume that some shocks have permanent effects on some variables, while a transitory one on others. There could also be shocks with no permanent effect on any variable. This procedure fits perfectly well the intuition of a growing economy where unemployment goes back to its natural rate, even though wages also grow, and the supply curve is vertical in the long run.[6]

[6]In this case, purchasing-power parity does not hold or, at least, real exchange rate movements are extremely persistent.

3.1 Structural identification

The structural VAR identification is derived directly from the model, as is also the interpretation of the shocks. For clarity, it is useful to rewrite several equations taken from the long-run equilibrium of the model.

$$\Delta(w - p^p) = \varepsilon_x$$

Only productivity shocks affect the real wage in the long run.

$$\Delta q = -\phi_z \varepsilon_z - \phi_x \varepsilon_x$$

The real exchange rate depends only on productivity and the terms of trade.

$$\Delta y = (1 + c(1 + \phi_x(1 - \gamma)/\gamma))\varepsilon_x + (c\phi_z(1 - \gamma)/\gamma)\varepsilon_z + \varepsilon_\tau$$

Output is affected in the long run by productivity, the terms of trade and the evolution of the labor force.

$$u = 0$$

Finally, although all shocks affect unemployment in the short run, none of them has a permanent effect on it since it is stationary in a partial hysteresis setting. As already discussed, our measure of unemployment persistence only depends on the size of the λ coefficient in the wage-setting equation.

Therefore, the identification is based on the assumption that the matrix of structural long-run multipliers, $C(1)$, is lower triangular. To find $C(1)$, it is necessary to first build the matrix $\Phi(1)\Sigma\Phi(1)$ from the reduced form estimation, where $\Phi(1)$ is the sum of the coefficients, and Σ is the variance-covariance matrix. It is possible to show that $C(1)$ is the Choleski factor of $\Phi(1)\Sigma\Phi(1)$. Once $C(1)$ is found, it is easy to compute all the structural coefficients, C, which are used to build the impulse-responses, because C_o=$\Phi(1)^{-1}C(1)$, and with C_o all Cs can be computed given that C(L)= Φ(L)C_o.[7]

3.2 Data

We use quarterly data from 1980.1 to 2002.4 for real producer wages (computed with the GDP deflator), the real exchange rate, output, and unemployment. Most countries' datasets come from the OECD data base. For non OECD countries, data was found in the respective central banks and, in some cases, in the IMF's International Financial Statistics data set. Table 1 reports the source of the time series for every country. The model assumes that real wages, real exchange rates and output are integrated processes, while unemployment is stationary. Dickey-Fuller tests were run for all variables, but in several countries the null hypothesis of a unit root for the unemployment rate could not be rejected (table 2).[8] However, we follow Balmaseda et al., assuming a partial hysteresis setup, because thinking of the consequences

[7] For a detailed explanation see Clarida and Galí (1994) and also Enders (1995).

[8] The Dickey-Fuller test rejects the unit root hypothesis for the real exchange rate of Denmark and Holland. Therefore, we run the stationary VAR $[\Delta(w - p^p), q, \Delta y, u]$ for these two countries.

of any shock on unemployment as being permanent, even in the most rigid economies, seems unreasonable.[9] Therefore, we estimated the following stationary VAR: $[\Delta(w-p^p), \Delta q, \Delta y, u]$' imposing the long-run restrictions above described. For the purpose of comparison we also run a three variable VAR $[\Delta(w-p^p), \Delta y, u]$' equivalent to the one found in Balmaseda et al. Most VARs were estimated using two lags based on the regular criteria (AIC, SW, HQ)[10] and the LM multivariate residual test for autocorrelation.

3.3 Estimation results

Impulse responses

Given the large number of economies in our sample, we decided to report the impulse responses of a small subgroup of countries with a wide range of labor market flexibility (figure 3). The confidence intervals were obtained with a bootstrap procedure using 500 replications.[11] In general, with a positive productivity shock, real wages increase in the short and long run. When a terms-of-trade shock hits the economy, real wages increase only in the short run[12]. In the case of positive labor force shocks, the response of real wages tends to be negative in the short run but in several cases it is non significant. Real wages also fall when there is a monetary shock. In fact, wages fall in the presence of a monetary shock in the case of Chile, US, and Colombia while are procyclical in Korea and Sweden, and do not move in UK.

The real exchange rate tends to appreciate when a positive productivity shock strikes the economy. After a positive terms-of-trade shock, the real exchange rate appreciates in both the short and the long run. The response of the real exchange rate after labor force shock is seldom significant. The real exchange rate tends to increase in the short run as a result of a monetary shock. Finally, the response of unemployment after a positive productivity shock is not clear-cut. In many countries unemployment decreases, but it goes the other way in several others. Unemployment tends to increase after a labor-supply shock and to decrease with a terms-of-trade shock and a positive monetary disturbance, but there are also exceptions.

Labor-market rigidity index

Table 3 shows the rankings we built by computing the half life of the impulse responses of unemployment after the shocks (AGR). We built rankings with three and four variables Korea and Hong Kong appear as the most flexible countries, followed by Chile, Mexico, and the US. This is consistent with recent evidence for the Korean economy, where unemployment peaked after the Asian crisis but quickly returned back to its previous level. On the other hand, Chile has had two labor reforms since 1990 that may have introduced some rigidity to the labor market. Nevertheless, the empirical approach here adopted is not suited to capture that kind of changes due, among other reasons, to the small number of data points after and before the reforms. For instance, we also run the same VAR for Chile from 1986 to 1998 and from 1990 to 2002 but there was no significant difference with respect to the responses of unemployment

[9] We also performed cointegration tests for all countries as in Balmaseda et al., and the null hyphotesis of no cointegration among the integrated variables [w-p,q,y] was not rejected.

[10] Kilien (2000) analizes which criterium performs better for VARs with different sample sizes.

[11] See Benkwitz and Lütkepohl (2001) for an analysis of alternative bootstrap procedures.

[12] In Chile and Colombia real wages go the wrong way falling in the short run after a positive terms-of-trade shock.

when we used the whole sample (figure 2).[13] At the other end of table 3, Germany, Sweden, Spain and Colombia are ranked as the most rigid labor markets. In Colombia, unemployment increased sharply during the 1999 crisis, reaching 20% but it has decreased very slowly during the past year. In the middle range of rigidity are Austria, Australia, Holland, Denmark and Belgium among others. The ranking has a positive and significant correlation with average unemployment, as can be expected. Table 3 also shows the OECD ranking and three other rankings used for comparison in the next section.

4 Assessment of the labor-market rigidity ranking

4.1 Alternative measures of labor-market rigidities

We present here the tests carried out to formally compare the country index built with our results using three and four variables (AGR3 and AGR4) and the OECD institutional ranking. First, it is useful to note that the OECD ranking assesses labor-market rigidity by analyzing employment protection legislation. They assign grades to each country considering collective dismissals, indefinite contract termination (procedural inconveniences, notice and severance pay, difficulty of achieving dismissal), and temporary jobs. All these aspects are expected to influence the cyclical rigidity of the labor market.

Such tests were implemented in Stata with the Wilcoxon method, which is a procedure designed to test the null hypothesis that the two samples are similar. In this case, a small probability value leads to the rejection of the null hypothesis. When we compare our index based on unemployment half life -including the 16 countries in our sample that appear too in the OECD ranking-, it is not possible to reject the null hypothesis that they are equal at any level smaller than 66%, in the case of our three variable VAR, and 81% when the AGR 4 was used (table 4).

We also ran similar tests for other rankings found in the literature.[14] In the case of the rankings of real wage rigidity in Vinals and Jimeno (1994) and Layard, Nickel and Jackman (1991) it is not possible to reject the null hypothesis that they are equal to the one of the OECD at any level under 66% and 50%, respectively. When we applied the same test to the two rankings computed by Balmaseda et al. (2000), we found that it is not possible to reject the null of their rankings being equal to the one produced by the OECD at any level under 90%, in the case of the three-variable VAR ranking, and 96% when the two-variable VAR is used.[15]

We performed a second test, including in our rankings the subset of countries that intersect our sample, and each of the ones considered by the mentioned authors. These subsets were compared to the OECD ranking, one at a time. We cannot reject that our half life of unemployment ranking built with the three-variable VAR is equal to the OECD's at any level lower than 85%, 85% and 86%, when we take into account the countries found in Vinals and Jimeno, Layard et al.

[13] In Figure 2, the responses of unemployment in Chile include the three exercises. The continuous black line is the response using the whole sample. The red line was built with data from 1990:1 until 2002:4. Finally, to obtain the the blue the VAR was run from 1986:1 to 1998:4. Given the degree of uncertainty, the differences among the three lines are non significant.

[14] Of course, we excluded from the OECD ranking the countries that they did not have in their sample to make them comparable, always keeping the order of each sample according to the rigidity score.

[15] It is important to point out that the OECD ranking we used as benchmark is a ranking published in 1999, while the studies we cite have samples that, at most, run until the mid nineties.

and Balmaseda et al., respectively (table 4). If we use our open-economy ranking (built with a four-variable VAR) taking into account the countries found in Layard et al., Vinals and Jimeno, and Balmaseda et al., we find that the null that it is equal to the OECD's cannot be rejected at any level lower than 96%, 96% and 91%, respectively, as can be seen in the bottom row of table 4. We consider that the ranking built with the open-economy model is more rigorous from a theoretical point of view and also more accurate from a statistical perspective. Therefore, the use of a four variable VAR is called for when comparing relative labor market rigidity among countries that are heterogenous as we do, given that in our sample we include some emerging economies together with OECD countries.

Given the close similarity between our index and the institutional OECD ranking, we are confident that our approach to measure labor market rigidities can be extended to other countries usually excluded from similar exercises in the related literature; in particular, Chile, which is the main objective of the present article.

5 Conclusions

We built a labor-market rigidity ranking for a sample of 18 countries, with the purpose of characterizing the relative rigidity of the labor market in Chile. We analyzed the dynamic responses of unemployment in the presence of macro shocks obtained with a structural VAR *a là* Blanchard-Quah. The setting of the empirical approach and the interpretation of the shocks are based on a model with rigidity in the labor market, through the insider-outsider bargaining setup, popularized by Blanchard and Summers (1986). Here it was extended for an open economy. We consider that opening the model is important, given that our sample includes several emerging countries, in particular Chile, a very open economy with frequent terms-of-trade shocks that have large effects on the economy.

The restrictions derived from the model imply that in the long run, wages only grow with productivity, and unemployment goes back to its natural rate. The model also allows us to build an indicator that depends only on the rigidity coefficient of the wage-setting equation: the half life of unemployment after the shocks. This measure is appropriate for assessing the cyclical persistence of the labor market. With this indicator we build a ranking and compare it formally to a ranking of labor market institutions recently issued by the OECD. We also built a ranking with a three-variable VAR for comparison.

The results of the test show that our rankings are very similar to the OECD's, both when we include all the countries we have in our sample, and when we consider only the countries that intersect with the other three rankings cited. The results also confirm that the ranking built with four variables is more accurate that the one with only three. Therefore, we are confident that the emerging economies we included were appropriately ranked.

We found that the labor markets of Korea and HongKong are the most flexible, followed by Chile, the US and Mexico. Regarding Chile, it is important to point out that it has had two labor reforms after 1990 that sometimes are blamed for introducing some degree of rigidity to the market. Unfortunately, we cannot test the effects of those reforms in terms of labor-market flexibility with our SVAR technique, given the large amount of data points needed to obtain reliable results. In fact, when we run our four-variable VAR for Chile using different time periods we found no significant difference in the impulse responses. At the other end of the ranking, Germany, Sweden, Spain and Colombia were found to be the most rigid countries. Finally, the results for the US are consistent with the common wisdom of being the most flexible labor market among developed economies.

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Appendix 1

In order to solve 18 and 19 using the method of undetermined coefficients we try the following solutions,

$$s = \pi_1 x + \pi_2 z + \pi_3 \tau + \pi_4 m$$
$$w = K_1 x + K_2 z + K_3 \tau + K_4 m$$

which replaced in 18 and 19, yield the following eight equations,

$$\begin{aligned}
\pi_1(-a + A_1 - A_2) + K_1(a - A_1) &= -(1-\lambda)((1-\gamma)/\gamma)((1-c)\eta_x - 1) \\
\pi_1 + K_1 a\gamma &= -\eta_x \\
\pi_2(-a + A_1 - A_2) + K_2(a - A_1) &= -(1-\lambda)\eta_x/\gamma \\
\pi_2 + K_2 a\gamma &= -\eta_z \\
\pi_3(-a + A_1 - A_2) + K_3(a - A_1) &= 0 \\
\pi_3 + K_3 a\gamma &= -1 \\
\pi_4(-a + A_1 - A_2) + K_4(a - A_1) &= 0 \\
\pi_4 + K_4 a\gamma &= 1
\end{aligned}$$

from which the parameters π_i and K_i are obtained;

$$K_1 = \partial E\left[w\right]/\partial x = \frac{(1-\lambda)(1-\gamma)\left[\eta_x(1-c) - 1 - \gamma c\right]}{1 + a\lambda + a(1-\lambda)\left[\gamma + c(1-\gamma)\right]}$$

$$\pi_1 = \partial s/\partial x = -\eta_x - a\gamma K_1$$
$$K_2 = \partial E\left[w\right]/\partial z = \frac{\eta_z(1-c)(1-\lambda)(1-\gamma)/\gamma}{1 + a\lambda + a(1-\lambda)\left[\gamma + c(1-\gamma)\right]}$$
$$\pi_2 = \partial s/\partial z = -\eta_z - a\gamma K_2$$
$$K_3 = \partial E\left[w\right]/\partial \tau = \frac{-(1-\lambda)(1 + c(1-\gamma)/\gamma)}{1 + a\lambda + a(1-\lambda)\left[\gamma + c(1-\gamma)\right]}$$
$$\pi_3 = \partial s/\partial \tau = -1 - a\gamma K_3$$
$$K_4 = \partial E\left[w\right]/\partial m = \frac{(1-\lambda)(1 + c(1-\gamma)/\gamma)}{1 + a\lambda + a(1-\lambda)\left[\gamma + c(1-\gamma)\right]}$$
$$\pi_4 = \partial s/\partial \tau = 1 - a\gamma K_4$$

Effect on q of a negative terms of trade shock

For a negative terms of trade shock to cause positive unemployment in our framework, a necessary condition is that the depreciation of q falls short of its new steady-state value after the shock. Defining the impact of ε_z on q and $\overline{q}$, respectively,

$d\overline{q} = \frac{\partial \overline{q}}{\partial z}\varepsilon_z = \phi_z$, while $dq = \frac{\partial q}{\partial z}\varepsilon_z = \frac{\partial q}{\partial s}\frac{\partial s}{\partial z}\phi_z = \gamma\pi_2\phi_z$

Replacing the value of π_2, $dq < d\overline{q}$ holds if (replacing the value of η_z from footnote 3 on page 6)

$1 < \frac{1+a}{\gamma+c(1-\gamma)} - a$,

which always holds if the elasticity of labor supply to real wages is less than 1. This "undershooting" of the real exchange rate, depends indeed on the magnitude of labor market rigidity; the higher λ, the higher the value of $\overline{q} - q$.

Table 1
Quarterly Series Source

	Data Spam	Unemployment	GDP	GDP Deflator	Nominal Wages	Real Exchange Rate
Australia	84.1 - 02.4	OECD	OECD	OECD	OECD *	OECD
Austria	80.1 - 02.4	OECD	IMF	IMF	OECD **	OECD
Belgium	80.1 - 02.4	OECD	OECD	OECD	OECD ***	OECD
Canada	80.1 - 02.4	OECD	OECD	OECD	OECD ***	OECD
Chile	86.1 - 02.4	NSO	Central Bank	Central Bank	NSO *	Central Bank
Colombia	84.1 - 02.4	Central Bank	Central Bank	Central Bank	Central Bank **	Central Bank
Denmark	88.1 - 02.4	OECD	OECD	OECD	OECD ***	OECD
France	80.1 - 02.4	OECD	OECD	OECD	OECD *	OECD
Germany	80.1 - 02.4	OECD	IMF	IMF	OECD ***	OECD
Hong Kong	86.1 - 02.4	HKMA	HKMA	HKMA	HKMA *	IMF"
Italy	80.1 - 02.4	OECD	OECD	OECD	OECD **	OECD
Korea	83.1 - 02.4	NSO	Bank of Korea	Bank of Korea	NSO *	IMF
Mexico	81.1 - 02.4	OECD	OECD	OECD	OECD ***	OECD
Netherlands	80.1 - 02.4	OECD	OECD	OECD	OECD ***	OECD
Spain	80.1 - 02.5	OECD	OECD	OECD	OECD *	OECD
Sweden	80.1 - 02.4	OECD	OECD	OECD	OECD ***	OECD
United Kingdom	80.1 - 02.4	OECD	OECD	OECD	OECD *	OECD
United States	80.1 - 02.4	OECD	OECD	OECD	OECD *	OECD

* All Sectors
** Industry
*** Manufacturing
" Constructed based on trade participation
OECD Unemployment corresponds in all cases to the standarized rate
NSO: National Statistics Office

Table 2
Dickey–Fuller Unit Root Tests*

	Real Wage		Q		Y		U	
Australia	-1.75	(-3.46)	-2.81	(-2.89)	-1.68	(-3.46)	-2.81	(-2.90)
Austria	-2.02	(-3.46)	-1.93	(-2.89)	-2.56	(-3.47)	-3.08	(-2.89)
Belgium	-1.12	(-3.46)	-3.19	(-3.46)	-2.89	(-3.46)	-4.2	(-3.47)
Canada	-2.43	(-3.46)	-2.32	(-3.46)	-2.4	(-2.90)	-3.86	(-3.47)
Chile	-1.14	(-2.90)	-1.37	(-2.91)	-2.4	(-2.91)	-2.82	(-2.90)
Colombia	-2.47	(-3.47)	-1.91	(-2.90)	-1.86	(-2.90)	-2.75	(-2.90)
Denmark	-2.28	(-3.49)	-4.78	(-2.91)	-2.89	(-3.49)	-2.74	(-3.49)
France	-2.61	(-3.46)	-2.52	(-2.89)	-2.57	(-3.46)	-2.1	(-2.90)
Germany	-2.94	(-3.46)	-1.94	(-2.89)	-0.66	(-2.89)	-2.63	(-2.89)
Holland	-1.18	(-2.89)	-4.73	(-3.46)	-0.65	(-2.90)	-4.21	(-3.46)
HongKong	-1.84	(-2.90)	-1.46	(-2.90)	-1.39	(-2.89)	-3.78	(-3.48)
Italy	-2.72	(-2.90)	-1.96	(-2.90)	-1.94	(-3.46)	-2.54	(-2.89)
Korea	-2.46	(-3.47)	-2.77	(-2.90)	-1.61	(-2.89)	-3.44	(-2.89)
Mexico	-1.47	(-2.91)	-2.52	(-2.91)	-2.85	(-3.48)	-2.44	(-2.89)
Spain	-2.86	(-3.47)	-1.85	(-2.89)	-2.69	(-3.46)	-2.21	(-2.89)
Sweden	-1.48	(-3.46)	-2.87	(-3.46)	-1.93	(-3.46)	-2.17	(-2.89)
UK	-2.14	(-3.46)	-2.23	(-2.89)	-2.4	(-3.46)	-4.14	(-3.46)
USA	-0.25	(-3.46)	-1.55	(-2.89)	-3.01	(-3.46)	-3.04	(-3.46)

* 5% critical value in parenthesis
Source: author's own computation

Table 3
Labor Market Rigidity Indexes

	Av. Unempl.*	LNJ	Viñals	Balmaseda 2	Balmaseda 3	AGR 3	AGR 4	OECD**
Australia	7.96	-1.10	-	-3.20	-3.90	7.58	7.50	1.20
Austria	5.51	-0.11	4.49	-1.55	-1.66	8.58	10.50	2.40
Belgium	11.63	-0.25	2.86	-4.50	-4.75	9.25	9.38	2.40
Canada	9.17	-0.32	-	-1.52	-2.07	5.75	6.75	1.10
Chile	8.27	-	-	-	-	5.67	4.63	-
Colombia	12.90	-	-	-	-	24.50	22.75	-
Denmark	6.32	-0.58	3.44	-3.82	-4.07	9.17	9.67	1.50
France	9.90	-0.23	5.13	-3.49	-2.51	7.63	9.00	2.80
Germany	6.85	-0.63	3.76	-1.74	-1.29	9.33	10.75	2.60
Hong Kong	3.11	-	-	-	-	4.25	4.25	-
Italy	10.61	-0.06	4.29	-4.84	-4.44	9.58	9.58	3.40
Korea	3.37	-	-	-	-	3.08	4.33	2.50
Mexico	3.39	-	-	-	-	5.33	5.50	2.60
Netherlands	5.87	-0.25	2.11	-2.35	-3.75	6.13	7.33	2.20
Spain	17.89	-0.52	4.20	-6.02	-5.37	11.42	11.38	3.10
Sweden	4.94	-0.08	4.92	-1.80	-2.16	12.83	12.13	2.60
United Kingdc	7.37	-0.77	3.43	-1.95	-2.08	6.92	7.38	0.90
United States	6.30	-0.25	2.39	-0.75	-0.80	4.42	5.75	0.70

* Corresponds to the OECD standardize rate of unemployment.
**OECD institutional ranking.
Source: OECD Employment Outlook (1999), Layard et al. (1991), Viñals and Jimeno (1996), Balmaseda et al. (2000) and author's own computation.

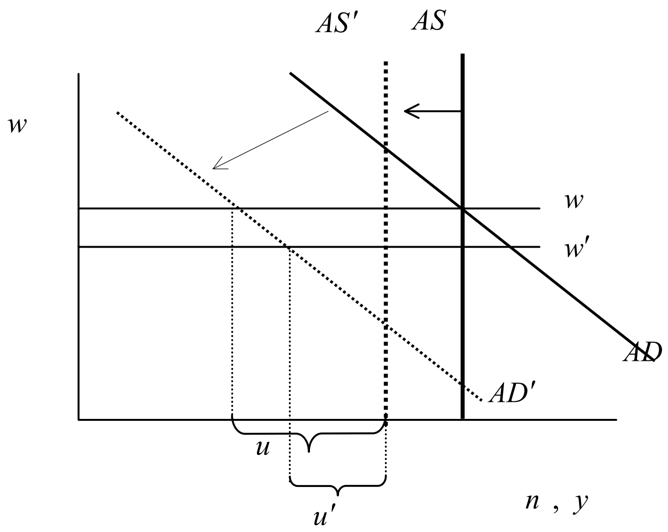
Table 4
Assessment of the Rigidity Ranking

	LNJ	VJ	BDL 3V	BDL 2V	AGR 3V	AGR 4V
OECD	50%	66%	90%	97%	66%	81%
	AGR V3 (LNJ)	AGR V3 (VJ)	AGR V3 (BDL)			
OECD	85%	85%	86%			
	AGR 4V (LNJ)	AGR 4V (VJ)	AGR 4V (BDL)			
OECD	96%	96%	92%			

Source: author's own computation

Figure 1
Response of output and unemployment to a negative terms of trade shock

a) Comparative statics



Where $u = c(1+(1+\pi_1)(1-\gamma)) - (-\pi_1\gamma(\frac{a}{B_1}-1) + K_1\gamma\frac{ba}{B_1} + \gamma - 1 + \eta_x\frac{b}{B_1})$

b) Dynamics

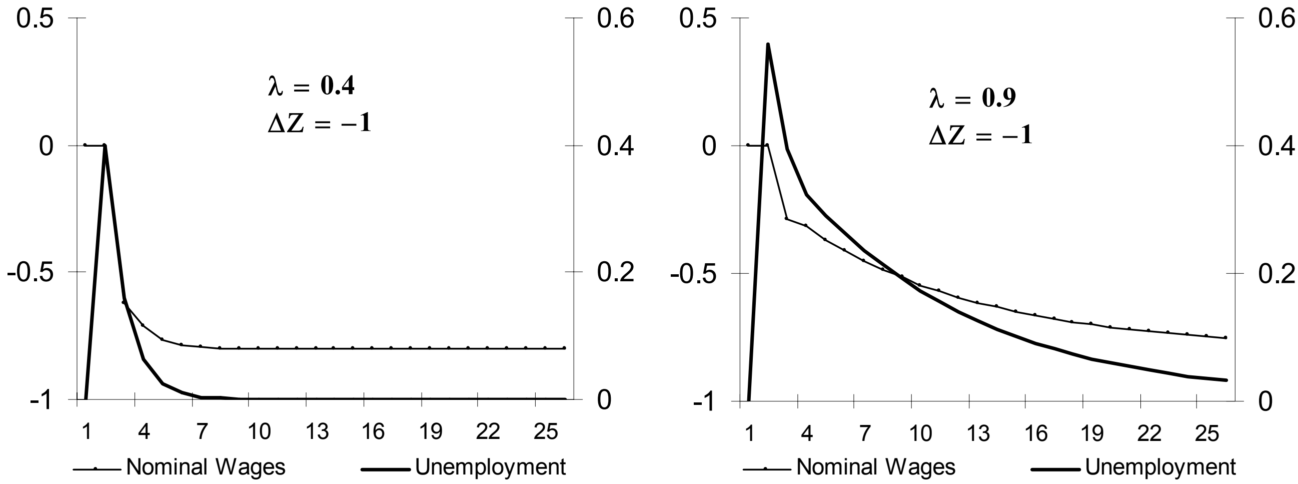
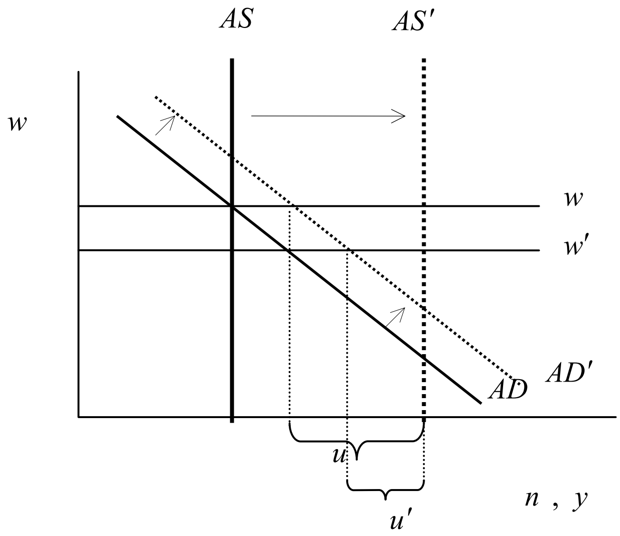


Figure 2

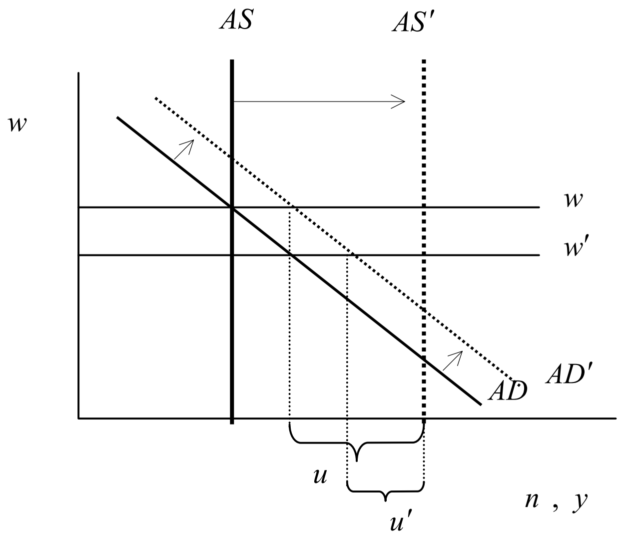
Response of output and unemployment to structural shocks

1. An increase in productivity



Where $u = c(1+(1+\pi_1)(1-\gamma)) - (-\pi_1\gamma(\frac{a}{B_1}-1) + K_1\gamma\frac{ba}{B_1} + \gamma - 1 + \eta_x\frac{b}{B_1})$

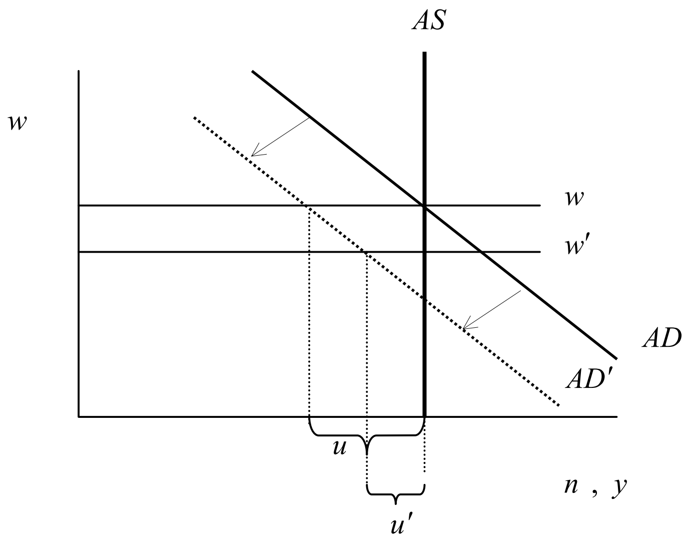
2. A positive labor supply shock



Where $u = 1 + \pi_3\gamma(-c + \frac{a}{B_1} - 1) - K_3\frac{ba}{B_1} - \frac{b}{B_1}$

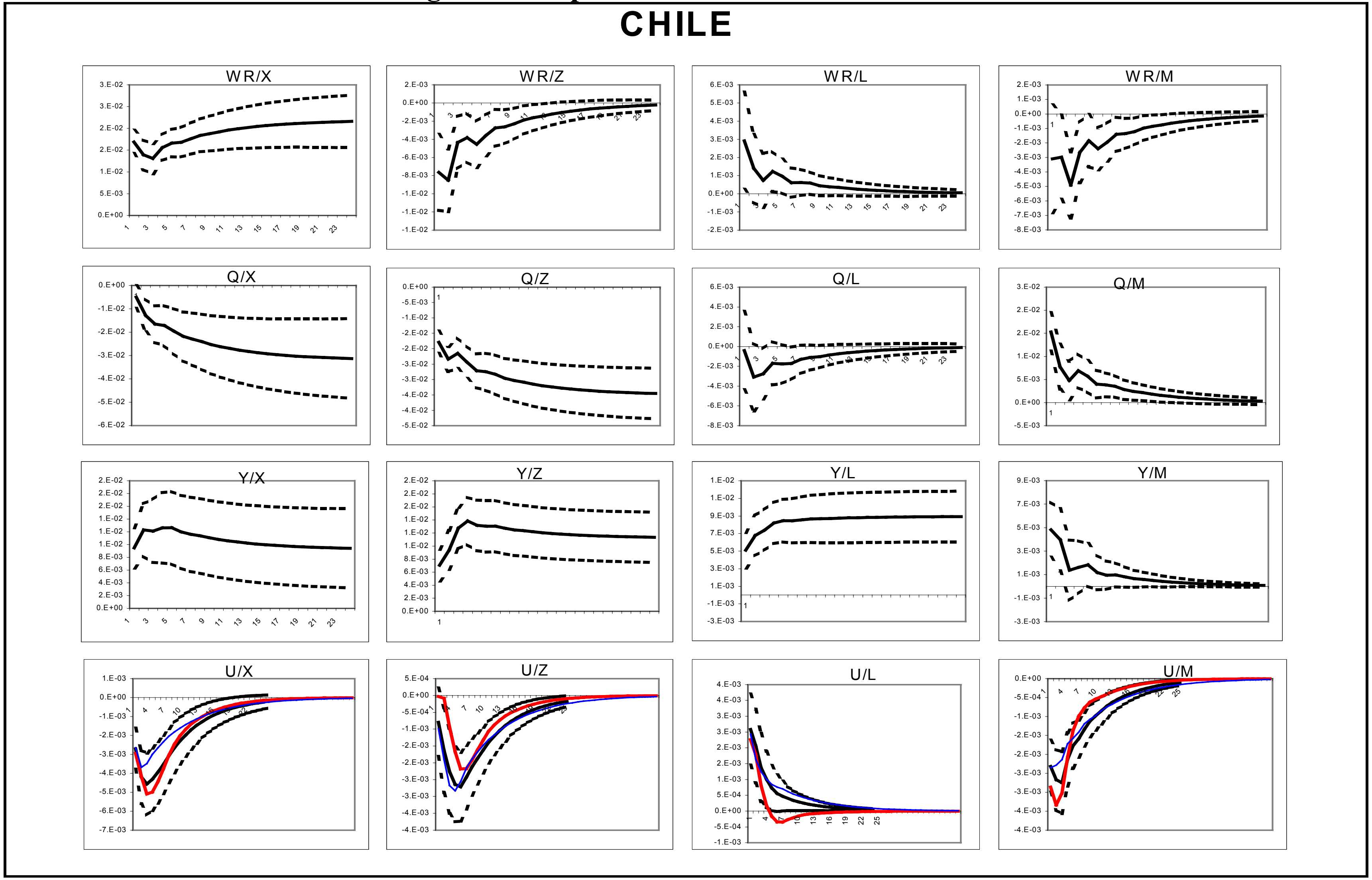
3. A monetary contraction

a) Comparative statics

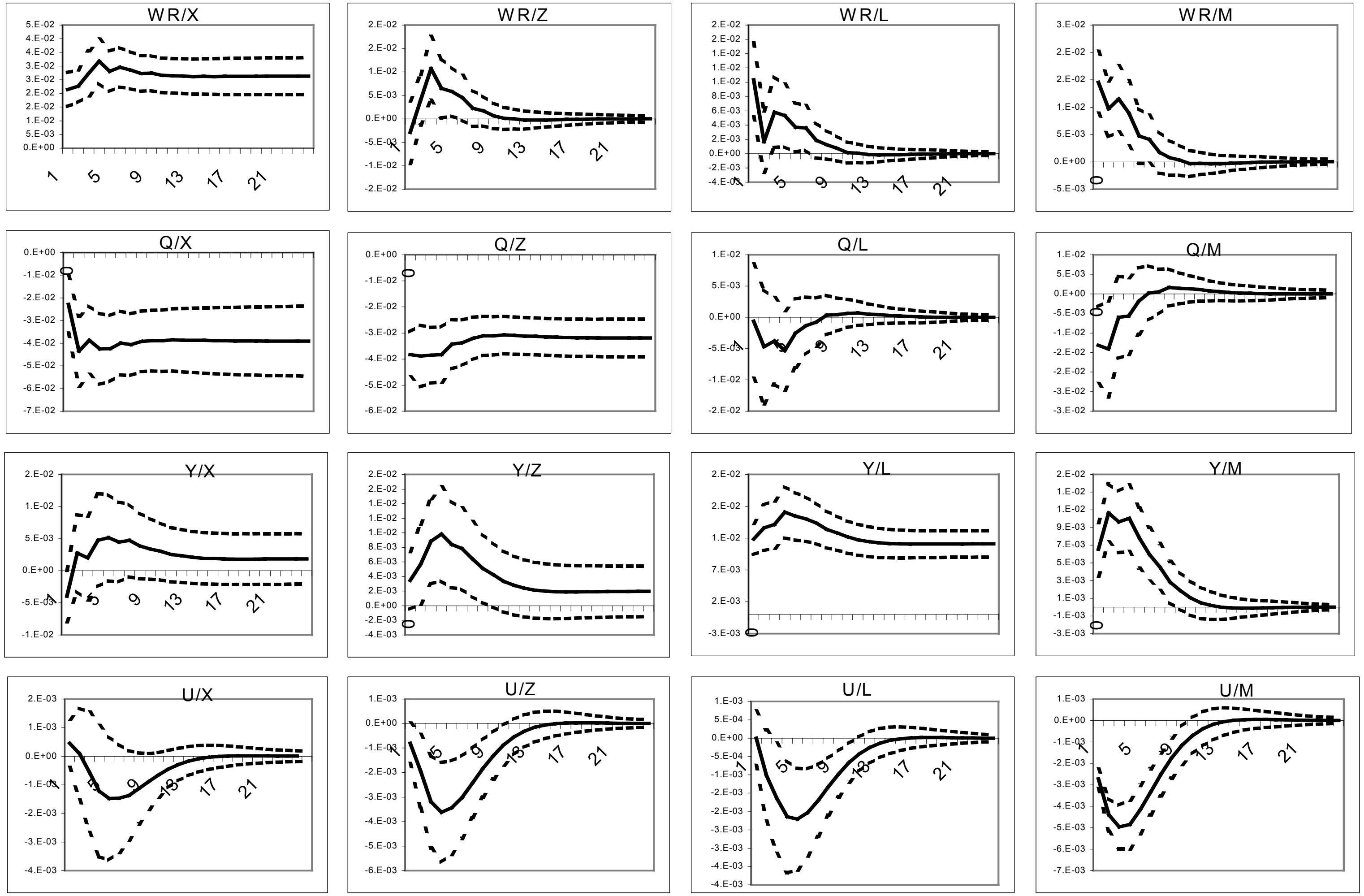


Where $u = -c\pi_4\gamma - \pi_4\gamma(\frac{a}{B_1} - 1) + K_4\frac{ba}{B_1} - 1$

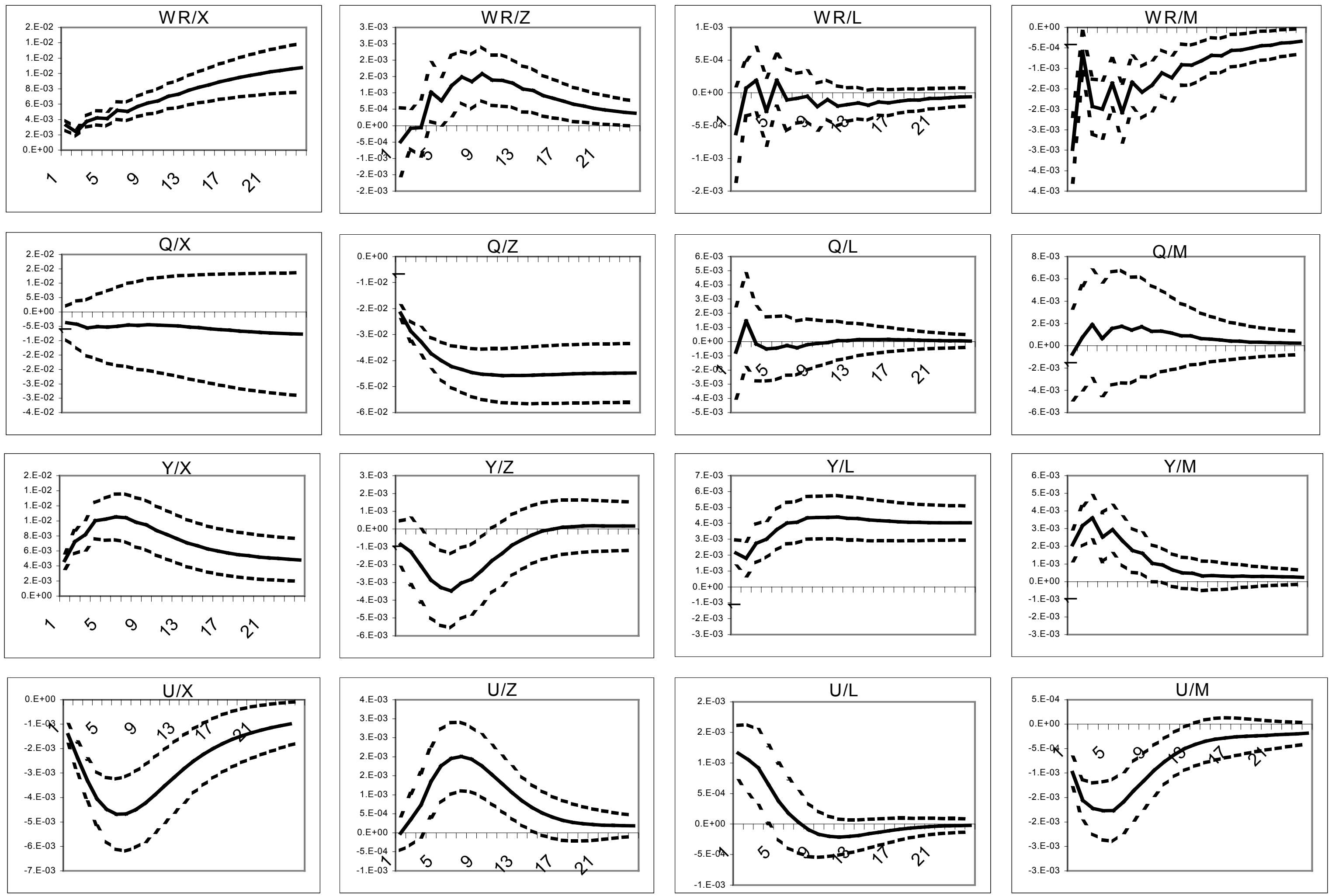
Figure 3: Response Functions to Structural Shocks



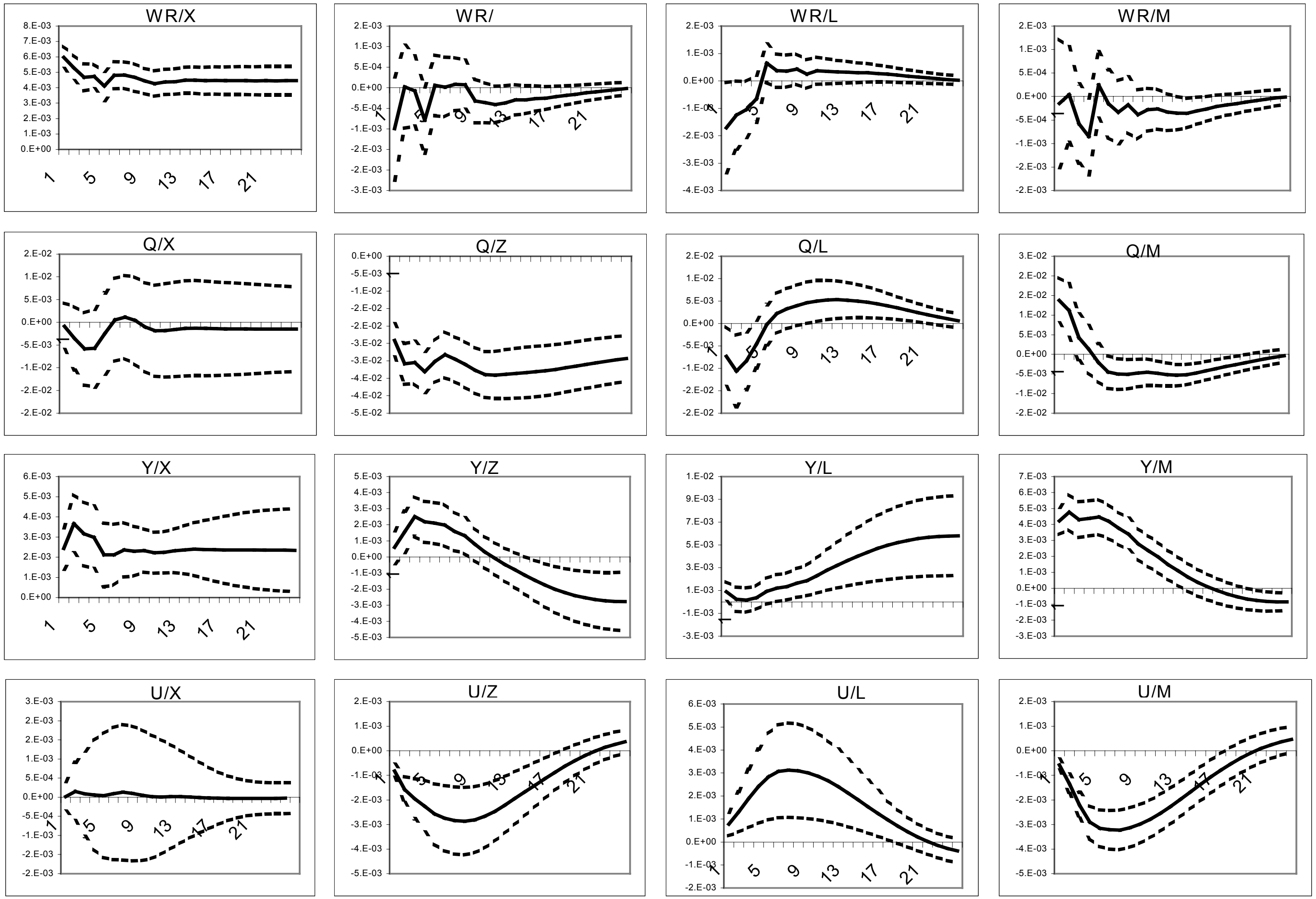
KOREA

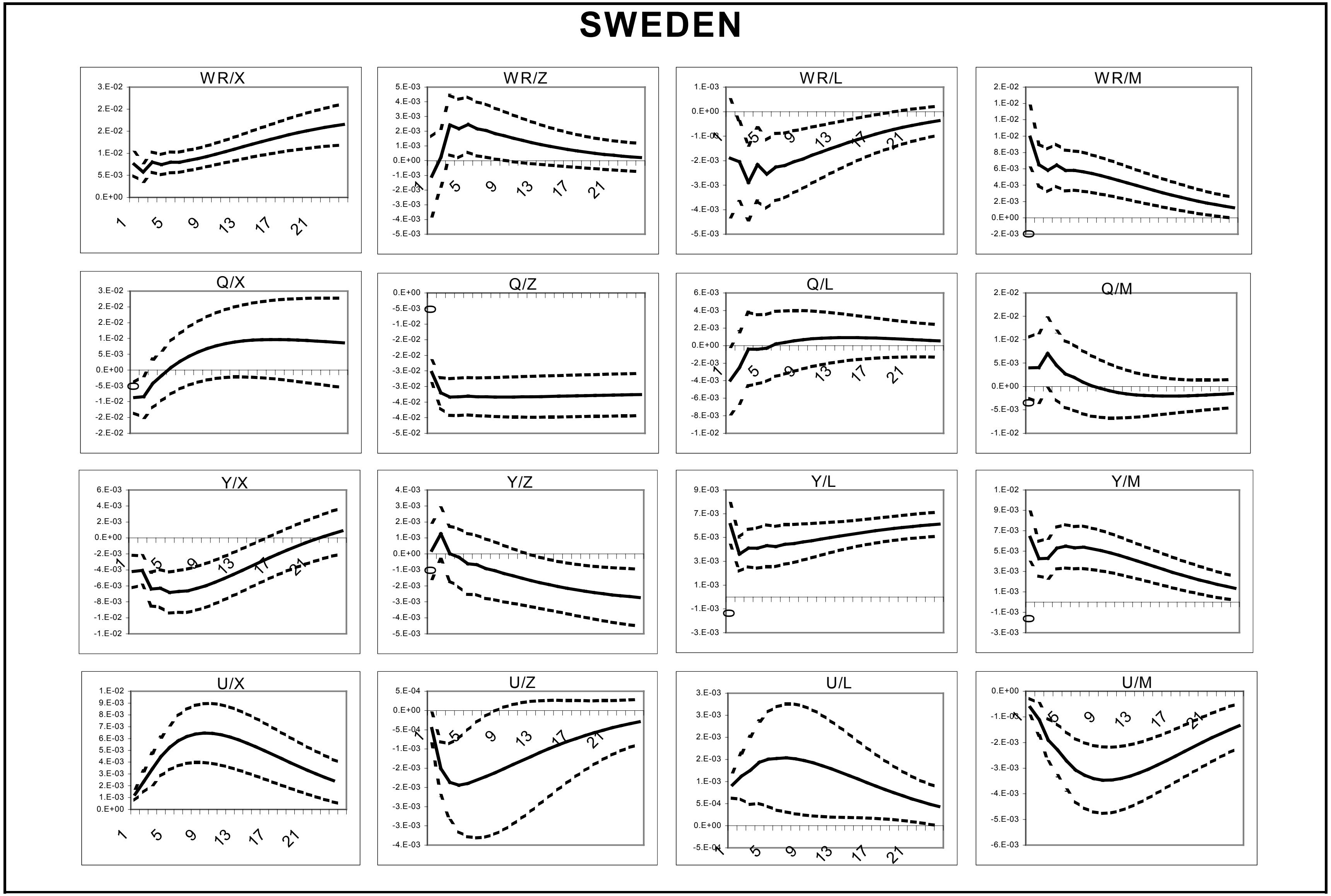


USA



United Kingdom




SWEDEN
WR/X
WR/Z
WR/L
WR/M
Q/X
Q/Z
Q/L
Q/M
Y/X
Y/Z
Y/L
Y/M
U/X
U/Z
U/L
U/M

COLOMBIA