EXOGENOUS SHOCKS AND

THE SOLVENCY OF THE ECONOMY[1]

(Velimir Bole[2])

1. Introduction

In a small open economy such as that of Slovenia, with micro-distortions in the labour market and a significant difference between the tradable and non-tradable sector market structure, firms may be exposed to considerable »domestic« and »foreign« real shocks. Policy interventions and changes in the relative prices of products and factors are the most important sources of domestic shocks. Fluctuations of foreign markets and economic policy or political interventions in the countries of trade partners generate foreign (external) shocks.

The question arises as to the nature and magnitude of the macroeconomic shocks that firms are most vulnerable to, i.e. those they are least able to withstand. From an economic policy viewpoint there are two reasons why it is important to understand the ability of firms to resist exogenous shocks. First, for the insight it provides into the potential impacts of economic policy measures. The adverse side-effects of certain economic policy interventions may be expressed, among other ways, in large changes in relative prices (real shocks) for particular sectors of the economy (particular groups of firms)[3]. Secondly, the resistance of firms to exogenous shocks is important for economic policy because of the asymmetric effects of potential external shocks. Precisely because of the possibility of external shocks, small open economies have a more active and therefore larger government, since the latter has to counter the effects of such shocks on specific segments of the economy (the Rodrik hypothesis)[4]. At entering the EU, both reasons for understanding the ability of firms to resist exogenous chocks are important for real and nominal convergence of the economy.

With the exception of a severe contraction of foreign markets in the initial period up to 1994, the economy did not face any major external (»foreign«) real shocks up to the end of the 1990s.[5] The first minor shocks were caused by jumps in the oil price after 2000. These too, however, were partly counteracted by economic policy (in the first half of 2003). The vulnerability of the relevant (tradable) part of the economy to such shocks has to date, therefore, not been unambiguously tested. Nevertheless, empirical findings show a statistically significant sensitivity of the solvency of firms that export considerable part of their production to the EU, that is, firms that confront a significantly more competitive market structure than others and face large exit costs.[6] In the same period since 1994 there have been significant real shocks of a domestic origin, concentrated in the years 1995-1996 and 2000-2002, when changes to the structure of taxation, major revisions to indirectly and directly

[1] Study prepared for the Ministry of Finance.

[2] EIPF Economic Institute, Prešernova 21, Ljubljana, info@eipf.si. Extensive data preparation was undertaken by Dr Robert Volčjak, an associate of the EIPF Economic Institute.

[3] See, for example, Bole(2003).

[4] See e.g. Rodrik (1998) or Begg and Wyplosz (1999).

[5] At the same time, however, significant nominal shocks in the form of fluctuations in (net) financial inflows from abroad (1993,1995-1996, 1999-2000) were present almost from the very outset of the economic transition. Economic policy has tackled these intensively from the very beginning.

[6] See Prašnikar et al (2003).

regulated prices and public sector wage hikes caused substantial and asymmetric changes in relative prices[7].

As a result of the reduction in the degrees of freedom and flexibility of economic policy in the last two years (and hence in its scope of potential effect) and the (still) pronounced micro-distortions in certain markets (principally the difference in market structure between the tradable and non-tradable sectors and the segmentation and inflexibility of the labour market), the effects of any exogenous shocks are likely to be confined to product and factor markets with the most competitive structure[8]. Naturally, this favours non-tradable sector, including the non-market service sector (the public sector), and therefore curbs market structure development of the non-tradable sector and spending restructuring of the public sector. The sustainable (long-term) efficiency of the economy could therefore be seriously reduced. Economic policy must therefore at least alleviate the adverse side-effects of the real shocks caused by its own interventions, even if it is (or will be) no longer able to alleviate the effects of external shocks to relative prices[9].

In determining economic policy, including policy designed to minimise at least the side-effects of economic policy interventions, two issues are important. On the one hand, the key channels by which potential exogenous shocks affect the solvency of firms and, on the other, size of the possible damage to the economy caused by potential exogenous shocks, primarily the increase in the number of insolvent firms (bankruptcies) and lost jobs.

The present analysis deals with both these issues. First, a model of »drastic« deterioration in solvency (solvency collapse) for tradable and non-tradable sectors of firms is specified and estimated. Then the effects of likely fluctuations in the factors relevant to the solvency of firms are analysed. The empirical distribution of actual effects of (fluctuations in) various key factors of the deterioration of firms' solvency in the period under review is analysed. Finally the change in firms' solvency and endangered jobs are assessed for different scenarios regarding the simultaneity and size of exogenous shocks.

2. A model of solvency collapse

Model specification. The specification of the model of solvency collapse is based on a model of credit risk for financial instruments. As the analysis is focused on the determinants of »large« changes in solvency, where the continued existence of the firm as a going concern is put in doubt, the model is specified in terms of a discrete transition of the firm into financial distress. Bankruptcy is only one of possible outcomes of financial distress, so the model analysed does not encompass specific factors of bankruptcy, i.e. it does not contain a specification of the factors determining the transition to bankruptcy.[10] We therefore speak of a solvency collapse model rather than a bankruptcy model.

Let Y_{it} be the present value of firm i at time t. Then the conditional probability of a collapse of solvency of firm i at time t is given by:

$$\Lambda_{it} = P(Y_{it} < c_{it} \mid Y_{it-1} \geq c_{it-1}) \tag{1}$$

[7] Apart from those in 1995, the shocks to relative prices in the period between the end of 1999 and 2001, which were caused by changes in the system of taxation, tax rates and regulated prices, were by far the largest in the analysed period of economic transition (see Bole (2003)).
[8] On reduction of degrees of freedom and flexibility of economic policy after 1999 see Bole(2003).
[9] See, for example, Bole(2003).
[10] For the additional elements required in modelling bankruptcy see Bernhardsen (2001).

where c_{it} is the critical threshold of the present value of the firm. Because the transition to financial distress (solvency collapse) for firms in Slovenia is generally not directly observable,[11] the analysis uses the change in firms' credit rating given by banks as an indicator of transition to financial distress. The present value features in the model only as a latent variable. It should be added that the analysis is restricted to a discrete model of changes in solvency because of the (annual) frequency of the available data.[12]

The change in present value at time t depends on specific (fundamental), systemic and random factors. Denote the vector of specific factors for firm i by x_{it} and the vector of systemic factors F_t [13]. We assume that because of the separate modelling of tradable and non-tradable sectors, the systemic factors for individual segments of firms can be combined into one (with only time variability).[14] Then the latent variable may be written in the following form:

$$(2) \qquad Y_{it} = bF_t + \sum \beta_l x_{it-l} + \zeta_i + \nu_{it}$$

where ζ_i captures the firm-specific (stable) present value of the firm in the period before the collapse of solvency and any other firm-specific attributes that influence the (time-invariant) deviation of the (unobservable) present value from the latent variable. Such firm-specific attributes may also arise as a result of the nature of the data sources. Because data from financial statements are used, this can refer to, for example, idiosyncracies in the accounting practices of individual firms. Let ν_{it} denote a well-behaved random disturbance (identically distributed and uncorrelated over i and t), which captures other unidentified factors determining the deviation of the present value from the measured latent variable; the final form of the model to be estimated is given by assuming that ν_{it} follows a logistic distribution.

Variables in the model. The dependent variable in the model is the discrete change (deterioration) in the expected solvency of the firm in consecutive periods. Expected solvency is represented by the firm's bank credit rating. The variable is conditional since it assumes that the firm had an A or B credit rating in the previous year.[15] The fundamental factors of solvency (x_{it}), unlike the systemic factors (F_t), differ between firms (they can be quantified by, for example, financial ratios calculated from accounting data, data on firm size, and investment betas). The key variables in empirical studies of the determinants of major changes in solvency and bankruptcies carried out in other countries generally include the volume of sales, liquidity, profitability, level of debt, size, and organisation, in addition to technological characteristics of the sector.[16]

A variety of proxy variables were tested for all of these determinants of solvency except organisation. Various lag structures were also experimented with. The following proxies for factors determining fluctuations in firms' present value were found to be empirically satisfactory candidates for inclusion among potential solvency variables: a liquidity measure (cashflow per unit of sales or assets), relative prices (material costs or costs of services per unit of output price), factor costs (labour costs per unit of output and to a lesser extent interest

[11] Data on market value are available only for a few firms, and even for them there is a question about capital market efficiency.

[12] See e.g. Basel Committee on Banking Supervision (2001).

[13] See Fama and French (1992) on models of fundamental factors and e.g. Pedrosa and Roll (1998) on the use of such models; on the inclusion of a systemic factor in a model of solvency see Hamerle et al (2002).

[14] As assumed in the Basel II model for yields on financial instruments.

[15] The A and B credit ratings are henceforth referred to as standard.

[16] See e.g. Hunter and Isachenkova (2002) and Bernhardsen (2001).

costs per unit of sales or output), and a variable for the volume and stability of demand (sales per unit of output).

Because descriptive analysis suggested that the effects of these solvency factors can differ greatly among firms operating in different market structures, the model was estimated separately for two categories of firm. The first consisted of firms with a presence on foreign markets and the second of firms that generally serve only the domestic market.

Because of the empirically significant effect on firms' credit ratings of sales to the markets of the advanced economies (in other words to markets with a competitive structure and large exit costs), which has been shown by an analysis of the sensitivity of the export economy,[17] a variable for sales to OECD countries as a proportion of total sales was included in the model of the first category of firms as an additional variable for the stability of demand.

The systemic determinants of solvency (F_t) were represented in the model by time dummies for individual years, while firm-specific (time-invariant) factors were captured by a component of the model disturbance (ζ_i). Since the probability in the model given by (1) is conditional (on lagged values), a firm is included in the estimation of the model at time t (by the vector of explanatory variables x_{it} and the credit rating Y_{it}) if its credit rating at time t-1 (Y_{it-1}) was standard, that is either A or B.

The dependent variable for the change in solvency in a particular year is defined as the difference in the firm's credit rating in credit agreements (for the same pair of firm and bank) in the current and previous year.[18] Since the model is estimated for a conditional dependent variable, that is for the deterioration in solvency from standard to sub-standard, the specific credit agreement in the current year (the associated credit rating of the borrower) is only used in quantifying the dependent variable if the condition in (1) is fulfilled, that is if a credit agreement existed in the previous year between the same bank and borrowing firm where the latter had an A or B credit rating.

The dependent variable analysed in the model (solvency collapse) is binary. It takes a value of zero if the firm's credit rating was unchanged in the current compared to the previous year (for each consecutive credit agreements of the same bank-firm pair), i.e. it remained standard (A or B). In all other cases the dependent variable takes a value of one, that is where (for consecutive credit agreements between the same bank-firm pair) the borrowing firm's credit rating deteriorated from the standard category (A or B) in the previous year to C, D or E in the current year.

Data. The model was estimated on a random sample of 5000 annual credit contracts between legal person (firms) in the corporate sector (sectors A to K in the Standard Classification of Activities) and resident banks in the period 1997-2001.[19] The term credit agreement is used provisionally in this analysis. Actual credit agreements between a particular firm and a bank can of course cover several years, and a bank and a firm may have several credit agreements in effect in any one year. For the sake of simplicity and concision we henceforth use the term credit agreement (in the current year of analysis) to denote the entire credit exposure of a particular bank to one and the same firm at the end of the year concerned. Each data point in the sample therefore refers to a credit agreement (thus defined) for a

[17] See Prašnikar et al (2003).

[18] And thus to the relevant "Cartesian product" of credit agreements.

[19] The random sample was created at the Bank of Slovenia from a database of all credit agreements, created as part of a project to estimate the migration matrix. The use of this sample of credit agreements in the present analysis of the effects of exogenous shocks on firms' solvency was made possible by the Bank of Slovenia.

particular bank-firm pair in a particular year. Each combination of firm, bank and year defines a unique observation.

For each data point the following data are available: data on financial statements of the borrower firm, data on receipts and outgoings arising from payment transactions by the borrower firm, the amount of credit under the relevant credit agreement, the borrower firm's credit rating, the grade of the credit, and export and import data for the borrower firm.

The grade of the credit is in general not the same as the credit rating of the corresponding borrower firm. If the firm has high-quality spare collateral available, it can achieve a higher grade of credit (and hence more favourable terms of borrowing). For this reason, rating of the borrower was used in constructing the variable for the change in solvency, since this only expresses the expected performance (solvency) of that firm by the bank. Thus, it is the borrower firm's credit rating alone, before taking account of collateral, that expresses its actual expected performance. In the following, such meaning of the credit rating is used as a rule, in the opposite the difference is explicitly accentuated.

A descriptive analysis was carried out on the entire sample of 5000 credit agreements, while in estimating the model it was necessary (for methodological reasons) to take a subset of the total. This was for two reasons.

Because the sample of credit agreements is random, it also contains firms which have multiple credit agreements for a given year, each one with a different bank. Because of that, the model described by (1) and (2) could only be estimated by using fixed (individual) effects for sectoral units (defined as bank-firm pairs), since, in the opposite, random effects estimation would involve the false assumption that these effects are randomly distributed among units (defined as bank-firm pairs).[20] But, this would lead to an unnecessary and large loss of degrees of freedom in estimation (by conditional logit). The sample was therefore »randomised« over banks by randomly selecting one credit agreement for each firm-year pair.[21]

Solvency collapse in this analysis is defined as a transition from an A or B rating to that of C or below. The model therefore analyses the (conditional) probability of transition from standard solvency, in which the borrower firm normally services its loan (with a slight delay at worst) to a critical solvency position (financial distress). For this reason, pairs of consecutive credit agreements (i.e. credit agreements for a firm-bank pair in two consecutive years) in which the firm rating in the first of the two consecutive agreements (the first of the two years) was not A or B were not included in the dataset of credit agreements on which the model was estimated.[22]

The number of credit agreements (observations) was further reduced by the use of lags.

Model estimation. Model (1) was estimated for two groups of observations (credit agreements for firm-bank pairs), denoted here as the tradable and non-tradable sector. The model for the non-tradable sector was estimated for all pairs of (consecutive) credit agreements in which the borrower firm had no sales to the rest of the world in the first year.

[20] Preparing software to estimate the model using an appropriate three-dimensional composite disturbance term (consisting of a constant firm-specific effect, a constant bank-specific effect and a pure disturbance) and randomly distributed individual (firm and bank) effects would exceed the purposes of the analysis.

[21] This procedure reduced the original sample of credit agreements by 10%. The remaining 90% of credit agreements are unique for each firm-year pair.

[22] The conditional nature of the dependent variable reduced the estimation sample by about a further 10% (see table of model estimation results).

The model for the tradable sector was estimated for all other credit agreements. In estimating each model, around 1500 complete data points (firm-year pairs) were used from an unbalanced panel with an average duration of 2.7 years in the tradable sector model and 3.0 years in the non-tradable sector model.

The logit model for the two economic sectors was estimated with random (individual) effects (ζ_i). The table of results shows the number of observations and the average duration for the sectoral firms that were actually used in the estimation. Because of the size of the panel, convergence was tested for both models.[23]

In the initial phase of estimating the model of solvency collapse, the potential explanatory factors for reductions in solvency were, as mentioned, various variables for liquidity, the level of debt, profitability (for relative prices and costs), size, foreign sales, the volume and stability of demand, and annual time dummies. As discussed, the annual time dummies captured systemic factors of fluctuations in solvency.[24] Quantification of the analysed variables is set out in the annex.

3. Descriptive analysis

Composition of (expected) solvency. A simple breakdown of firms' expected solvency (ratings) in the analysed random sample of credit agreements is given in Table 1. The first five columns show the proportion of agreements in which the borrower firm falls into each credit rating for the sample period as a whole and for each individual year. The penultimate column gives the proportion of consecutive credit agreements in which a solvency collapse occurred in the current year (given in each row), i.e. where a particular bank classified the firm in the standard credit rating bracket (A or B) in the previous year but gave it a credit rating of C or lower in the current year. The final column shows the proportion of bank-firm pairs in which a solvency collapse occurred in the current year, but where by means of appropriate collateral the firm avoided the financial distress (specific credit rating was higher than firm rating) that would otherwise have occurred as a result of its inability to service its debt obligations.

The broad distribution of firms' solvency is clear. Much the largest proportion of firms (around 70%) have a credit rating of A, the proportion of firms with a credit rating of B fluctuates around 20%, while the remaining 10% have a lower credit rating, or in other words a lower expected solvency, in the years analysed. Because, as discussed above, the analysis uses credit ratings relating to the performance of the borrower (i.e. assessments of expected solvency without taking account of collateral), the composition of the standard credit rating category (A and B) differs from what it would be if the nature of the collateral were taken into account. Specifically, the proportion of firms rated A is smaller and the proportion of those rated B larger because collateral is not taken into account. Furthermore, the proportion of firms in the standard category (A and B combined) is smaller than in the breakdown of expected solvency of claims (in which collateral is reflected).

The penultimate column shows the frequency of solvency collapse in the analysed sample. It can be seen that the annual incidence of solvency collapse during the period analysed was about 4.6%. In other words, in about 4.6% of credit agreements between a bank

[23] Because the conditional probabilities (appropriate integrals) in the logit model with random (individual) effects are calculated by a quadrature formula, the products of the cumulative functions of the logistic distribution must be sufficiently well-behaved functions (so that they can be adequately approximated by a polynomial). If they are not, problems can occur with convergence of the algorithm.

[24] See the description of the Basel II model in e.g. Hamerle et al (2002).

and a firm, the firm encountered financial difficulties in the current year, causing it to be downgraded to a credit rating of C or lower, having been rated in the standard category (A or B) by the same bank in the previous year. It should be added that the analysis of solvency collapse in advanced economies in other countries gives rates of incidence that are not substantially different from this figure.[25]

The difference between the second-to-last and last columns illustrates the importance of collateral for financial stability of the economy. It can be seen that, of those firms that experience a collapse of solvency, only some actually enter financial distress. On average for the sample period as a whole, the proportion of firms actually moving from standard solvency (a credit rating of A or B) into financial distress is only 2.9%. In other words, almost 40% of firms experiencing a drastic deterioration in solvency avoid financial distress through appropriate collateral. The collateral involved must have been of very high quality (generally real estate) to persuade the relevant bank to grade the claim on the firm in the standard category (A or B) despite the considerable deterioration in solvency. A significant fact for the analysis of the resistance of firms to financial difficulties is that the difference between the incidence of solvency collapses and the incidence of financial distress is declining. This can be taken to imply that the potential for firms to absorb fluctuations in solvency by pledging real estate collateral is declining, and in particular that a fall in the assets (real estate) market (combined with an exogenous shock to the economy) could significantly increase the number of instances of financial distress, and hence also the costs to the economy as a whole (such as unemployment).[26]

Solvency collapse. Table 2 illustrates, for certain variables, the situation before and at the time of a collapse in solvency. The variables selected are those that foreign studies identify as (potential) determinants of a major deterioration in a firm's solvency.[27] They are: liquidity (cashflow per unit of sales), level of debt (short-term liabilities per unit of assets), relative prices (materials and services costs per unit of output), factor prices (labour and interest costs per unit of sales), and volume of demand (sales per unit of output and foreign sales as a proportion of total sales). For each variable the (average) value in the current year and the change with respect to the previous year are given.

The average values shown are calculated only for firms having credit agreements with a bank that gave them a credit rating of A or B in the previous year. The table is divided into two sections. The first section (the first two columns) shows the values for the manufacturing sector (sector D), and the second for other economic activities (up to and including sector K). For each sector, average values for cases of solvency collapse and cases of unchanged (and therefore standard) solvency are shown separately.

In the manufacturing sector, which has the largest proportion of sales to markets with a competitive structure, the values of studied determinants of solvency clearly illustrate the key differences between firms approaching a phase of drastic deterioration in solvency and those whose expected solvency is assessed to be sound (unchanged)). The cashflow of manufacturing sector firms in the year of solvency collapse is already negative (by about 1% of sales), while for firms with unaltered solvency it is on average considerably higher (and positive) at around 8% of sales. The deterioration in liquidity in the last year (before collapse)

[25] In an analysis of bankruptcy in the United Kingdom the average annual incidence of bankruptcy in the (significantly smaller) sample was found to vary between 1% and 3.3% (see Hunter and Isachenkova (2002)).

[26] For more on the significance of real estate for the ability of firms to resist solvency fluctuations see Bole (2003a), "The Real Estate Market and Exogenous Shocks", in preparation.

[27] See e.g. the pioneering analysis of Beaver (1966) and later studies by Altman (1968) and Ohlson (1980), up to recent work by Geroski and Gregg (1996) and the study of bankruptcy in the United Kingdom by Hunter and Isachenkova (2002), already cited.

is very high for firms approaching a drastic deterioration in solvency, since cashflow on average falls by around 24.6% of the value of sales in the year prior to the solvency collapse. Firms experiencing a drastic decline in solvency also have a substantial level of (short-term) debt – over 30% higher than firms with unchanged (standard) solvency, although the rise in debt in the year prior to collapse is relatively small (around 5%). There are also marked differences in interest cost burdens, which are almost 90% higher as a proportion of sales among firms experiencing a collapse in solvency than among those with a stable (standard) credit rating. Labour, services and materials costs are also higher (per unit of output) and demand (sales per unit of output) lower in the case of firms undergoing a collapse in solvency, although the differences are smaller than 10%.

In the other sectors, which by and large operate in significantly less competitive markets than manufacturing firms, the differences between firms with deteriorated and standard solvency are smaller, and marked differences exist only in the level of debt, interest costs and demand deterioration.

4. Model results

Estimates. The estimated model of solvency collapse for the tradable sector is shown in Table 3, while the model for the non-tradable sector is shown in Table 4. Each table shows the significance of the model (a joint test of the coefficients on the explanatory variables), the value and significance of individual coefficients, the number of observations used in the estimations and the average duration of the individual sectoral units of the panel. Lags (annual) are denoted in parentheses.

Both models are statistically adequate. As discussed, the model is estimated incorporating random individual effects in both cases, although in each case the variance of the distribution of the random effects is not significantly different from zero at a 5% significance level.

In the model for the tradable sector the following factors are highly significant in explaining deteriorations in solvency: the level of short-term debt, labour costs, the change in relative prices (growth in materials costs per unit of output), decline in demand and the speed of decline in demand. The estimated model of solvency collapse confirms to a statistically significant degree that firms' sensitivity (to potential exogenous shocks) increases significantly with their presence (the proportion of their sales) on developed foreign markets (markets of OECD countries).[28] It should be noted that, in addition to significant effects of changes in the determinants of weakening (expected) solvency already mentioned, the deterioration in liquidity (which emerged strongly in the descriptive analysis of the data) also increases the risk of solvency collapse, although its effect is not statistically significant even at the 10% level. The distribution of the latent variable across firms on average for the period 1997-2001 is shown in Figure 2.1.

Statistically significant factors determining the collapse of solvency of firms in the non-tradable sector are the speed of deterioration of liquidity, decline in demand in the year before collapse and the level of short-term debt. The speed of decline in demand (change in demand from previous year) also increases the probability of solvency collapse, although the effect is statistically insignificant even at 10%. Neither labour costs nor changes in relative prices have a statistically significant effect on solvency in the non-tradable sector. This finding is not surprising, as firms in the non-tradable sector find it easier to alleviate the pressure of labour costs by raising prices than firms in the tradable sector because of the significantly less

[28] The study by Prašnikar et al (2003), conducted on an entirely separately drawn sample of firms, finds a similar sensitivity.

competitive structure of the markets they serve[29]. Since, for the same reason, the relative competitiveness of sales markets in comparison with purchase markets is less for firms in the non-tradable sector than for those in the tradable sector, relative prices are much less important in explaining deteriorations in solvency for firms in non-tradable sector. The distribution of the latent solvency variable across firms on average for the period 1997-2001 is shown in Figure 2.1.

Effects of historic shocks. The model estimates indicate which exogenous shocks could seriously endanger the solvency of the economy. However, in analysing the effects of (potential) exogenous shocks, the size of the assumed fluctuations in the factors determining solvency collapse that are specified and quantified in the model is naturally of key relevance.

Hypothetical shocks of arbitrary size can be considered. As discussed earlier, except for rises in the price of oil, the economy has not been subjected to major real external shocks since 1994. At the same time, however, in the periods 1995-1996 and 2000-2001 it underwent a substantial change to relative prices, brought about by the government through alterations to the tax system and revisions to regulated prices. On the whole, neither the economics profession nor economic policy-makers consider either of these shocks to be noteworthy for the achievements of the economy. In analysing potential exogenous shocks we therefore take the effects of (actual) historic exogenous shocks from the period under analysis as a baseline for the minimum magnitude of shock. To this end an empirical distribution of historic shocks was calculated for each explanatory factor of the deterioration in solvency for the period analysed. The distribution of historic shocks for each variable was obtained by taking the largest adverse deviation from the mean value (for the period 1997-2001) of the variable in question for each firm in the sample as the corresponding historic shock for this firm and variable.

Multiplying the »historic shocks« thus calculated for each variable and each firm by the relevant coefficient from the estimated model yields a distribution of effects of historic shocks to the latent solvency variable across firms, or in other words an increase in the latent variable above its average value, caused by the realisation of the (baseline, i.e. minimum) »historic shock« for that variable.

Tables 5 and 6 give the decile boundaries of the distribution of the effects of historic shocks on the latent solvency variable. As an illustration of the size of the costs to the national economy of such (minimum baseline) historic shocks (for each particular variable-determinant of solvency), the final row shows the increase in the number of endangered jobs caused by so defined historic shock in each firm for the period 1997-2001. The rise in endangered jobs is shown as a percentage of endangered jobs in the average case, i.e. in the case in which for each firm each determinant of solvency takes the average value for that firm in the period analysed. Endangered jobs are therefore calculated using the expression:

$$(3) \qquad \sum z_i F_l(lat_i)$$

where z_i is the firm's average employment prior to collapse if a collapse occurred during the analysed period, or its average employment over the whole period if no collapse occurred. The logistical distribution function is denoted by F_l and the corresponding (analysed) value of the latent variable for the i-th firm by lat_i.

The distribution of the effects of historic shocks shows that demand (both a contraction in the volume of demand and the speed of contraction) in the period analysed had the largest adverse effect on the solvency of firms in the tradable sector. The effects of the historic shocks in the last two deciles of firms are roughly twice as high for demand (contraction in

[29] See, for example, Bole(2002).

volume and speed of contraction) as for relative prices. Historic demand shocks (given average values for the other determinants of solvency) would by itself increase endangered jobs by around 35%, while if such historic shocks occurred in a single year the number of endangered jobs could increase by around 70%.

The historic shocks to the change in relative prices were the second most important reason for deteriorations in solvency of the tradable sector in the period of the analysis, followed by shocks to the level of debt and to wages. Besides the historic shocks to demand, shocks to relative prices likewise had considerable effect on the majority of firms in the tradable sector, since the contribution to the latent solvency variable in one instance or other was greater than 0.1 in over half of all firms. The magnitude of the relative price shocks impact is of the outmost importance for the process of the real and nominal convergence after entering the EU. Namely, after entering the ERMII policy makers will be able to tackle relative price shocks, emanating from differences in the market structure between tradable and non-tradable sector, only through accelerating restructuring of the non-tradable sector, because monetary policy will not be able to control real interest rates (final demand) any more. Therefore, shocks into the relative prices will be far the most dangerous, and long lasting, asymmetric shocks for the economy, after entering the ERMII.

The distribution of the effects of historic shocks in all determinants of solvency deterioration is heavily skewed towards the upper values. For example, the range of the effects of historic shocks to demand in the tradable sector from the lowest decile of the distribution to the median is as little as one-seventh as wide as the range of effects from the median to the highest decile. It is far higher in the case of exports to OECD markets, since the entire effect on the deterioration of firms' solvency is concentrated in the top decile of firms, who contributed markedly to a deterioration of their expected solvency by a rapid rise in export share of OECD markets. Since the majority of domestic shocks since 1994 were the adverse side-effects of economic policy itself (change in the structure of taxation and increases in indirectly and directly regulated prices), the severe right-skew of the distribution of historic shocks shows unambiguously that the effects of the corresponding economic policy interventions presented strong real shocks as they were highly asymmetrically amortised (between firms).

In the non-tradable sector the most significant effects were from historical shocks to the level of debt. The effects of historic shocks to demand, while significant, are nevertheless far smaller than in the tradable sector. While the historic shocks to the level of debt had marked effects on more than half of firms, the effects of the decline and speed of decline in demand were concentrated in the last two deciles of (the most exposed) firms. Endangered jobs would therefore be most severely increased – by almost 20% – by historic shocks to short-term debt levels, in the non-tradable sector.

The effects of historic shocks on the number of endangered jobs are smaller in the non-tradable sector than in the tradable sector. There are particularly large differences in potential effects of exogenous macroeconomic shocks caused by adverse side-effects of economic policy interventions (the demonstration and financial effects of public sector wages, the effects of alterations in the structure of taxation and revisions to regulated prices, and movement in the exchange rate) and fluctuations in foreign markets. This is documented both by the size of the effects of historic shocks in the most affected firms and by the wide dispersion of firms exposed to the effects of the shocks in question. Demand shocks reduce the solvency of firms in the tradable sector by about three times as much as firms in the same deciles of the non-tradable sector. At the same time, however, over half of all firms in the tradable sector are affected by shocks to demand and relative prices, which reduce solvency (increase the latent solvency variable by at least 0.1) to the same extent as demand shocks in less than 30% of non-tradable sector firms.

Effects of hypothetical exogenous shocks. The question of the resistance of the economy to potential exogenous shocks is naturally connected to that of (the probability distribution of) the sizes of potential shocks. As an illustration of the distribution of the magnitude of historical exogenous shocks to the four key determinants of deteriorations in solvency in the tradable sector, Table 7 summarises the size of the analysed historical shocks for the median and the ninth decile of the distribution of firms (in terms of percentages of the average value of the variable concerned). Clearly, especially in the demand factors, even relatively small shocks can induce a significant deterioration in solvency. Even in the highest decile of the distribution of historic shocks, the market contracted only by about 11% relative to the size of production. As a second illustration, in the case of historic relative price shocks, even at the median of the shock distribution the fluctuation (the percentage magnitude of the shock) is smaller than the gap between the increase of producer prices and the increase of the price of services and all non-tradable products in 2002.

Table 8 shows the model estimates of the effects on the number of endangered jobs for some hypothetical changes in the latent solvency variable. It can be seen that the implicitly assumed shocks are of the same order of magnitude as the historic shocks already analysed (shown by the effects on the latent solvency variable in Tables 5 and 6). Thus, for example, the largest assumed change in the latent variable (1.0) is identical to the effect of the historic demand shocks actually experienced by the upper decile of firms in the tradable sector during the period studied.

It should be noted, however, that for a serious threat to economy-wide solvency to arise (a systemic crisis), simultaneity of exogenous shocks to several determinants of solvency is necessary. For tradable sector firms, which are already more heavily affected, a simultaneous shock to several determinants of solvency could increase the latent solvency variable (as shown in Table 5) to significantly above 1.0 quite easily, given the historical size of shocks. A hypothetical scenario of »non-gradualist« economic policy in less benign external conditions than are assumed for 2003 or 2004[30] could increase the latent solvency variable for firms around the median of the distribution of subjection to shocks by almost 0.38.

The effects on the number of endangered jobs shown in Table 8 are expressed as a percentage of endangered jobs given the average values of the determinants of solvency for the period 1997-2001. As previously discussed, the proportion of endangered jobs (given average values of the solvency factors) is 4.6% in the tradable sector and 3.6% in the non-tradable sector.

A uniform increase in the latent solvency variable of 0.1 would increase endangered jobs in both sectors by somewhat under 10%. Even an exogenous change roughly equal to the differential effect (on the expected solvency, i.e. the corresponding value of the latent variable) of sales to the highly developed markets would increase endangered jobs to, respectively, around 3.9% and 5.0% of all employees.

A less »gradualist« economic policy in the context of slightly less favourable external economic conditions than are otherwise assumed for this and next year could increase endangered jobs by around a further 35% (i.e. to 4.9% or 6.2% of employees).

Clearly, the effects of major simultaneous exogenous shocks on solvency and hence employment are large. For example, in the hypothetical extreme case involving simultaneous exogenous shocks to demand, relative prices and wages of the same magnitude as witnessed historically (but not simultaneously) in the sixth decile (for each factor separately) of the

[30] For example a 2% contraction in the export market, 5% growth in relative prices (due to fixing of the exchange rate) and 7% wage inflation (5% price inflation plus an additional 2% due to productivity growth).

distribution of firms by their degree of subjection to shocks, the number of endangered jobs in the tradable sector could more than double.

The effects on employment in the case of exogenous shocks are further dependent on the effects of the analysed exogenous shocks on the property market. A considerable decline in the property market associated with exogenous shocks would increase endangered jobs by around a further 40% due to reduction in the value of collateral. What is more, this is based on the average level of firms' collateral volume for the period 1997-2001, ignoring the downward trend in the available amount of collateral, that took place in the studied period.

5. Extended summary

A model of drastic deterioration in solvency (solvency collapse) in the tradable and non-tradable sectors of the economy is estimated. Determinants of solvency collapse in the tradable sector are the level of short-term debt, labour costs (per unit of output), relative prices (growth of materials costs per unit of output), declining demand and the speed of decline in demand. The estimated model confirms that the vulnerability of firms to potential external shocks increases significantly with the (relative) presence on the developed foreign markets. In the non-tradable sector the determinants of solvency collapse are the speed of deterioration in liquidity, decline in demand and firms' level of short-term debt.

In analysing the effects of potential external shocks, the effects of historic exogenous shocks during the period of the analysis are taken as the baseline for the minimum magnitude of effect. The magnitude of the costs to the national economy of such (baseline - minimum) historic shocks is illustrated by considering the increase in endangered jobs caused by the shocks. The increase in potential lost employment is calculated as a proportion of the actual level of employment in firms suffering a solvency collapse during the period analysed (4.6% of jobs endangered in the tradable sector and 3.6% in the non-tradable sector).

The distribution of the effects of the historic shocks indicates that demand (market fluctuation) has been the most significant factor endangering the solvency of firms in the tradable sector. Even just demand shocks of the historic magnitude (given average values of the other solvency factors) would increase the number of endangered jobs by around 35%, while if the historic shocks occurred within the space of a single year (that is, in the case of fast deterioration of demand), endangered jobs could increase by around 70%. The second most important reason for deterioration of solvency of firms in the tradable sector during the period analysed were historic shocks to relative prices (the ratio of sales prices to input prices), followed by shocks to the level of debt and to the size of wages (relative to output). Besides demand shocks a large proportion (roughly half) of firms were substantially affected just by shocks to the relative prices.

The magnitude of the relative price shocks impact is of the outmost importance for the process of the real and nominal convergence after entering the EU. After entering the ERMII policy makers will be able to tackle relative price shocks only through accelerating restructuring of the non-tradable sector, because monetary policy will not be able to control real interest rates (final domestic demand) any more. Therefore, shocks into the relative prices will be far the most dangerous, and long lasting, asymmetric shocks impinging on the economy, after entering the ERMII.

The distribution of the effects of historic shocks to all determinants of solvency deterioration is heavily skewed towards the higher values. Since the majority of domestic real shocks since 1994 were the adverse side-effects of economic policy itself (change in the structure of taxation and increases in indirectly and directly regulated prices), the severe right-skew of the distribution of historic shocks illustrates that the effects of the corresponding economic policy interventions were themselves highly asymmetrically amortised.

In the non-tradable sector the most significant effects were from historical shocks to the level of debt. The effects of historic shocks to demand, while significant, are nevertheless far smaller than in the tradable sector. Neither labour costs nor changes in relative prices have a statistically significant effect on solvency in the non-tradable sector. Less competitive market structure in the non-tradable sector enables firms in the non-tradable to alleviate the pressure of labour costs or input prices by raising output prices much more easy than firms in the tradable sector. Endangered jobs in the non-tradable sector would therefore be most severely increased – by almost 20% – by historic shocks to short-term debt levels.

The effects of historic shocks on endangered jobs would be smaller in the non-tradable sector than in the tradable sector. There are particularly large differences in potential effects of exogenous macroeconomic shocks caused by side effects of economic policy interventions (the demonstration and financial effects of public sector wages, the effects of alterations in the structure of taxation and revisions to regulated prices, and movement in the exchange rate) and fluctuations in foreign markets. This is documented both by the size of the effects of historic shocks in the most affected firms and by the wide dispersion of firms affected by the shocks in question. Demand shocks reduce the solvency of firms in the tradable sector by about three times as much as firms in the same deciles of the non-tradable sector.

It must be emphasised that simultaneity of exogenous shocks to several determinants of solvency is crucial for serious threat to the solvency of a large section of the economy. The study estimates the effects on the deterioration of solvency (the percentage increase in the number of endangered jobs) for some such hypothetical scenarios. A hypothetical scenario of »non-gradualist« economic policy in less benign external conditions than are assumed for 2003 or 2004 (2% contraction in the export market, 5% growth in relative prices and 7% wage increase) could increase endangered jobs by around 35% (i.e. to 4.9% of employees in the non-tradable sector and 6.2% of those in the tradable sector). In the hypothetical extreme case involving simultaneous exogenous shocks to demand, relative prices and wages of the same magnitude as witnessed historically (but not simultaneously) in the seventh decile of the distribution of firms by their degree of subjection to shocks, endangered jobs in the tradable sector could more than double.

Size of external shocks effects on employment depends also on the effects of the analysed exogenous shocks on the real estate (assets) market. A decline in the real estate market associated with exogenous shocks would increase endangered jobs by around a further 40% due to reduction in the value of collateral. What is more, this estimate is based on the average level of firms' collateral for the period 1997-2001, ignoring the downward trend in the amount of collateral available that took place in the studied period, and which reduced the potential for firms to absorb fluctuations in solvency by pledging real estate collateral.

6. Annex

Table 1:Sample distribution of credit ratings

	A	B	C	D	E	Fall in credit rating of firm	Fall in grade of credit
Whole period	0.70	0.21	0.05	0.03	0.01	0.046	0.029
1997	0.80	0.17	0.02	0.01	0.00	-	-
1998	0.67	0.25	0.05	0.02	0.01	0.058	0.019
1999	0.73	0.20	0.04	0.02	0.00	0.031	0.025
2000	0.67	0.21	0.06	0.03	0.01	0.042	0.029
2001	0.63	0.22	0.07	0.06	0.02	0.053	0.044

Source: Credit agreements database of Bank of Slovenia; own calculations.

Table 2: Description of changes in solvency

	Manufacturing		Other sectors	
	Solvency collapse	No change in solvency	Solvency collapse	No change in solvency
Liquidity	- 0.0107	0.0737	- 0.0056	- 0.0042
Δ(-1)	- 0.2454	0.0051	- 3.5405	- 0.0887
Debt	0.6374	0.4799	0.6029	0.5440
Δ(-1)	0.0352	0.0027	- 0.0212	0.0006
Labour costs	0.2666	0.2319	0.1891	0.1891
Δ(-1)	0.0248	0.0030	- 0.0081	0.0070
Materials costs	0.4968	0.5037	0.4893	0.4872
Δ(-1)	0.0383	- 0.0049	0.0274	- 0.0038
Services costs	0.2253	0.1833	0.2496	0.2579
Δ(-1)	0.0165	- 0.0105	- 0.0099	0.0002
Interest	0.0760	0.0413	0.1204	0.0849
Δ(-1)	0.0246	0.0023	0.0423	0.0189
Demand	0.9856	1.0023	0.9852	1.0012
Δ(-1)	- 0.0076	- 0.0052	- 0.0037	- 0.0043
Foreign sales	0.2410	0.2573	0.1074	0.0960
Δ(-1)	- 0.0255	0.0065	0.0063	0.0020

Note: Δ(-1) change from previous year.
Source: Credit agreements database of Bank of Slovenia; income statements and balance sheets of enterprises, APP (Payments Agency); own calculations.

Table 3: Solvency collapse model (tradable sector)

	Coefficient	T-statistic
Liquidity	- 0.4569	- 1.30
Short-term debt (-1)	1.2766	2.79
Labour costs (-1)	2.5559	4.12
Change in relative prices	2.6352	2.93
Change in demand	- 8.8466	- 4.57
Demand (-1)	- 10.5973	- 4.05
Sales to OECD (-1)	1.8117	2.90
1998 dummy	0.4268	1.53
Constant	6.0649	2.53

χ^2 (8) = 51.38 (0.000)
N=1474
T=2.7

Source: Credit agreements and foreign trade transactions database of Bank of Slovenia; income statements and balance sheets of enterprises, APP (Payment Agency); own calculations.

Table 4:Solvency collapse model (non-tradable sector)

	Coefficient	T-statistic
Short-term debt (-1)	1.8491	4.03
Change in liquidity	- 0.0065	- 2.00
Demand (-1)	- 2.7527	- 1.73
Change in demand	- 1.7605	- 1.27
1998 dummy	- 0.7251	- 2.08
Constant	- 1.2717	- 0.78

χ^2 (5) = 27.30 (0.000)
N = 1539
T = 3.0

Source: Credit agreements and foreign trade transactions database of Bank of Slovenia; income statements and balance sheets of enterprises, APP (Payment Agency); own calculations.

Table 5: Effects of historic shocks (tradable sector)

Decile of firms	Debt	Liquidity	Labour costs	Change in relative prices	Demand	Change in demand	Exports to OECD
1.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.	0.0139	0.0002	0.0104	0.0	0.0	0.0	0.0
3.	0.0333	0.0071	0.0196	0.0272	0.0042	0.0	0.0
4.	0.0526	0.0117	0.0316	0.0718	0.0587	0.0215	0.0
5.	0.0741	0.0171	0.0443	0.1089	0.1297	0.1024	0.0
6.	0.0929	0.0247	0.0652	0.1560	0.2347	0.2345	0.0
7.	0.1274	0.0316	0.0858	0.1988	0.3413	0.3683	0.0003
8.	0.1627	0.0438	0.1155	0.2886	0.5379	0.6418	0.0277
9.	0.2324	0.0724	0.1738	0.4531	0.9528	1.0236	0.1248
10.	-	-	-	-	-	-	-
Increase in endangered employment (%)	8.0	0.0	8.0	12.0	34.0	36.0	12.0

Note: Contributions to the latent solvency variable are calculated as $\beta_l \, x_{it-l}$ in equation (2).
Source: Credit agreements and foreign trade transactions database of Bank of Slovenia; income statements and balance sheets of enterprises, APP (Payment Agency); model estimates.

Table 6: Effects of historic shocks (non-tradable sector)

Decile of firms	Debt	Liquidity	Demand	Change in demand
1.	0.0	0.0	0.0	0.0
2.	0.0401	0.0001	0.0	0.0
3.	0.0713	0.0002	0.0	0.0
4.	0.1031	0.0003	0.0016	0.0008
5.	0.1464	0.0004	0.0248	0.0181
6.	0.1760	0.0006	0.0605	0.0547
7.	0.2236	0.0009	0.1106	0.0885
8.	0.3053	0.0012	0.1826	0.1442
9.	0.4122	0.0025	0.3481	0.2664
10.	-	-	-	-
Increase in endangered employment (%)	19.0	0.0	8.4	4.8

Note: Contributions to the latent solvency variable are calculated as $\beta_l x_{it-1}$ in equation (2).
Source: Credit agreements and foreign trade transactions database of Bank of Slovenia; income statements and balance sheets of enterprises, APP (Payment Agency); model estimates.

Table 7: Size of historic shocks (as a percentage of mean)

	Median	Highest decile
Wages	16.9	39.5
Change in relative prices	5.6	26.7
Demand	1.7	8.9
Change in demand	1.9	11.5

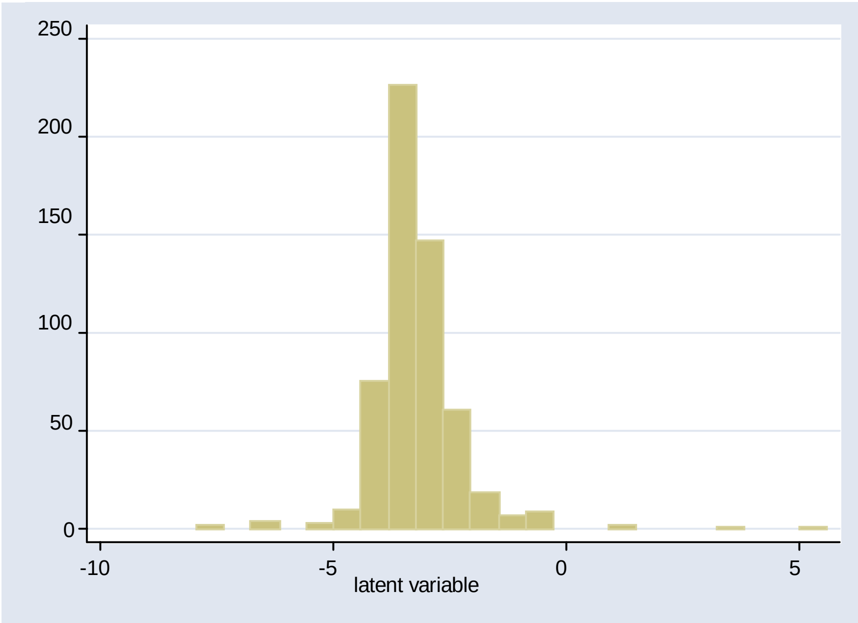
Note: Size of historic shocks are calculated as average of $(\max_t(x_{it}) - x_{i.})/\mathrm{abs}(x_{i.})*100$. across firms "i" at median and in the highest decile of distribution of
$(\max_t(x_{it}) - x_{i.})/\mathrm{abs}(x_{i.})*100$.
Source: Income statements and balance sheets of enterprises, APP (Payment Agency); own calculations.

Table 8: Effects of exogenous shocks on endangered employment (% of actual endangered employment)

Size of shock	Non-tradable sector	Tradable sector
0.1	9.4	9.3
0.2	19.7	19.6
0.3	30.8	30.5
0.4	43.1	42.7
0.5.	56.6	55.6
0.6	70.9	69.7
0.7	86.9	84.9
0.8	103.8	100.0
0.9	122.6	120.6
1.0	143.9	137.5

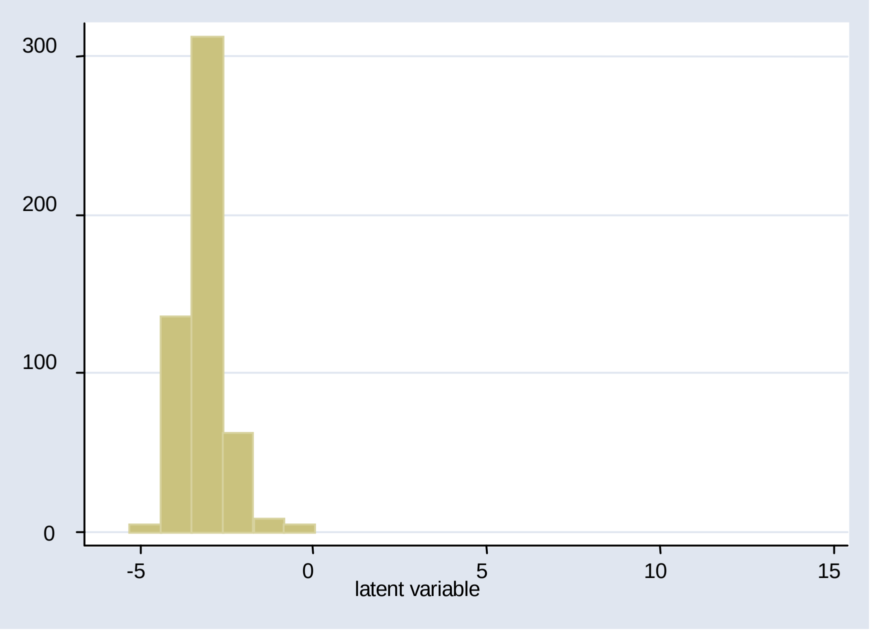
Note: Size of exogenous shock quantified as a change in latent solvency variable
$\Delta(bF_t + \sum \beta_l x_{it-l})$ in equation (2).
Source: Model estimates.

Figure 1:Frequency distribution of latent solvency variable (tradable sector)



Note: Latent solvency variable quantified as $bF_t + \sum \beta_l x_{it-l}$ in (2).
Source: Model estimates.

Figure 2: Frequency distribution of latent solvency variable (non-tradable sector)



Note: Latent solvency variable quantified as $bF_t + \sum \beta_l x_{it-l}$ in (2).
Source: Model estimates.

7. Appendix

Variable definitions.

ind_i : input prices
ind_o : sales prices
qb : output
sq : sales
exOECD : sales to OECD countries (in Slovenian tolars)
cf : cashflow
mat_i : costs of materials and services

Input prices for sectors in the two-digit classification are calculated using IO tables and the value added deflators of the same sectors in the two-digit classification

The other variables are calculated as follows.

qb=aop050 + (aop011-aop011(-1)*ind_o)+(aop012-aop012(-1)*ind_o)+
(aop013-aop013(-1)*ind_o)

mat_i=aop063+aop062+aop061-(aop010-aop010(-1)*ind_i)

cf = B09[31]

Codes of aop* variables used in definitions correspond to balance sheets codes used by Payments Agency (APP) .

Variables in the model of the solvency collapse are .

Short-term debt : aop32/aop19
Liquidity : cf/aop050
Labour costs : aop64/qb
Relative prices : mat_i/qb
Demand : sq/qb
Exports to OECD : exOECD/sq

"Change in variable x" refers to the first difference in variable x.

[31] See Prašnikar et al (2003).

References

Altman, E. (1968), »Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy«, **Journal of Finance**, 589-609.

Basel Committee on Banking Supervision (2001), The New Basel Capital Accord. Consultative Document.

Beaver, W. (1966), »Financial Ratios as Predictors of Failure«, **Journal of Accounting Research**, 77-111.

Begg, D. and C. Wyplosz (1999), »How big a government? Transition economy forecasts based on OECD history«, presented at the 5th Conference on Transition Economies, Dubrovnik, June 1999.

Bernhardsen, E. (2001), »A Model of Bankruptcy Prediction«, Norges Bank, Working Paper 10.

Bole, V. (2002), »Disinflation and Labor Market Distortions; Lessons from Slovenia«, www.wiiw.ac.at/balkan/longterm.

Bole, V. (2003), »Monetary Policy During Countdown«, Working Papers EIPF , and **GG**, EIPF, 2003/2, 23-43.

Bole, V.(2003a), »The Real Estate Market and Exogenous Shocks«, in preparation.

Fama, E. and K.R. French (1992), »The Cross Section of Expected Stock Returns«, **Journal of Finance**«, 47, 427-465.

Geroski, P.A. and P. Gregg, (1996), »What Makes Firms Vulnerable to Recessionary Pressures?«, **European Economic Review**, 40, 551-557.

Hamerle, A., T. Liebig and A. Rosch, (2002), »Credit Risk Factor Modeling and the Basel II IRB Approach«, University of Regensburg, Deutsche Bundesbank.

Hunter, J. and N. Isachenkova, (2002), »A Panel Analysis of UK Industrial Company Failure«, ESRC, Working Paper 228.

Ohlson, J. (1980), »Financial Ratios and the Probabilistic Prediction of Bankruptcy«, **Journal of Accounting Research**«, 109-131.

Pedrosa, M. R. Roll, (2001), »Systematic Risk in Corporate Bond Credit Spreads«, **Journal of Fixed Income**, 8, 7-26.

Prašnikar J., V. Bole, M. Koman in A. Ahčan, (2003), »Občutljivost izvoznega gospodarstva na zunanje šoke«, study prepared for the Ministry of Finance of the Republic of Slovenia; presented also at the CEPR/WDI Annual International Conference on Transition Economies under the title »Sensitivity of the Exporting Economy on the External Shocks; Evidence from Slovenia«.

Rodrik, D, (1998), »Why do more open economies have bigger governments**?«, Journal of Political Economy**, 106, 997-1032.