
# Does trade openness increase firm-level volatility?

Claudia M. Buch
(University of Tübingen and IAW)

Jörg Döpke
(University of Applied Scienes Merseburg)

Harald Strotmann
(Institute for Applied Economic Research IAW, Tübingen)

Discussion Paper
Series 1: Economic Studies
No 40/2006

Deutsche Bundesbank, Wilhelm-Epstein-Strasse 14, 60431 Frankfurt am Main,
Postfach 10 06 02, 60006 Frankfurt am Main

Tel +49 69 9566-1
Telex within Germany 41227, telex from abroad 414431, fax +49 69 5601071

Please address all orders in writing to: Deutsche Bundesbank,
Press and Public Relations Division, at the above address or via fax +49 69 9566-3077



ISBN 3–86558–231–1 (Printversion)
ISBN 3–86558–232–X (Internetversion)

## Abstract:

From a theoretical point of view, greater trade openness affects firm-level volatility by changing the exposure and the reaction of firms to macroeconomic shocks. The net effect is ambiguous, though. This paper provides firm-level evidence on the link between openness and volatility. Using two novel datasets on German firms, we analyze the evolution of firm-level output volatility and the link between volatility and trade openness. We find that firm-level output volatility displays patterns similar to those found in aggregated data for Germany. Also, smaller firms and firms that grow faster are more volatile. Increased trade openness tends to lower volatility.

Keywords: firm-level volatility, trade openness

JEL-Classification: F41, E32, G15

## Non-technical summary

Greater openness to foreign trade has advantages. Countries may benefit from foreign trade through lower prices and a wider range of goods. However, there are also fears that greater openness may increase instability, say, because the country is more exposed to foreign shocks. This paper uses firm-level data to analyze empirically the link between trade openness and the volatility of real sales. A partial equilibrium model is used to show that the impact of increased openness to trade on the volatility of output is ambiguous. On the one hand, volatility may increase with the level of trade openness. This is because firms which trade more react more to exogenous shocks than purely domestic firms if their factor demand and supply schedules become more elastic. Also, firms that trade more are exposed to domestic and foreign shocks. On the other hand, an imperfect correlation between domestic and foreign shocks might have a dampening impact on volatility. Hence, volatility may decline in the degree of trade openness.

The empirical analyses rely on firm-level data. Two new datasets on German firms are employed. The first is taken from the corporate balance sheet statistics provided by the Deutsche Bundesbank. The advantage of this dataset is that changes in the behavior of firms can be analyzed over a comparatively long time frame, starting in the mid-1970s and extending into the late 1990s. The second dataset is restricted to manufacturing firms in the state of Baden-Wuerttemberg, but has the advantage of providing a direct measure of trade openness.

The empirical analysis on the link between trade openness and volatility has three main findings. First, there has been a relatively parallel pattern of firm-level and aggregated volatility over the past three decades. This is in contrast to recent findings for other countries such as the US. Furthermore, average level of firm-level volatility is higher than the level of aggregated volatility. Second, regression analyses reveal that smaller firms and firms which grow faster have higher volatility of real sales. Third, the evidence suggests that exporters tend to have a lower volatility of sales than non-exporters. This result is quite robust against changes in the specification, and in particular against including proxies for the productivity of firms.

## Nicht-technische Zusammenfassung

Eine größere Offenheit für Handel mit anderen Ländern hat viele Vorteile. So kann eine Land durch niedrigere Preise und die Verfügbarkeit von zusätzlichen Gütern vom Handel profitieren. In der öffentlichen Meinung wird aber auch die Befürchtung geäußert, dass eine höhere Offenheit einer Volkswirtschaft die Instabilität erhöhen könnte, etwa, weil ein Land auch anfälliger für ausländische Schocks wird. Dieses Papier nutzt Firmen-Daten um den Zusammenhang zwischen Offenheit und Volatilität des Outputs empirisch zu untersuchen. Zunächst wird ein partielles Gleichgewichtsmodell verwendet, um zu zeigen, dass der Zusammenhang theoretisch nicht eindeutig ist. Auf der einen Seite kann die Hypothese, nach der die Volatilität durch eine größere Offenheit erhöht wird, durch zwei Wirkungskanäle begründet werden: Erstens reagieren offenere Firmen stärker auf ausländische Schocks wenn z. B. die Arbeitsnachfrage elastischer ist. Zweitens sind Firmen, die Handel treiben, ausländischen Schocks in höherem Maße ausgesetzt. Auf der anderen Seite kann eine geringe Korrelation von aus- und inländischen Schocks einen dämpfenden Einfluss auf die Volatilität ausüben.

Die empirische Analyse des Papiers beruht auf Firmendaten. Zwei neue Datensätze werden verwendet. Zum einen benutzen wir Daten aus der Bilanzdatenbank der Deutschen Bundesbank. Der Vorteil dieses Datensatzes ist, dass Veränderungen im Firmenverhalten über einen relativ langen Zeitraum, von der Mitte der siebziger bis Ende der neunziger Jahre, hinweg untersucht werden können. Der zweite Datensatz enthält nur Firmen aus dem Verarbeitenden Gewebe Baden-Württembergs. Er hat den Vorteil, dass ein direktes Maß der Offenheit auf Firmenebene verfügbar ist.

Die empirische Untersuchung des Zusammenhangs zwischen Volatilität und Offenheit beginnt mit der Darstellung einiger stilisierter Fakten. Es zeigt sich eine relativ parallele Entwicklung der gesamtwirtschaftlichen Volatilität und der durchschnittlichen einzelwirtschaftlichen Volatilität über die drei zurückliegenden Jahrzehnte. Dies steht im Widerspruch zu aktuellen Untersuchungen für andere Länder, insbesondere für die USA. Zudem ergibt sich, dass die Volatilität auf Firmenebene spürbar höher ist als die gesamtwirtschaftliche. Eine Regressionsanalyse zeigt darüber hinaus, dass kleine und

schnell wachsende Firmen eine höhere Volatilität aufweisen. Weiter ergibt sich, dass exportierende Firmen tendenziell eine niedrigere Volatilität aufweisen als nicht exportierende Firmen. Dieses Ergebnis ist recht robust gegen Änderungen in der Spezifikation der Schätzgleichung, und es bleibt insbesondere dann erhalten, wenn wir ein Maß für die Produktivität der Unternehmen in unsere Regressionen aufnehmen.

## Contents

## Lists of Tables and Figures

# Does Trade Openness Increase Firm-Level Volatility? *

## 1. Introduction

Does increased openness to foreign trade affect the volatility of output? Public policy discussions suggest that globalization may increase uncertainty by raising the volatility of output and consumption. Econometric work using aggregated or sector data indeed shows that greater openness to trade may lead to increased output volatility (Easterly et al. 2000, Braun and Larrain 2004, Kose et al. 2003).[1] Hence, the recently observed decline in output volatility across industrialized countries (see, e.g., Blanchard and Simon 2001) cannot be attributed to greater openness but rather to smaller shocks, better inventory management, or better monetary policy.

Studying the development of aggregated output volatility may mask important differences across individual firms. If output across firms is imperfectly correlated and if these correlations change over time, firm-level and aggregated volatility may even develop differently. (See, e.g., Imbs (2003) or Comin and Philippon (2005).) For individual households and consumers, in turn, it is the development of output volatility at the firm-level rather than the development of aggregate volatility that matters. As firm-level volatility increases, households must find channels of diversifying firm-level risks and shielding their consumption patterns against fluctuations of output. This is one

* Authors: Claudia M. Buch, (University Tübingen, Department of Economics, Mohlstrasse 36, 72074 Tübingen, Phone: +49 (0)7071 2972962, claudia.buch@uni-tuebingen.de), Jörg Döpke (University of Applied Sciences Merseburg, Geusaer Strasse, 06217 Merseburg, Phone: +49 (0)3461-46 2441; email: joerg.doepke@hs-merseburg.de), Harald Strotmann (Institute for Applied Economic Research, Ob dem Himmelreich 1, 72074 Tübingen, Phone: +49 (0)7071 989624, herald.strotmann@iaw.edu). The authors wish to thank the Federal Statistical Office of Baden Württemberg and the Statistics Department of the Deutsche Bundesbank and, in particular, Tim Körting, for their excellent data assistance and their most helpful discussions on the data. We would also like to thank Jörg Breitung, Heinz Herrmann, Steinar Holden, Harald Stahl, and the participants of seminars at the European University Institute in Florence and the WHU Koblenz for their most helpful discussions and comments. Nico Zorell has provided most efficient research assistance. The views presented in this paper are those of the authors and do not necessarily reflect the opinions of the Deutsche Bundesbank.

[1] In a recent paper, however, Cecchetti et al. (2006) do not find a significant impact of trade openness on growth volatility across countries. Also, establishing a significant link between financial openness and output volatility is difficult (Easterly et al. 2000, Razin and Rose 1994).

channel through which changes in firm-level output volatility can affect economic welfare.[2]

In this paper, we provide evidence on the evolution of firm-level output volatility for German firms. We employ two new firm-level datasets. The first is taken from the corporate balance sheet statistics provided by the Deutsche Bundesbank. The advantage of this dataset is that changes in the behavior of firms can be analyzed over a comparatively long time frame, starting in the mid-1970s and extending into the late 1990s. The second dataset is restricted to manufacturing firms in the state of Baden-Wuerttemberg, but it has the advantage of providing a direct measure of trade openness. To the best of our knowledge, this is the first paper to address the issue of firm-level output volatility using German data.

Our aim in this paper is two-fold:

First, we analyze whether patterns of firm-level output volatility in Germany resemble those found in aggregated data. The evolution of aggregated output volatility in Germany has differed from the patterns observed in other industrialized countries, where volatility has been on a trend decline. Output volatility in Germany followed the trend decline, but it increased temporarily in the period following re-unification (Aßmann et al. 2006, Buch et al. 2004). We test whether similar patterns are found in firm-level data.

Second, we analyze how increased openness to trade affects firm-level output volatility. Despite the concern that globalization may increase uncertainty, little is known about this link. Work by Ber, Blass, and Yosha (2002) provides one piece of evidence that the degree of internationalization of firms affects their exposure to domestic shocks. For Israeli firms, they find that more export-orientated firms react less to monetary policy shocks than more domestically-oriented firms. The importance of financial market development for firm-level volatility has been studied by Thesmar and Thoenig (2004), who use a firm-level dataset of large French firms. They find that financial market development and greater participation by foreign investors increase

[2] An additional channel is the impact that volatility can have on growth. So far, the empirical literature has remained inconclusive with regard to the link between growth and volatility (see e.g. Norrbin and Ygit (2005) and the papers cited therein). While we will control for the impact of growth on volatility, we do not discuss this issue further in this paper.

volatility. This trend has been reinforced by greater product market competition, which could be taken as indirect evidence for a positive link between volatility and trade openness. Recent research has also tried to explain differences in the evolution of firm-level and aggregate output volatility. Comin and Philippon (2005) show that, for large US firms, a declining aggregated output volatility has been associated with increased volatility of output at the firm-level. (See also Comin et al. (2006) for evidence on the labor market.) They also find that firm-level volatility is higher the more deregulated markets are, the more firms invest in research and development, and the better their access to debt and equity markets. Each of these variables may be related to increased trade openness, but the effect of openness is not tested directly.

The finding that firm-level volatility of output has been increasing is mirrored by an increasing degree of idiosyncratic risk in individual stock returns. Campbell et al. (2000) use US stock market data and find that, between 1962 and 1997, there was a positive trend in idiosyncratic firm-level volatility but no similar trend in industry or market volatility. We are not aware of comparable evidence for Germany.

Studying German evidence on the link between trade openness and volatility is interesting not only because volatility of output has increased temporarily due to reunification. Germany is also one of the countries in the OECD with quite rigid labor market institutions, and product market regulations are still relatively widespread (OECD 2005). German firms might thus adjust differently to external developments than firms from countries with more flexible institutional structures.

The starting point of our analysis is a partial equilibrium model which links output volatility to trade openness. This model allows decomposing the impact of trade on volatility into two components. The first is the volatility of aggregated shocks and the correlation of shocks across countries. The second is the elasticity of factor demand and supply, which determines the response of output to macroeconomic shocks. Both of these parameters – the *exposure* to shocks and the *reaction* to shocks – are potentially affected by a firm's degree of openness. (See Rodrik (1997) for a similar argument concerning employment volatility.) We also review implications of open economy general equilibrium models. The main hypothesis which can be taken from these models is that (firm-level) output volatility might be higher for firms which trade more.

However, a counterbalancing effect comes through imperfect correlations between domestic and foreign shocks and, thus, through diversification effects. Hence, the link between trade openness and output volatility is ambiguous from a theoretical point of view.

In Part 2, we derive testable implications from a stylized model of export openness and output volatility. In Part 3, we describe our datasets and provide descriptive statistics on the evolution of the volatility of firm-level output volatility. Part 4 provides an empirical analysis of the determinants of volatility at the level of the individual firm. Part 5 presents robustness tests based on data for the state of Baden-Württemberg and sector data, and Part 6 concludes. Our results show that output volatility at the firm-level – unlike in the US – displays patterns similar to those in aggregated data. As regards the impact of export openness, we distinguish between the effects of being an exporter per se and the volume of exports. We find that volatility is smaller for exporters than for non-exporters. The volume of exports tends to have a negative impact on volatility as well. Moreover, smaller firms and firms that grow faster are more volatile.

## 2. A Simple Model of Trade Openness and Output Volatility

The openness of firms can have many dimensions. Firms can buy inputs from foreign suppliers, sell their products abroad, and establish foreign affiliates for production or sales. In this section, we define openness in a narrow sense as the share of exports to total sales. Our aim is to show the channels through which export openness affects the volatility of output. We begin by sketching these mechanisms in a simple partial equilibrium model, and we briefly review the implications of open economy general equilibrium models.

### 2.1 Exposure and Reaction to Shocks

Output volatility of domestic and of export firms can differ either because firms are exposed to different types of shocks or because firms react to these shocks differently. (See Barba-Navaretti and Venables (2004) for a more detailed discussion.) As regards the *exposure* to shocks, foreign operations increase the volatility of output if foreign shocks are larger than domestic shocks. A low correlation between domestic and

foreign shocks potentially counterbalances this effect as it gives rise to diversification effects. As regards the *reaction* of firms to shocks, internationally active firms might react differently than purely domestic firms as they can substitute domestic and foreign inputs and customers more easily, because they might be less committed to a particular location, or because their input and output elasticities differ.

Modeling differences in the exposure to shocks and differences in reactions to shocks would require a full-fledged model of a multinational firm. To set the stage for our empirical analysis below, we focus on a simple model of an export firm in a partial-equilibrium framework.

Assume that a domestic firm *i* produces an output $Y_{i,t}$ in the domestic economy, using domestic labor $L_{i,t}$ and capital $K_{i,t}$ under the following production function:

$$Y_{i,t} = A_t L_{i,t}^{\alpha} K_{i,t}^{1-\alpha} \tag{1}$$

where $0 < \alpha < 1$ denotes the labor share and $A_t$ is a technology parameter. The firm sells a share $\omega_i$ of output on the foreign market and a share $(1-\omega_i)$ on the domestic market. Hence profits are given by

$$\Pi_{i,t} = \left[p_t(1-\omega_i) + \left(p_t^* - c_t\right)\omega_i\right]Y_{i,t} - r_t K_{i,t} - w_t L_{i,t} \tag{2}$$

where $c_t$ is a per-unit cost of exporting and $p$ ($p$*) denote domestic (foreign) prices. In the short run, the firm takes all prices and the capital stock as given ($K_{i,t} = \overline{K}_{i,t} = 1$), and the profit-maximizing input of labor is given by the following first-order condition:

$$\left[p_t(1-\omega_i) + \left(p_t^* - c_t\right)\omega_i\right]\alpha A_t L_{i,t}^{\alpha-1} = w_i \tag{3}$$

Hence, the optimal input of labor depends on the marginal product of labor and on the net revenues from selling in the domestic and the foreign market. Solving for $L_{i,t}$ yields the labor demand function:

$$L_{i,t}^{D}=\left(\frac{w_t}{\left[p_t(1-\omega_i)+\left(p_t^{*}-c_t\right)\omega_i\right]\alpha A_t}\right)^{\frac{1}{\alpha-1}}=\left(\frac{w_t}{x\alpha A}\right)^{-\eta^{D}} \tag{4}$$

where $\eta^{D}=1/(1-\alpha)$ is the absolute value of the labor demand elasticity, and $x=\left[p\ (1-\omega_i)+\left(p^{*}-c_t\right)\omega_i\right]$ is a weighted average of demand conditions on the home and on the foreign market.

Assuming that labor supply is given by $L^{S}=w^{\eta^{S}}$, where $\eta^{S}$ is the elasticity of labor supply, dropping time indices, and solving for the equilibrium level of wages gives $w=(x\alpha A)^{\frac{\eta^{D}}{\eta^{D}+\eta^{S}}}$. Substituting into the labor supply equation gives $L=(x\alpha A)^{\frac{\eta^{D}\eta^{S}}{\eta^{D}+\eta^{S}}}$.

This framework can be used to derive the volatility of wages, employment, and output. (For a similar argument see Barba-Navaretti and Venables (2004).) To see this, note that the percentage change in wages and in labor for firm *i* is given by: $\hat{w}=\frac{dw}{w}=\left(\frac{\eta^{D}}{\eta^{D}+\eta^{S}}\right)\left(\hat{x}+\hat{A}\right)$ and $\hat{L}=\frac{dL}{L}=\left(\frac{\eta^{S}\eta^{D}}{\eta^{D}+\eta^{S}}\right)\left(\hat{x}+\hat{A}\right)=\mathrm{E}\left(\hat{x}+\hat{A}\right)$ where $\hat{x}$ captures random demand shocks, $\hat{A}$ captures technology shocks, and $\mathrm{E}=\frac{\eta^{S}\eta^{D}}{\eta^{D}+\eta^{S}}$ summarizes the demand and supply elasticities on the labor market. To simplify the presentation, we assume that demand and technology shocks are uncorrelated. Dropping this assumption would not change our main argument below, but it would make the exposition more cumbersome. The change in output is given by $\frac{dY}{Y}=\frac{L^{\alpha}dA}{AL^{\alpha}}+\frac{A\alpha L^{\alpha-1}}{AL^{\alpha}}dL=\hat{A}+\alpha\hat{L}=\alpha E\hat{x}+(1+\alpha E)\hat{A}$. The volatility of output is thus given by:

$$\sigma^{2}\left(\hat{Y}\right)=\sigma^{2}(\hat{x})(\alpha\mathrm{E})^{2}+\sigma^{2}\left(\hat{A}\right)(1+\alpha\mathrm{E})^{2} \tag{5}$$

Equation 5 shows that there are three factors affecting the volatility of output

First, domestic and export firms might *react* differently to shocks because their elasticities of labor demand and supply differ.[3] Several pieces of evidence point into this direction. Work by Fabbri, Haskel, and Slaughter (2003) and Checchi, Barba-Navaretti, and Turrini (2003) shows that the elasticity of labor demand tends to be higher for multinational than for national firms. Slaughter (1996) finds, between 1961 and 1991, demand for US production labor became more elastic while there has been no significant change in the elasticity of demand for non-production labor. However, he has difficulties in linking these patterns in the data to the openness of sectors. Rather, he finds that "the time series of labor-demand elasticities are explained largely by a residual, time itself" (p. 27).

Second, firms that export are exposed to domestic *and* foreign demand shocks and to domestic technology shocks. Domestic firms, by contrast, are exposed only to the domestic shocks. In our empirical model below, we include two proxies for domestic shocks (the volatility of domestic government spending and the volatility of total factor productivity (TFP)) and two proxies for international shocks (the volatility of oil prices and the volatility of the real exchange rate).

Third, the correlation between domestic and foreign demand shocks affects the exposure to shocks and, thus, the volatility of output. If shocks are imperfectly correlated across countries, export firms might benefit from a diversification effect, which dampens the volatility of output. To see this, we can decompose the term $\sigma^2(\hat{x})$ into shocks to domestic and foreign demand:

$$\sigma^2(\hat{x}) = \frac{1}{x}\left[\omega_i^2\sigma(\varepsilon_{i,t}^*)^2 + (1-\omega_i)^2\sigma(\varepsilon_{i,t})^2 + 2\omega_i(1-\omega_i)\sigma(\varepsilon_{i,t}^*)\sigma(\varepsilon_{i,t})\rho\right] \quad (6)$$

where $\sigma^2(\varepsilon_{i,t}^*)$ is the volatility of foreign demand, $\sigma^2(\varepsilon_{i,t})$ is the volatility of domestic demand, and $\rho$ is the correlation between domestic and foreign demand shocks. Increasing the share of exports in total sales ($\omega_i$) raises volatility (i), the higher is the volatility of foreign relative to domestic demand, and (ii) the greater is the correlation between domestic and foreign demand shocks:

[3] Endogenizing the capital stock would yield a similar qualitative argument with respect to the elasticity of the demand and supply for capital.

$$\frac{\partial \sigma^2(\hat{x})}{\partial \omega_i} = \frac{1}{x}\left[\omega_i \sigma^2(\varepsilon^*_{i,t}) + (1-\omega_i)\sigma^2(\varepsilon_{i,t}) + (1-2\omega_i)\sigma(\varepsilon^*_{i,t})\sigma(\varepsilon_{i,t})\rho\right] \gtrless 0 \qquad (7)$$

A similar relationship can be derived at the aggregated level. However, the aggregate response might differ from the firm-level response because of differences in the share of exports or a different covariance structure. (See Imbs (2003) for a related argument concerning the link between volatility and growth.)

### 2.2 General Equilibrium Models

The model sketched so far highlights some key channels through which increased exports of firms affect the volatility of output. However, we consider only a limited range of macroeconomic shocks, and we ignore feedback effects between the domestic and the foreign economy. These restrictions are relaxed in open economy general equilibrium models.

Feedback effects between the domestic and the foreign economy as well as implications of endogenous capital can be addressed in open economy real business cycle models. Backus, Kehoe, and Kydland (1992) show that lower barriers to trade increase the volatility of output. This is because the integration of markets allows agents to shift production to countries that experience positive productivity shocks. The effects of productivity shocks are thus magnified. Stockman and Tesar (1995) calibrate an open-economy real business cycle model in which each country produces traded and non-traded goods. They find a higher standard deviation of output and labor in the traded sector than in the non-traded goods sector, which is driven by a higher variance of productivity shocks in the traded goods sector. Also, elasticities of substitution might differ for traded and non-traded goods sectors. Hence, the implication of these models is that output volatility increases with the degree of trade openness.

The impact of different macroeconomic shocks on the volatility of output can be analyzed with the help of a new open economy macroeconomic model. Senay (1998) has a model which accounts for differences in the degree of openness to trade. Her model combines pricing-to-market behavior and thus imperfect integration of goods markets with the assumption of incomplete integration of financial markets. She finds that greater integration of goods markets tends to increase volatility of output because of

an expenditure-switching effect of real exchange rate changes. This effect is largely independent of the degree of financial market integration. The impact of monetary and of fiscal shocks on the volatility of output is thus positive, and it is larger the more countries trade.

**2.3 Implications**

Three main testable implications can be derived from these models

First, greater shocks to technology, shocks to domestic demand, and shocks to foreign demand tend to raise the output volatility of export firms. Firms that sell only on the domestic market are less affected by foreign demand shocks.

Second, imperfect correlations between domestic and foreign demand shocks dampen the output volatility of export firms relative to domestic firms. The net impact of openness on output volatility is thus ambiguous.

Third, firms that trade more might, ceteris paribus, react more to given shocks than firms which are active only on the domestic market.

Our main testing equation thus links the volatility of output to openness and aggregated shocks:

$$\sigma^2\left(Y_{ijt}\right) = \alpha_{1i} + \alpha_{2j} + \beta_1 X_{it} + \beta_2 X_{jt} + \beta_4 \sigma^2\left(X_t\right) + \beta_5 \omega_{it} + \varepsilon_{ijt} \tag{8}$$

where $\sigma^2\left(Y_{ijt}\right)$ = volatility of sales of firm *i* in sector *j* in time *t*, $\alpha_{1i}$ = firm-fixed effects, $\alpha_{2j}$ = sector-fixed effects, $X_{it}$ = time-varying explanatory variables at the firm level, $X_{jt}$ = time-varying explanatory variables at the sector level, $\sigma^2\left(X_t\right)$ = macroeconomic volatility, and $\omega_{it}$ = a measure of the openness of firms or sectors.

To measure volatility, we need to define a time window over which volatility will be computed. Following earlier research at the macroeconomic level such as Blanchard and Simon (2001), we choose a five-year window. This also corresponds to the typical length of a business cycle. Hence, our dependent variable is specified as a moving average process.

Analyzing the impact of macroeconomic volatility on firm-level volatility is difficult because, by definition, macroeconomic volatility does not vary across cross-

sections. Hence, including a large number of different measures of macroeconomic volatilities would artificially boost the significance of these variables, and interpreting the effects separately would be difficult because of a relative high degree of colinearity. Hence, we adopt two approaches. In a first model, we include time fixed effects which capture the joint effect of different aspects of unobserved heterogeneity with respect to time. This approach has the disadvantage though that we cannot simultaneously include proxies for macroeconomic volatility. In a second model, we include measures of macroeconomic volatility, such as the volatility of oil prices, the volatility of the real exchange rate, the volatility of total factor productivity, and the volatility of domestic government spending one-by-one. In this specification, we also add a linear time trend.

Note that we cannot directly estimate the effect of greater trade openness on the *reaction* of different firms to macroeconomic volatility. This is because our estimated coefficients do not allow disentangling the effects of openness on the elasticities of factor demand. Hence, our testing strategy is indirect. We argue that differences in the reaction of firms to macroeconomic shocks could be due to their degree of openness. We cannot test whether different reactions are due to differences in factor demand and supply elasticities, differences in the elasticities of product demand, or a combination of these.

## 3. The data

Testing the predictions of the above framework requires firm-level data which have a sufficiently large time series dimension – in order to capture the time-varying nature of output volatility – and which provide information on the export openness of firms – in order to capture cross-sectional differences in the openness of firms. We use two datasets. The first comes from the Deutsche Bundesbank's corporate balance sheets statistics database (*Unternehmensbilanzstatistik*, UBS for short). This dataset has the advantage that it covers a large cross-section of German firms for the period 1971-1998. However, a shortcoming is that information on the openness of firms is patchy. Hence, we use a second dataset which has information on export firms and domestic firms in the state of Baden-Wuerttemberg. This dataset has the advantage that it includes a direct measure of the trade openness of firms. The disadvantage is its regional coverage and its focus on manufacturing firms. Since these datasets are being used for an empirical

analysis of output volatility for the first time, we use the remainder of this section to describe their main features.

### 3.1 Bundesbank Data[4]

The Bundesbank's corporate balance sheet database is the largest database of non-financial firms in Germany. The data have been collected in the context of the rediscounting and lending facilities conducted by the Bundesbank.

This restricts the cross-sectional dimension of the database, since only firms which used these refinancing facilities are included, and it restricts the time series dimension of the database, since rediscounting operations ceased with the introduction of the euro in 1999.

In terms of sector coverage, the manufacturing, construction, and retail sectors dominate the sample. This is because trade bills are an important source of external finance in these sectors. According to Stoess (2001), the dataset comprises only about 4% of the total number of enterprises in Germany, but about 60% of the total turnover of the corporate sector. Although the sample is non-random and therefore affected by a possible selection bias, it tracks aggregated German GDP quite well. The correlation coefficient between GDP growth and the mean growth rate of firms covered in the sample was 0.89 over the sample period 1971 to 1998. Another advantage of this database is that it comprises both incorporated and unincorporated firms. Hence, small and medium-sized firms in Germany generally show up in our sample. In terms of the time series dimension, we use data from 1971 to 1998 for most of the analysis. Owing to changes in the sector definitions, the dataset has to be restricted to the years 1971 to 1995 whenever industry dummies are used.

Our main variable of interest is real sales. For this variable, we have relatively few data losses owing to incomplete and inconsistent reporting. We convert nominal variables into real variables by deflating each firm's sales with the deflator of real GDP and taking the difference of the logarithm of real sales.

Descriptive statistics are presented in Table 1. On average, volatility of real sales was 0.11 percentage points across all sectors during the period under study (1975-

1998). This is significantly higher than the volatility of aggregated output. However, there is also a quite significant variation across sectors. Volatility was highest in the construction sector (0.18) and lowest in utilities (energy, gas, water supply) (0.07).

The main disadvantage of the Bundesbank dataset is that it lacks consistent time series information on the openness of firms. Thus, we measure trade openness using sector information on exports and imports as a percentage of total value added. We obtain this information from the OECD's STAN database. Generally, the database starts in 1970. However, for the years 1970-1979, we have information for only 12 manufacturing sectors. For later years, we have more complete data, but there is virtually no information on the openness of the services sectors. From these data, we construct a measure of openness, which is given by the sum of exports and imports over value added, and we also decompose this measure into export and import openness.

### 3.2 Data for Baden-Wuerttemberg

One shortcoming of the Bundesbank database is that it lacks detailed information on the exports of each firm. Hence, we complement our empirical analyses by using a second establishment-level data base from German official statistics. With respect to its sector coverage, this dataset is limited to the manufacturing sector; with respect to its regional coverage, the dataset is limited to a single German federal state, the state of Baden-Wuerttemberg. In 2003, Baden-Wuerttemberg accounted for 13% of the German population, 15% of GDP, and 16% of German exports. In addition, the state is host to the largest and the seventh-largest German firms, i.e. Daimler Chrysler AG and Robert Bosch GmbH.

Despite the regional and sector limitations, the data have two major advantages over the Bundesbank data. First, they include firm-level information on export

[4] See the data appendix for a more detailed description of the data.

openness. Second, the data comprise the total population of manufacturing establishments in Baden-Wuerttemberg with a very good coverage of small firms.[5]

To create this establishment-level panel dataset, we use two sources of German industrial statistics. The first data source contains information on all manufacturing establishments with at least 20 employees and on establishments which are part of an enterprise with at least 20 employees. These data are taken from monthly reports of manufacturing firms. The second data source contains information from an annual report of small manufacturing establishments covering all establishments with less than 20 employees. From these reports, a longitudinal dataset is created which includes all manufacturing establishments in the German state of Baden-Wuerttemberg in the period from 1980 to 2001. Although this panel dataset contains relatively few variables, it comprises a large number of establishments, offers a high quality of data, and allows tracking individual establishments over time.

With the help of these data, we can measure openness at the firm-level either through a binary dummy variable indicating the exporter status (1 = export firm, 0 = domestic firm) or through the firm's share of exports in total sales. Studying the changing patterns of firms over a four-year time window shows that about 44% of the firms in the sample remain purely domestic firms. Another 45% of the firms are continuing exporters, i.e. they have foreign sales over the four-year period considered. A similar share of 3-4% of firms are export starters and stoppers. The average exporting firm is about larger and more productivity than the average non-exporting firm. This confirms recent theories suggesting that productivity (i.e. size) positively affects the probability of exporting (Melitz 2004). In our empirical model below, we will also include size and productivity to isolate the impact of exporting.

To calculate the volatility of a firm's real sales, we apply the same procedures as for the Bundesbank data. Nominal real sales are converted into real sales by deflating each firm's sales with the deflator of GDP. We also use a 50% cut-off-point for the growth of real sales to ensure that our results do not depend on outliers. As shown in Table 2, dropping outliers and using only firms with a sufficiently large number of

[5] Handcraft firms with fewer than 20 employees are, however, missing from the data.

observations needed to calculate volatilities implies changes in the composition of the full and of the restricted sample.

Owing to a change in the classification of industries in 1995, we do not pool the data. Rather, we present results separately for the period from 1984 to 1994 and for the period 1995 to 2001.[6]

Descriptive statistics for the Baden-Wuerttemberg data are given in Table 1c. The basic descriptive results derived from the Bundesbank data are confirmed using data for manufacturing in Baden-Wuerttemberg. Differences between industries are substantial, with volatilities ranging from about 0.10 in 'Tobacco Products' and in 'Food Products and Beverages' to almost 0.18 in 'Office Accounting and Computing Machinery' or 'Basic Metals' and more than 0.21 in 'Recycling' in the 1995 to 2001 period. Compared with the results from the Bundesbank data, the volatility of real sales is larger in the manufacturing sector of Baden-Wuerttemberg. This might partly result from the fact that the group of small firms is covered in a better manner in the data for Baden-Wuerttemberg.

## 4. Empirical Results

Do firms that trade more exhibit higher output volatility than domestic firms? In this section, we first present descriptive statistics on the link between openness and volatility at the firm level. We proceed with regression-based evidence on the link between trade openness and firm-level volatility.

### 4.1 Descriptive Statistics

Figure 1 compares the volatility of real sales at the firm-level to the volatility of GDP, bringing out three stylized facts. First, the data show a downward trend in firm-level volatility, which is interrupted by a high-volatility period around German unification. A similar pattern is found in the data for Baden-Wuerttemberg. Second, Figure 1 also shows a quite significant degree of heterogeneity across firms, indicated by the relatively wide bands for the 10% and the 90% quantile. The magnitudes of these differences are similar to those found in the US data (Comin and Phillipon 2005). Third,

firm-level volatility resembles patterns of aggregated volatility. In this regard, evidence for Germany differs from evidence for the US, where firm-level volatility for large firms and aggregated volatility have developed differently.

To check whether the time trend visible in Figure 1 is also statistically significant, Table 2 reports results of a regression of firm-level volatility on a time trend. The estimated equation is $\ln\sigma(Y_{ijt}) = \alpha_i + \beta \cdot trend + \gamma \cdot dummy + u_{ijt}$ where $i$ = firm, $j$ = sector, $t$ = time, and *dummy* is set at one for the three years following German re-unification (1991-1993). Results reported in Table 2 confirm that there is a negative trend in the volatility of firm-level volatility for German firms in the regressions including the re-unification dummy. Running the same regression for each of the industrial sectors separately shows that the negative time trend in output volatility is common across sectors.

For 13 out of 20 sectors, however, we find a statistically negative time trend over the full period. There are six sectors for which the time trend is insignificant (mining, transport equipment, construction, wholesale and retail trade, and two services sectors). For the full period, a positive time trend can be found for only one sector – electricity, gas, and water supply. This finding is interesting insofar as the energy sector is also the sector where the volatility of output is quite low.

Breaking up the sample into two sub-periods shows that the negative time trend found in the full data is driven by the most recent years. The negative time trend in volatility across sectors is confirmed in the state level data for the second sub-period (1995-2001). In the first period (1984-1994), however, we find evidence for a positive time trend in both datasets.[7]

How can we explain the recent downward trend in firm-level and aggregate volatility? Trade openness is a possible candidate. Yet, over time, trade openness has increased which, in itself, would imply a negative link between openness and volatility. Between 1970 and 2000, the average ratio of exports over sector value added increased from about 40% to 150%, imports over value added increased from 55 to 170%. Data for Baden-Wuerttemberg confirm the positive trend in trade openness. Here, the average

[6] Note that our data start already in 1980 but, due to the construction of the dependent variable, the estimation period starts only in 1986.

firm-level export share (exports/total sales) increased from 10,9% in the period 1980 to 1994 to 13,3% in the period 1995 to 2001. Thus, at first sight, more trade openness seems to be associated with less – rather than more – volatility.

Cross-sectional evidence shows that the link between trade openness and volatility is rather weak (Figure 2). We distinguish between export and import openness. If anything, there is a slightly positive correlation. Results are similar for the Baden-Wuerttemberg data. Here, we do not find a significant cross-sectional correlation between sector openness (measured as the sector export share) and sector volatility.

If anything, more trade seems to lead to less rather than more volatility. However, we have so far ignored the role of macroeconomic shocks. If macroeconomic volatility had declined, this could account for the fall in firm-level volatility, thus potentially counterbalancing the impact of trade openness. All our proxies for macroeconomic volatility (government spending, real exchange rate, total factor productivity, interest rates) have indeed shown a downward trend. There are only two exceptions. First, the volatility of government spending increased around the re-unification period. Second, the volatility of oil prices has increased since 2000. Owing to data limitations, however, this period is not covered by our regressions. Analyzing the impact of trade openness on (firm-level) volatility thus requires disentangling it from the impact of the overall reduction in macroeconomic volatility.

### 4.2 Estimation Issues

Our empirical model is based on Equation (8) above. This equation specifies the effect of macroeconomic volatility on the volatility of firms' sales, controlling for firm-level, sector, and macroeconomic factors. The explanatory variables at the firm level and those at the sector level can contain variables that capture the firms' degree of trade openness.

Due to the specification of our dependent variable, the residuals follow a moving-average autoregressive process of order 4. By construction, our dependent variable is thus serially correlated, and we have to take the autocorrelation structure of the residuals into account. We follow Arellano (1987) and compute robust standard errors which

[7] Note that a reunification dummy is included for both periods.

allow for both heteroscedasticity and autocorrelation of arbitrary form. Moreover, we estimate dynamic panel models, including a set of up to five lags of our dependent variable. However, for the firm-level data used, we had difficulties finding appropriate instruments, and we could not reject the hypothesis of remaining residual autocorrelation. Hence, we do not report these results here.

### 4.3 Regression Results

Table 3 presents the baseline regression results using the Bundesbank data. Panel (a) presents results including a full set of time fixed effects, Panel (b) reports results including proxies for macroeconomic volatility. In all equations, the volatility of real sales at the firm level is the dependent variable. We show specifications which differ with regard to the measurement of openness.

In column 1 of Panel (a), we use a sector measure of openness as the sum of exports and imports of each sector over sector value added. In columns 2 and 3, we break this measure down into exports and imports over value added. In column 4, we additionally include the growth of real sales as an explanatory variable. In columns 5 and 6, we look at the response of the smallest and largest 10% of the firms in terms of total sales.[8] Here, the motivation is that small firms are typically active in only a few foreign countries. Hence, the diversification effect would weigh less heavily than for the larger firms.

All specifications show that it is difficult to establish a statistically significant link between the openness of sectors and firm-level output volatility. The only exception is the specification using data for the smallest 10% of firms. Here, the aggregated measure of openness (imports plus exports) is positive and statistically significant at the 10% level. Unreported regressions show that this effect is driven by export openness, which is even significant at the 5% level. However, this positive effect is confined to the smallest firms, which would be consistent with a lower degree of diversification of these firms. For all other percentiles, we obtain an insignificant effect.

Splitting the sample into two time periods and dropping the re-unification period essentially gives the same results. According to unreported regressions, all openness

[8] Small and large firms are defined over the whole sample, not by sector.

variables are positive but insignificant in the first sub-period (before 1990). In the second sub-period (after 1991), the openness variables tend to come in with a negative sign, which is even significant at the 10% level for import openness. A possible interpretation of this is that firms have increasingly diversified the set of countries with which they trade, and are hence able to reap the benefits of diversification through low correlations of shocks.

As regards the control variables, there is a clear negative correlation between the size of a firm (measured as the log of its total sales) and the volatility of real sales. Hence, real sales of small firms are more volatile than sales of large firms. This result confirms prior expectations. Large firms, owing to more complex organizational structures and greater potential for adjusting production across different plants, are likely to exhibit lower volatility than smaller firms.

Another finding, which is robust across specifications, is that faster growing firms are more volatile (column 4 of Table 3a). One interpretation is that growing firms are active in less mature – and thus more volatile – markets than firms that grow less quickly. Obviously, the reverse causality is conceivable as well – more volatility caused by a greater intensity of search for new products and production processes may lead to higher growth. Addressing the link between growth and volatility in more detail, however, is an issue that we leave for future research.

In Table 3b, we report results for regressions including proxies for macroeconomic volatility – which are identical for all cross sections in the sample – rather than time-fixed effects. We use the macroeconomic volatilities separately since they are highly correlated. In addition, we include a linear time trend and a unification dummy which is set at one for the years 1990-1994. With the exception of the volatility of the real exchange rate, all proxies for macroeconomic volatility enter with a positive and highly significant sign.

If we include separate measures of macroeconomic volatilities rather than time dummies for each year, the openness variable becomes negative and significant in all specifications (Table 3b). This shows that, at the firm level, it is difficult to disentangle the impact of changes in the shock processes and of changes in the degree of openness over time. Since openness is measured at the sector rather than the firm-level, it picks

up a significant amount of the time-varying nature of shocks. Hence, in Table 3b, the openness variables pick up the effects of the macroeconomic volatilities that are not included. As firm-level output volatility has tended to decline, macroeconomic shocks have become smaller as well. This explains the positive sign on the macroeconomic volatilities. At the same time, the openness of sectors has increased. Hence, the negative sign on the openness variable could either be due to the fact that the macroeconomic volatilities do not fully capture the time trend in macroeconomic shocks or that greater openness has indeed been associated with lower volatility. We return to this issue below as we look at firm-level evidence on openness.[9]

To check how the different ways to capture time trends affect our results, we also re-estimate the baseline model without accounting for any time effects and including a time trend only. In unreported regressions, we find that openness is negative and significant in both sets of regressions. These results also do not depend on the measure of openness used (imports, exports, or the combined measure). However, openness is insignificant in the regressions including time fixed effects as the most flexible way of controlling for time effects. This shows the difficulties in separating the effects of time itself and openness in firm-level regressions using sector measures of openness.

We also check whether firm's leverage has an impact on volatility. However, the effect is insignificant throughout.

In sum, we thus find little evidence for a strong and significant link between trade openness and firms' output volatility using data for Germany as a whole. This, however, may be due to the fact that we are not able to fully disentangle the impact of greater trade openness at the sector level – which potentially increases output volatility – and lower macroeconomic shocks – which potentially lowers output volatility. Both of these potential drivers of firm-level volatility have a significant time trend, and we thus cannot fully isolate their effects. Below, we therefore re-run our regressions using sector data and firm-level data for the state of Baden-Wuerttemberg. Both datasets provide evidence on the degree of openness for each cross-section.

[9] We have also re-estimated the regressions reported in Table 4b including an interaction term between openness and volatility. While the macroeconomic volatilities remained positive and significant, the openness variable became positive and significant. However, the signs of the interaction terms differed across specifications without a clear economic interpretation. Since this is due to problems of multicollinearity, we refrain from interpreting these results any further.

# 5. Robustness Tests

## 5.1 Data for Baden-Wuerttemberg

As a first test for the robustness of our results, we use firm-level data for the state of Baden-Wuerttemberg. This dataset has the advantage of providing a more direct measure of openness. It has the disadvantage that it covers firms only from one German state. We now measure openness through the export share of each firm and a binary dummy indicating exporter status. Since the sector classification has changed in the mid-1990s, we present results for two non-overlapping sub-periods. Results are reported in Table 4.

Starting with the results for openness, we find a negative relationship between the export share and volatility for the first sub-period. The effect for the second sub-period remains negative but becomes insignificant. The dummy for the exporter status is negative and significant for the full period. The explanatory power of the model is similar for the two sub-periods with an overall $R^2$ of around 0.16. Interestingly, this is driven by the within $R^2$ in the first and the between $R^2$ in the second sub-period.

One explanation for the relatively consistent finding that exporter status and volatility are negatively correlated could be that exporter status is related to size. Recent theoretical work suggests that heterogeneity of firms with regard to productivity results in different strategies with regard to internationalization (Melitz 2004). The least productive firms stay domestic whereas more productive firms export. To control for this possibility, we include a measure of labor productivity at the firm-level, which is computed as annual real turnover of a firm divided by its average number of employees.[10] Labor productivity has a negative but insignificant effect on volatility in the first period, but a strongly positive and significant effect in the second period. Most importantly, including labor productivity does not change our main result for the openness variables.

In unreported regressions, we check whether the results for the openness measures depend on the way we measure macroeconomic shocks. Hence, we replace the time-

[10] Note that we cannot follow a similar strategy with the Bundesbank data since labor is measured with a considerable margin of error in this dataset.

fixed effects with proxies for macroeconomic volatilities. While our results for openness are not affected, results on the macroeconomic control variables are difficult to interpret because of a high degree of colinearity between the individual series. Volatility of total factor productivity, for instance, switches from being significantly negative in the first sub-period to being significantly positive in the second sub-period. Hence, we refrain from interpreting these results further. Importantly though, our results for the openness variables are unaffected.

As regards the remaining control variables, we generally confirm the results using Bundesbank data. Smaller firms and firms that grow faster are again more volatile in every model estimated. Finally, neither the multi-plant dummy nor our proxy for the R&D intensity of a firm's industry has a significant impact on volatility.

We additionally check the robustness of our results in two different ways. First, we measure openness at the sector level as in the Bundesbank data, and we confirm the negative impact link between export openness and volatility. Second, we include separate dummies for continuing exporters, export starters, and export stoppers within the four-year period for which the volatility is computed. Results show that the continuing exporters drive the results. The link between this variable and output volatility at the firm-level is consistently negative and significant. This result is partly underlined by the fact that export starters seem to have a somewhat smaller output volatility relative to the purely domestic firms. However, this effect is weakly significant in only a few of the specifications. Export stoppers do not exhibit output volatility that differs significantly from that of domestic firms.

### 5.2 Sector Data

Table 5 gives the results using sector data. In Table 5a, we present regressions for the full sample, including time-fixed effects. In Table 5b, we include proxies for macroeconomic volatility. Table 5a shows a positive impact of openness on output volatility (Columns 1-3). However, splitting the sample into the period before and after 1991, as is done in Columns 4 and 5, shows a positive and significant impact of openness only for the first sub-period. In the second sub-period, the coefficients turn negative and insignificant. We report results only for the combined measure of openness (export plus import openness), but the patterns are very similar for the two sub-

components. To some extent, this mirrors results for the (Bundesbank) firm-level data, where we also obtain evidence of a negative link between openness and volatility for the 1990s. One potential interpretation could be that trade has become more dispersed across countries and that firms have benefited from diversification effects.

Size (measured in terms of the log of real value added) does not have a significant impact. Moreover, the positive impact of openness that we find for the full sample depends on the measure of size used. If we use employment instead of value added, openness is insignificant for the full sample.

As for the firm-level data, we also include all proxies for macroeconomic volatility separately (Column 6b), and we replace the time fixed effects by a linear time trend to avoid problems of multicollinearity between the macroeconomic volatilities and the time dummies. We confirm a positive impact of macroeconomic volatility on sector volatility for total factor productivity, government spending, and interest rate volatility. However, the impact of real exchange rate volatility is negative, and the volatility of oil prices is insignificant.

To check whether more open sectors react differently to macroeconomic shocks than less open sectors, we further split our sample into sectors which have a degree of openness above and below the median. In unreported regressions, we find the main difference between the more and less open sectors with regard to the impact of government spending. Volatility of less open sectors reacts positively to volatility of domestic government spending, while government spending is insignificant for the more open sectors. This would be consistent with our theoretical framework.

## 6. Summary and Conclusions

Greater openness to foreign trade benefits countries through lower prices and a larger variety of goods. However, greater openness also creates fears that instability and the exposure to foreign shocks might increase.

In this paper, we have taken a firm-level approach to study the link between trade openness and volatility. Starting from a partial equilibrium model, we have shown that the impact of increased openness to trade on the volatility of output is ambiguous. A potential increase in volatility comes through two channels. First, firms that trade more

react more to exogenous shocks than purely domestic firms if their factor demand and supply schedules are more elastic. Second, firms that trade more are exposed to domestic and foreign shocks. This might increase volatility of output. However, imperfect correlation between domestic and foreign shocks might have a dampening impact on volatility.

We have tested the predictions of this model using two novel firm-level datasets for German firms. Some results are robust across specifications.

First, stylized facts show relatively parallel patterns of firm-level and aggregated volatility over the past three decades. In contrast to findings for other countries such as the US, there is thus little evidence for diverging patterns of firm-level and aggregated volatility. At the same time, the level of firm-level volatility is significantly higher than the level of aggregated volatility.

Second, smaller firms and firms that grow faster have higher volatility of output. Both of these results are consistent with expectations.

Third, exporters have a lower volatility of sales than non-exporters. Since we obtain these results in regressions including size and productivity, the effect is indeed driven by the openness of firms.

Fourth, the link between the volume of exports and volatility is negative as well in the firm-level data. Results using sector-level data confirm that the impact of openness on volatility is not robust across time and across specifications. If anything, we find evidence of a positive link for some sub-periods, which is in line with earlier cross-country evidence using aggregated data.

Overall, our results show that the evolution of firm-level volatility over time is driven by two factors. First, trade openness has increased, thus affecting volatility through a change in the exposure and the reaction to shocks. While the theoretical predictions of this link have been inconclusive, the data suggest that the 'diversification effect' stemming from a low correlation of domestic and foreign shocks dominates. Second, macroeconomic volatility has fallen, thus potentially lowering volatility on the firm level. Better inventory management is an alternative interpretation for the decline in firm-level volatility, but our data do not allow testing this hypothesis directly.

Finally, we note that the welfare implications of changes in firm-level output volatility are not clear-cut. Our results show that firm-level output volatility in Germany has tended to decline. Whether this lower volatility at the firm level led to a lower volatility of wages, income, and ultimately consumption, and hence had positive welfare implications, cannot be answered with the data at hand. Moreover, the impact of firm-level output volatility on growth is left for future analyses. It is not clear a priori, whether lower volatility at the firm-level has a negative impact on growth because the process of 'creative destruction' is moderated, or whether it has a positive impact through lower uncertainty.

## References


Arellano, M. (1987). Computing Robust Standard Errors for Within-groups Estimators. *Oxford Bulleting of Economics and Statistics* 49(4): 431-43.

Aßmann, C., J. Hogrefe, and R. Liesenfeld (2006). The Decline in German Output Volatility: A Baysian Analysis. Christian-Albrechts-Universität Kiel. Mimeo.

Backus, D.K., P.J. Kehoe, and F.E. Kydland (1992). International Real Business Cycles. *Journal of Political Economy* 100 (4): 745-775.

Barba-Navaretti, G.B., and A.J. Venables (2004). *Multinational Firms in the World Economy*, Princeton: Princeton University Press.

Ber, H., A. Blass, and O. Yosha (2002). Monetary Policy in an Open Economy: The Differential Impact on Exporting and Non-Exporting Firms. Centre for European Policy Research. CEPR Discussion Paper 3191. London.

Blanchard, O.J. and Simon, J.A. (2001). The Long and Large Decline in U.S. Output Volatility. *Brookings Papers on Economic Activity*: 165-173.

Braun, M., and B. Larrain (2004). Finance and the Business Cycle: International, Inter-Industry Evidence. Anderson School, University of California, and Harvard University. Mimeo.

Buch, C.M., J. Döpke, and C. Pierdzioch (2004). Business Cycle Volatility in Germany. *German Economic Review* 5(4): 451-479

Buch, C.M., J. Döpke, and C. Pierdzioch (2005). Financial Openness and Business Cycle Volatility. *Journal of International Money and Finance* 24 (5): 744-765

Campbell, J.Y., M. Lettau, B.G. Malkiel, and Y. Xu (2000). Have Individual Stocks Become More Volatile? An Empirical Exploration of Idiosyncratic Risk. National Bureau of Economic Research (NBER). Working Paper 7590. Cambridge, MA.

Carlino, G, DeFina, R., and Sill, K. (2003). Postwar Period Changes in Employment Volatility: New Evidence from State/Industry Panel Data. Federal Reserve Bank of Philadelphia. Working Paper 03-18.

Cecchetti, S.G., A. Flores-Lagunes, and S. Krause (2006). Assessing the Sources of Changes in the Volatility of Real Growth. National Bureau of Economic Research. NBER Working Paper 11946. Cambridge, MA.

Checchi, D., G. Barba Navaretti, und A. Turrini (2002). Adjusting Labor Demand: Multina-tional versus National Firms – A Cross-European Analysis. CEPR Discussion Paper 3751. London.

Chirinko, R.S. and U. Von Kalckreuth (2002). Further Evidence on the Relationship between Firm Investment and Financial Status. Deutsche Bundesbank. Bundesbank Discussion Paper 28/02. Frankfurt a.M.

Comin, D., and T. Philippon (2005). The rise in firm-level volatility: causes and consequences. National Bureau of Economic Research. NBER Working Paper 11388. Cambridge MA.

Comin, D., E.L. Groshen, and B. Rabin (2006). Turbulent Firms, Turbulent Wages? National Bureau of Economic Research (NBER). Working Paper 12032. Cambridge, MA.

Easterly, W., R. Islam, and J.E. Stiglitz (2000). Shaken and Stirred: Explaining Growth Volatility. The World Bank. Washington D.C., mimeo.

Fabbri, F., J.E. Haskel, und M.J. Slaughter (2003). Does Nationality of Ownership Matter for Labor Demands? *Journal of the European Economic Association* 1(2-3): 698-707.

Higson, C., Holly, S. and P. Kattuman (2002). The Cross-Sectional Dynamics of the US Business Cycle: 1950 – 1999, *Journal of Economic Dynamics and Control* 26, 1539-1555.

Higson, C., Holly, S., Kattuman, P. and S. Platis (2004). The Business Cycle, Macroeconomic Shocks and the Cross Section: The Growth of UK Quoted Companies, *Economica* 71, 299-318.

Imbs, J. (2003). Growth and Volatility Revisited. London Business School and CEPR. Mimeo.

Kose, M.A., E.S. Prasad, and M.E. Terrones (2003). Financial Integration and Macroeconomic Volatility. International Monetary Fund. Working Paper 03/50. Washington DC.

Melitz, M. (2003). The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity. *Econometrica* 71, 1695-1725.

Norrbin, S.C. and F.P. Yigit (2005). The robustness of the link between volatility and growth of output. *Review of World Economics* 141: 343-356.

OECD (2005). OECD Regulatory Data Base. http://www.oecd.org/statisticsdata/

Razin, A., and A.K. Rose (1994). Business-cycle volatility and openness: an exploratory analysis. In: Leiderman, L. (ed.). *Capital mobility: the impact on consumption, investment, growth*: 48-75.

Rodrik, D. (1997). *Has Globalization Gone Too Far?* Institute for International Economics, Washington DC.

Senay, O. (1998). The Effects of Goods and Financial Market Integration on Macroeconomic Volatility. *The Manchester School Supplement* 66: 39–61.

Slaughter, M.J. (1996). International trade and labor-demand elasticities. *Journal of International Economics* 54: 27-56.

Stockman, A., and L. Tesar (1995). Tastes and Technology in a Two-Country Model of the Business Cycle: Explaining International Comovements. *American Economic Review*: 168-185.

Stoess, E. (2001), Deutsche Bundesbank's corporate balance sheet statistics and areas of application. *Schmollers Jahrbuch: Zeitschrift für Wirtschafts- und Sozialwissenschaften* 121: 131-137.

Thesmar, D., and M. Thoenig (2004). Financial Market Development the Rise in Firm Level Uncertainty. ENSAE-CREST, CERAS-CNRS, and CEPR. Mimeo.

Von Kalckreuth, U. (2004). Financial constraints for investors and the speed of adaptation: Are innovators special? Deutsche Bundesbank. Bundesbank Discussion Paper 20/2004. Frankfurt a.M.

Windmeijer, F. (2005). A Finite Sample Correction for the Variance of Linear Two-Step GMM Estimators. *Journal of Econometrics* 126: 25-51.

White, H. (1980). A Heteroskedasticity Consistent Covariance Matrix Estimator and a Direct Test of Heteroskedasticity. *Econometrica,* 48, 817-838.

# Data Appendix

## Firm-Level Data

Unternehmensbilanzstatistik (UBS, Deutsche Bundesbank)

One of the new firm-level datasets that we use comes from the balance sheets of German firms (*Unternehmensbilanzstatistik*) of the Deutsche Bundesbank. The Bundesbank has collected the data when offering rediscounting and lending operations on a strictly confidential basis. Section 19 of the Bundesbank Act (§ 19 BBankG) stipulates that enterprises have to submit their financial statements to the Bundesbank in connection with collateralized rediscount and lending operations. Under the provisions of the Bundesbank Act, the Bundesbank was authorized to perform credit assessments in line with its obligation to purchase and lend only bills of exchange, which fulfill stringent eligibility criteria, such as backing by three parties which are known to be solvent. Technically, enterprises submitted their annual accounts to the branch offices of the German State Central Banks (*Landeszentralbanken*). These accounts were then recorded electronically, audited, and evaluated for purposes of trade bill transactions. Since the Bundesbank performed checks for logical errors and missing data in the database as well as consistency checks and error corrections, the quality of the data is quite high.

The data have been collected on a strictly confidential basis and can thus be used on the premises of the Deutsche Bundesbank only. The dataset has been used frequently in economic research. See, for example, Chirinko and von Kalckreuth (2002) and von Kalckreuth (2003). For more details regarding the dataset see Stoess (2001).

Overall, the Bundesbank received around 60,000 annual accounts per annum. Since not all firms submitted reports in all years, the panel of firms is unbalanced. More than 80% of the enterprises are small and medium-sized enterprises (SME's) with an annual turnover less than 100 million DM, and more than half of the dataset consists of unincorporated firms. Even though the number of rediscount lending operations dropped sharply with the start of European Monetary Union at the beginning of 1999, the Bundesbank continues to collect information on the credit standing of German firms. However, eligible enterprises now submit their balance sheets to the European Central Bank. Hence we use 1998 as the last year of observations.

The dataset does not contain information on merger events.[11] Growth rates of real sales may thus be inflated if two firms have merged during the period under study. To correct for outliers, we follow Higson et al. (2002, 2004) and employ several cut-off rates, i.e. a fraction of, say a ±50% growth rate, is truncated from the data.

From this database, we take the firms' total turnover as a measure of real sales. We convert nominal into real variables by deflating the firm's sales with the deflator of real GDP and taking the difference of the logarithm of real sales. We use the deflator of real GDP rather than sector price indices since the latter are highly correlated.

[11] As in other studies using firm-level data, the cut-off may also eliminate some newly founded firms as well as firms going bankrupt.

**Sector-Level Data**

All sector-level data are taken from the OECD's STAN database. Data prior to 1991 are for West Germany, data after 1990 are for united Germany. The industrial classification used follows NACE Rev. 1.

Exports and imports: Exports and imports of goods at current prices in million euro

Value added: Value added at current prices in million euro.

**Macroeconomic Data**

Government spending: Real, seasonally adjusted government consumption. Source: OECD Economic Outlook.

Interest rate: Short term interest rate. Source: OECD, Economic Outlook.

Oil prices: Source: OECD, Main Economic Indicators.

Real effective exchange rate: Source: Deutsche Bundesbank.

Total factor productivity (TFP): The change in total factor productivity is calculated as $\Delta\ TFP = \Delta\ Value\ Added - 1/3 \cdot \Delta\ Capital\ stock - 2/3 \cdot \Delta\ Employment$. Data are taken from the 60-industry database of the Groningen Growth and Development Centre (http://www.ggdc.net/dseries/60-industry.shtml)

Volatility of the macroeconomic variables is calculated as the conditional variance. We model the systematic component of growth in each variable as an AR(1) process and estimate this process using rolling samples. See Carlino et al. (2003) for a recent application to employment data.

**Table 1: Summary Statistics**

a) German Firm-Level Data (1974 to 1994)

| | Volatility real sales | Log (Real sales) | Export open-ness | Import open-ness | Export elastici-ties | Volatility of total factor produc-tivity | Volatili-ty of go-vern-ment spending | Volatility of oil prices |
|---|---|---|---|---|---|---|---|---|
| Mean | 0.11 | 10.50 | 0.78 | 0.80 | -0.00 | 1.40 | 1.48 | 24.56 |
| Median | 0.10 | 10.36 | 0.78 | 0.61 | 0.00 | 1.38 | 1.51 | 23.41 |
| Maximum | 0.45 | 18.50 | 1.66 | 2.69 | 0.12 | 1.76 | 2.07 | 45.41 |
| Minimum | 0.00 | 3.86 | 0.01 | 0.02 | -0.14 | 1.27 | 0.85 | 12.52 |
| Std. Dev. | 0.06 | 1.84 | 0.34 | 0.55 | 0.01 | 0.11 | 0.34 | 7.87 |
| Skewness | 1.00 | 0.61 | -0.20 | 1.68 | -1.05 | 1.00 | -0.25 | 1.22 |
| Kurtosis | 3.93 | 4.02 | 2.33 | 4.90 | 17.19 | 3.39 | 2.18 | 4.63 |
| Observations | 54,451 | 54,451 | 54,451 | 54,451 | 54,451 | 54,451 | 54,451 | 54,451 |

b) Volatility of Real Sales by Sector, German Firm-Level Data

| Sector | Mean | Std. Dev. | Obs. |
|---|---|---|---|
| Agriculture, hunting, forestry and fishing | 0.143 | 0.071 | 4,981 |
| Basic metals and fabricated metal products | 0.137 | 0.063 | 17,183 |
| Chemical, rubber, plastics, and fuel products | 0.111 | 0.059 | 18,771 |
| Community, social, and personal services | 0.120 | 0.070 | 2,482 |
| Construction | 0.187 | 0.077 | 18,223 |
| Electrical and optical equipment | 0.124 | 0.062 | 36,092 |
| Electricity, gas and water supply | 0.073 | 0.053 | 2,261 |
| Financial intermediation | 0.100 | 0.056 | 44 |
| Food products, beverages, and tobacco | 0.096 | 0.061 | 17,240 |
| Hotels and restaurants | 0.088 | 0.053 | 291 |
| Machinery and equipment, n.e.c. | 0.150 | 0.069 | 34,070 |
| Mining and quarrying | 0.123 | 0.061 | 13,991 |
| Pulp, paper, and paper products | 0.102 | 0.057 | 7,138 |
| Real estate, renting, and business activities | 0.123 | 0.076 | 3,613 |
| Textiles and leather | 0.117 | 0.061 | 29,824 |
| Transport and storage | 0.105 | 0.059 | 8,747 |
| Transport equipment | 0.128 | 0.067 | 4,538 |
| Wholesale and retail trade, repairs | 0.118 | 0.065 | 142,831 |
| Wood and wood products | 0.127 | 0.062 | 16,710 |
| **All** | 0.125 | 0.067 | 379,030 |

c) State Firm-Level Data

| | Volatility Real Sales | | | Log (Real sales) | | | Export openness | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1980-2001 | 1980-1994 | 1995-2001 | 1980-2001 | 1980-1994 | 1995-2001 | 1980-2001 | 1980-1994 | 1995-2001 |
| Mean | 0.168 | 0.181 | 0.153 | 15.67 | 15.61 | 15.74 | 0.119 | 0.109 | 0.133 |
| Median | 0.162 | 0.180 | 0.140 | 15.64 | 15.59 | 15.71 | 0.001 | 0.000 | 0.006 |
| Maximum | 0.499 | 0.468 | 0.499 | 24.44 | 23.93 | 24.44 | 1.000 | 1.000 | 1.000 |
| Minimum | 0.004 | 0.004 | 0.004 | 6.04 | 6.09 | 6.04 | 0.000 | 0.000 | 0.000 |
| Std. Dev. | 0.080 | 0.077 | 0.080 | 1.73 | 1.72 | 1.74 | 0.19 | 0.18 | 0.21 |
| Coefficient of variation | 0.473 | 0.427 | 0.522 | 0.11 | 0.11 | 0.111 | 1.61 | 1.66 | 1.54 |
| Observations | 138,243 | 77,098 | 61,145 | 138,243 | 77,098 | 61,145 | 138,243 | 77,098 | 61,145 |

Source: Deutsche Bundesbank and Statistisches Landesamt, authors' calculations.

## Table 2: Trend Analysis of Volatility at the Firm-Level, German Data

Regressions are based on fixed effects. The unification dummy is set at 1 for the years 1991, 1992, and 1993, and 0 otherwise. *** (**), * denotes significance at the 1(5, 10) percent level. Robust standard errors using the method suggested by White (1980).

| Type of trend | Constant | Trend parameter | Unification Dummy | Adjusted $R^2$ |
|---|---|---|---|---|
| Increasing for each observation per cross section | -2.349*** [-106.81] | 0.0026 [0.60] | [-] | 0.742 |
| Increasing for each observation per cross section | -2.337*** [-162.64] | -0.0076** [-2.02] | 0.202*** [4.76] | 0.748 |
| Increasing by calendar year | -2.365*** [-50.64] | 0.0026 [0.60] | [-] | 0.742 |
| Increasing by calendar year | -2.290*** [-67.26] | -0.0077** [-2.02] | 0.202 [4.76] | 0.748 |

Source: Deutsche Bundesbank, authors' calculations.

## Table 3: Regression Results Bundesbank-Data

### (a) Baseline regressions

The dependent variable is the volatility of real sales of firm *i*. Data are taken from the Bundesbank's corporate balance sheet statistics for the years 1975-1995. Results are based on fixed effects panel regressions, using heteroscedasticity and autocorrelation corrected t-statistics following Arellano (1987). All estimations include sector dummies and dummy variable for the legal form of the reporting firm. Sales, openness, and sales growth are standardized variables to have a zero mean and a standard deviation of one. * significant at the 10% level, ** significant at 5% level, *** significant at 1% level. Absolute t-values are reported in brackets.

| | (1) | (2) | (3) | (4) | (5) Largest 10% | (6) Smallest 10% |
|---|---|---|---|---|---|---|
| | Full sample | | | | | |
| Log Sales | -0.244*** | -0.246*** | -0.243*** | -0.258*** | -0.399*** | -0.094 |
| | [8.71] | [8.78] | [8.67] | [8.46] | [4.06] | [0.89] |
| Export + import openness | 0.010 | | | 0.010 | -0.019 | 0.103* |
| | [0.90] | | | [0.89] | [0.51] | [1.72] |
| Export openness | | -0.002 | | | | |
| | | [0.14] | | | | |
| Import openness | | | 0.018 | | | |
| | | | [1.41] | | | |
| Sales growth | | | | 0.006** | | |
| | | | | [2.47] | | |
| Constant | 1.102* | 1.084* | 1.101* | 1.113* | 0.389 | -0.471 |
| | [1.85] | [1.82] | [1.85] | [1.87] | [1.26] | [1.11] |
| Observations | 152,600 | 152,600 | 152,600 | 152,600 | 22,280 | 10,037 |
| Number of groups | 23,900 | 23,900 | 23,900 | 23,900 | 3,133 | 3,000 |
| R-squared | 0.04 | 0.04 | 0.04 | 0.04 | 0.07 | 0.01 |
| R2 within | 0.04 | 0.04 | 0.04 | 0.04 | 0.07 | 0.01 |
| R2 overall | 0.07 | 0.07 | 0.07 | 0.07 | 0.04 | 0.00 |
| R2 between | 0.07 | 0.07 | 0.07 | 0.07 | 0.05 | 0.00 |

## (b) Regressions including macroeconomic volatility

The dependent variable is the volatility of real sales of firm *i*. Data are taken from the Bundesbank's corporate balance sheet statistics for the years 1975-1995. Results are based on fixed effects panel regressions, using heteroscedasticity and autocorrelation corrected t-statistics following Arellano (1987). All estimations include sector dummies and dummy variable for the legal form of the reporting firm. Sales, openness, and the macroeconomic volatilities are standardized variables to have a zero mean and a standard deviation of one. * significant at the 10% level, ** significant at 5% level, *** significant at 1% level. Absolute t-values are reported in brackets.

| | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|
| Log Sales | -0.352*** | -0.296*** | -0.277*** | -0.344*** | -0.357*** |
| | [12.81] | [10.74] | [9.97] | [12.50] | [12.97] |
| Export + import | -0.058*** | -0.059*** | -0.054*** | -0.048*** | -0.046*** |
| openness | [5.41] | [5.58] | [5.16] | [4.51] | [4.36] |
| Volatility of … | | | | | |
| Interest rates | 0.034*** | | | | |
| | [10.81] | | | | |
| Government spending | | 0.076*** | | | |
| | | [26.66] | | | |
| Total factor productivity | | | 0.068*** | | |
| | | | [25.04] | | |
| Oil prices | | | | 0.052*** | |
| | | | | [13.38] | |
| Real exchange rate | | | | | -0.015*** |
| | | | | | [4.74] |
| Time trend | 0.013*** | 0.007*** | 0.009*** | 0.015*** | 0.006*** |
| | [9.34] | [5.43] | [6.87] | [10.83] | [4.46] |
| Unification | -0.000 | -0.068*** | -0.003 | -0.013** | 0.014** |
| Dummy | [0.03] | [9.18] | [0.40] | [2.01] | [2.07] |
| Constant | -25.687*** | -13.490*** | -17.249*** | -27.910*** | -11.466*** |
| | [8.80] | [4.95] | [6.35] | [10.18] | [4.01] |
| Observations | 152,600 | 152,600 | 152,600 | 152,600 | 152,600 |
| Groups | 23,900 | 23,900 | 23,900 | 23,900 | 23,900 |
| R-squared | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 |
| R2 within | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 |
| R2 overall | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 |
| R2 between | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 |

## Table 4: Regression Results Data for Baden-Wuerttemberg

The dependent variable is the (log) volatility of real sales of firm *i*. Firm-level data for manufacturing firms in Baden-Wuerttemberg 1980-2001. Results are based on fixed effects panel regressions, using heteroscedasticity and autocorrelation corrected t-statistics following Arellano (1987). All estimations include sector and time dummies. Sales, the export share, and growth are standardized variables to have a zero mean and a standard deviation of one. Multi-plant establishment = 1 if plant belongs to a multi-plant firm, = 0 otherwise. Technology regime of the industry is based on the NIW/ISI-classification of R&D-intensive industries. Reference group = low-tech sectors. Unification dummy = 1 for the years 1989-1993. All estimations include sector dummies. * significant at the 10% level, ** significant at 5%,level; *** significant at 1% level. t-values are reported in brackets.

| | 1984-1994 | | | | 1995-2001 | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Log real sales | -0.257*** | -0.255*** | -0.252*** | -0.418*** | -0.577*** | -0.575*** | -0.572*** | -0.766*** |
| | [6.47] | [6.42] | [6.54] | [9.10] | [11.54] | [11.59] | [11.46] | [13.39] |
| Labour productivity | -0.003 | -0.003 | -0.003 | -0.010 | 0.055*** | 0.053*** | 0.053*** | 0.041*** |
| | [0.38] | [0.40] | [0.51] | [1.42] | [3.37] | [3.34] | [3.34] | [2.92] |
| Export share | -0.046*** | | -0.033** | -0.033** | -0.028* | | -0.016 | -0.013 |
| | [3.31] | | [2.34] | [2.30] | [1.80] | | [0.98] | [0.84] |
| Exporter dummy | | -0.087*** | -0.071*** | -0.062*** | | -0.084*** | -0.075*** | -0.067*** |
| | | [3.85] | [3.08] | [2.68] | | [3.23] | [2.78] | [2.48] |
| Sales growth | | | | 0.050*** | | | | 0.051*** |
| | | | | [13.50] | | | | [12.10] |
| Multi-plant | -0.045 | -0.046 | -0.045 | -0.038 | 0.019 | 0.018 | 0.018 | 0.020 |
| establishment | [1.18] | [1.19] | [1.18] | [0.99] | [0.50] | [0.47] | [0.48] | [0.54] |
| Medium-tech | 0.084 | 0.082 | 0.084 | 0.084 | 0.021 | 0.019 | 0.016 | 0.014 |
| | [0.85] | [0.83] | [0.85] | [0.83] | [0.15] | [0.13] | [0.11] | [0.09] |
| High-tech | -0.095 | -0.107 | -0.104 | -0.110 | -0.043 | -0.045 | -0.047 | -0.050 |
| | [0.68] | [0.76] | [0.74] | [0.78] | [0.28] | [0.29] | [0.31] | [0.32] |
| Constant | 0.767*** | 0.827*** | 0.805*** | 0.828*** | -1.788*** | -1.757*** | -1.754*** | -1.686*** |
| | [3.31] | [3.56] | [3.46] | [3.52] | [4.02] | [3.94] | [3.93] | [3.64] |
| Observations | 77,098 | 77,098 | 77,098 | 77,098 | 60,979 | 60,979 | 60,979 | 60,979 |
| Groups | 14,261 | 14,261 | 14,261 | 14,261 | 12,381 | 12,381 | 12,381 | 12,381 |
| R2 within | 0.29 | 0.29 | 0.29 | 0.29 | 0.03 | 0.03 | 0.03 | 0.04 |
| R2 overall | 0.16 | 0.17 | 0.15 | 0.15 | 0.16 | 0.16 | 0.16 | 0.16 |
| R2 between | 0.09 | 0.09 | 0.10 | 0.10 | 0.21 | 0.22 | 0.22 | 0.22 |

## Table 5: Regression Results Sector Data

### a) Baseline

The dependent variable is the volatility of value added of sector *j*. Data are taken from the OECD's STAN statistics for the years 1975-2001. Interaction terms are for export plus import openness and macroeconomic volatility. Results are based on fixed effects panel regressions, using heteroscedasticity and autocorrelation corrected t-statistics following Arellano (1987). Employment and openness are standardized variables to have a zero mean and a standard deviation of one. * significant at the 10% level, ** significant at 5% level, *** significant at 1%-level. Absolute t-values are reported in brackets.

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | Full sample | | | Before 1991 | After 1991 |
| Export + import openness | 0.534** | | | 0.873*** | -0.124 |
| | [2.46] | | | [3.57] | [0.33] |
| Export openness | | 0.436* | | | |
| | | [1.77] | | | |
| Import openness | | | 0.573** | | |
| | | | [2.19] | | |
| Log value added | 0.176 | 0.162 | 0.17 | -0.294 | -0.382 |
| | [0.88] | [0.93] | [0.68] | [0.93] | [1.06] |
| Unification dummy | -0.558** | -0.505** | -0.478** | | 0.225 |
| | [2.77] | [2.68] | [2.75] | | [0.77] |
| Constant | 1.021*** | 1.059*** | 0.993*** | 0.730** | 0.482 |
| | [7.50] | [7.23] | [7.13] | [2.10] | [1.43] |
| Observations | 476 | 478 | 470 | 233 | 219 |
| R2 within | 0.266 | 0.265 | 0.257 | 0.291 | 0.101 |
| R2 overall | 0.171 | 0.234 | 0.134 | 0.058 | 0.021 |
| R2 between | 0.145 | 0.182 | 0.102 | 0.018 | 0.297 |

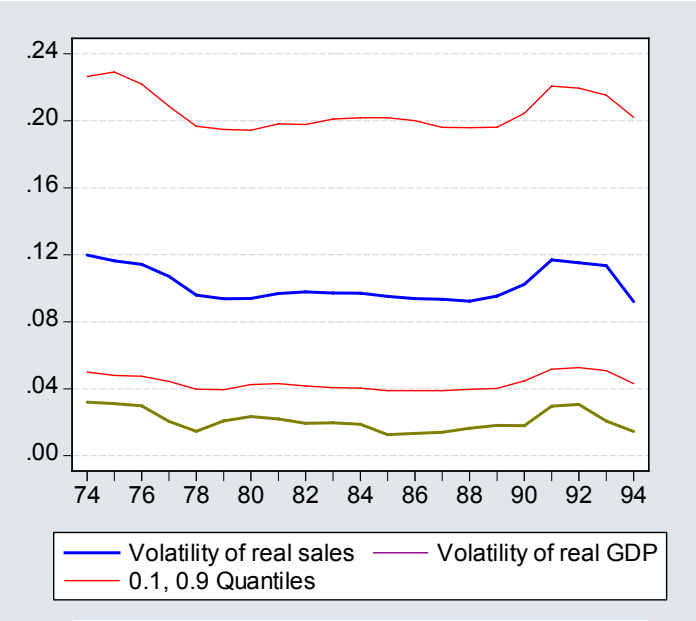
## b) With Macroeconomic Volatilities

The dependent variable is the volatility of value added of sector *j*. Data are taken from the OECD's STAN statistics for the years 1975-2001. Results are based on GMM estimations with Windmeijer's (2005) corrected t-statistics. * significant at the 10% level, ** significant at 5% level; *** significant at 1% level. Absolute t-values are reported in brackets.

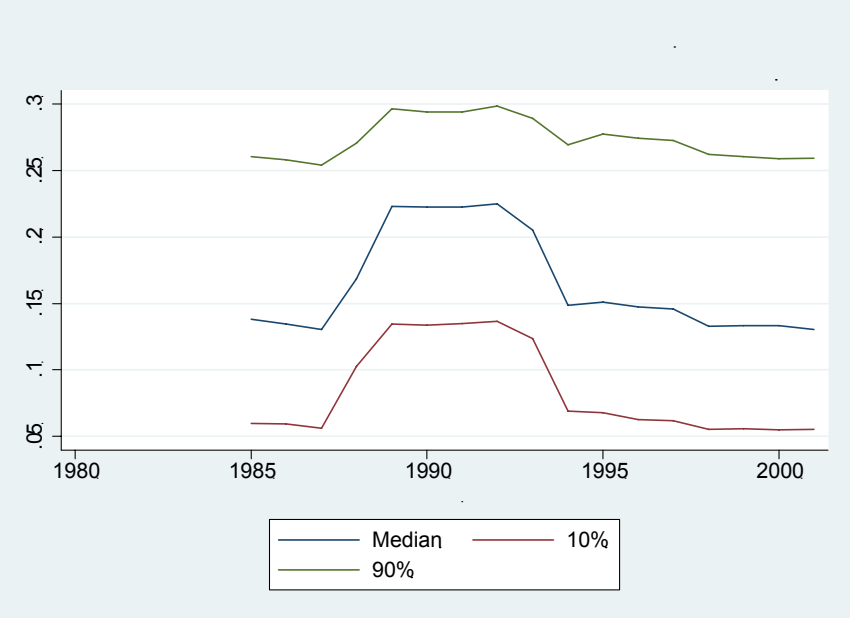
| | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|
| Export + import openness | 0.552** [2.15] | 0.551** [2.15] | 0.545** [2.10] | 0.535** [2.15] | 0.529** [2.11] |
| Volatility of | | | | | |
| Total factor productivity | 0.149* [1.88] | | | | |
| Oil prices | | -0.074 [1.36] | | | |
| Real exchange rate | | | -0.141* [1.98] | | |
| Government spending | | | | 0.161** [2.22] | |
| Interest rates | | | | | 0.200** [2.38] |
| Log value added | 0.154 [0.72] | 0.13 [0.63] | 0.128 [0.62] | 0.16 [0.74] | 0.142 [0.69] |
| Unification dummy | 0.059 [0.33] | 0.245 [1.64] | 0.166 [1.22] | 0.053 [0.29] | 0.195 [1.31] |
| Time trend | 0.033 [1.20] | 0.013 [0.58] | 0.005 [0.22] | 0.011 [0.48] | 0.036 [1.37] |
| Constant | -66.282 [1.20] | -24.877 [0.58] | -10.066 [0.22] | -21.105 [0.48] | -71.847 [1.37] |
| Observations | 476 | 476 | 476 | 476 | 476 |
| R2 within | 0.168 | 0.156 | 0.159 | 0.185 | 0.177 |
| R2 overall | 0.114 | 0.11 | 0.113 | 0.124 | 0.122 |
| R2 between | 0.141 | 0.143 | 0.143 | 0.139 | 0.142 |

**Figure 1: Mean Volatility of Real Sales and of Real GDP (1973-1994)**

(a) German data

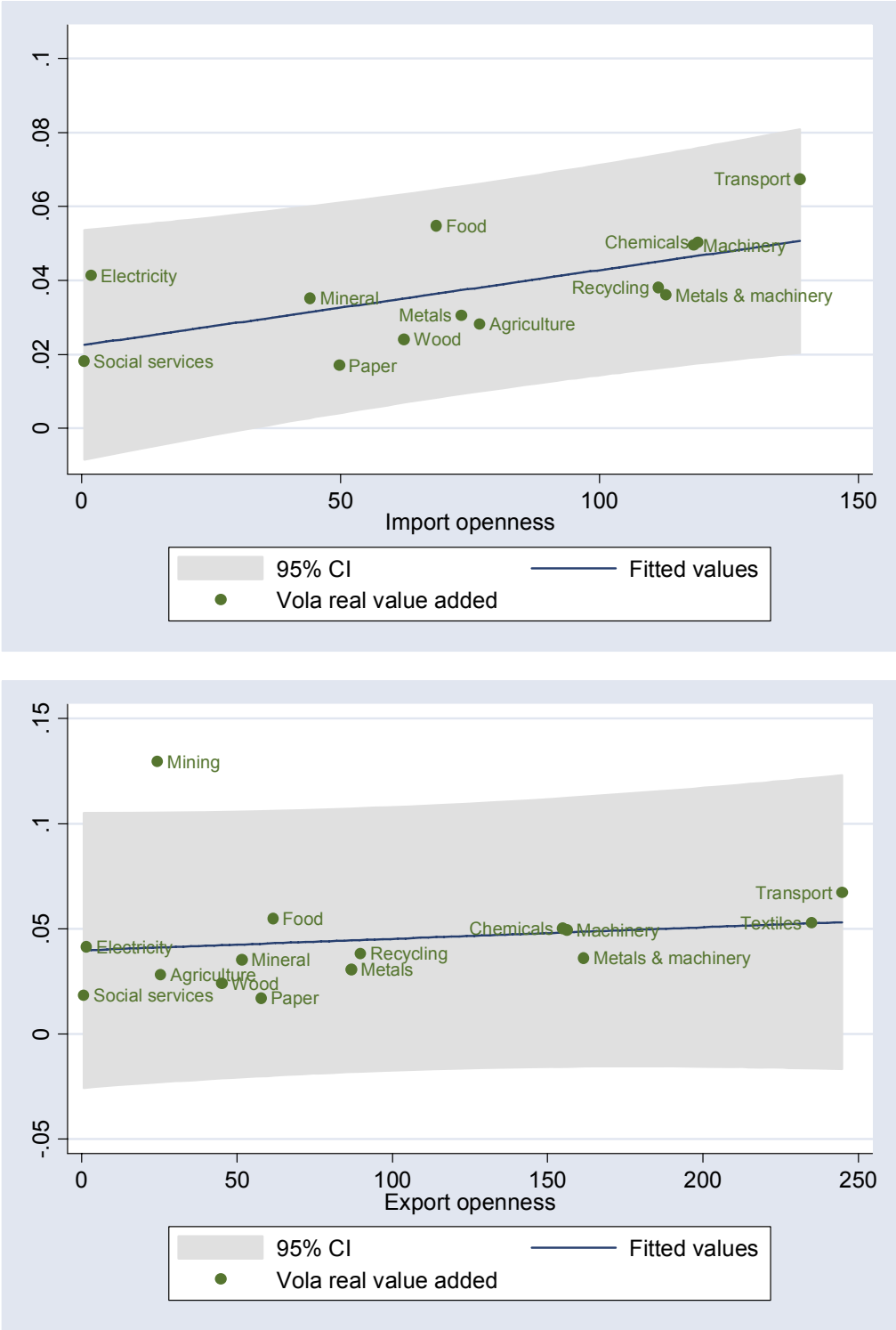



(b) Data for Baden-Wuerttemberg: Volatility of real sales




Source: Deutsche Bundesbank and Statistisches Landesamt, authors' calculations.

**Figure 2: Cross-Section Correlation Between Openness and Volatility, Sector Data**




Source: OECD, authors' calculations.

## The following Discussion Papers have been published since 2005:

### Series 1: Economic Studies

| | | | |
|---|---|---|---|
| 1 | 2005 | Financial constraints and capacity adjustment in the United Kingdom – Evidence from a large panel of survey data | Ulf von Kalckreuth<br>Emma Murphy |
| 2 | 2005 | Common stationary and non-stationary factors in the euro area analyzed in a large-scale factor model | Sandra Eickmeier |
| 3 | 2005 | Financial intermediaries, markets, and growth | F. Fecht, K. Huang, A. Martin |
| 4 | 2005 | The New Keynesian Phillips Curve in Europe: does it fit or does it fail? | Peter Tillmann |
| 5 | 2005 | Taxes and the financial structure of German inward FDI | Fred Ramb<br>A. J. Weichenrieder |
| 6 | 2005 | International diversification at home and abroad | Fang Cai<br>Francis E. Warnock |
| 7 | 2005 | Multinational enterprises, international trade, and productivity growth: Firm-level evidence from the United States | Wolfgang Keller<br>Steven R. Yeaple |
| 8 | 2005 | Location choice and employment decisions: a comparison of German and Swedish multinationals | S. O. Becker, K. Ekholm, R. Jäckle, M.-A. Muendler |
| 9 | 2005 | Business cycles and FDI: evidence from German sectoral data | Claudia M. Buch<br>Alexander Lipponer |
| 10 | 2005 | Multinational firms, exclusivity, and the degree of backward linkages | Ping Lin<br>Kamal Saggi |

| | | | |
|---|---|---|---|
| 11 | 2005 | Firm-level evidence on international stock market comovement | Robin Brooks<br>Marco Del Negro |
| 12 | 2005 | The determinants of intra-firm trade: in search for export-import magnification effects | Peter Egger<br>Michael Pfaffermayr |
| 13 | 2005 | Foreign direct investment, spillovers and absorptive capacity: evidence from quantile regressions | Sourafel Girma<br>Holger Görg |
| 14 | 2005 | Learning on the quick and cheap: gains from trade through imported expertise | James R. Markusen<br>Thomas F. Rutherford |
| 15 | 2005 | Discriminatory auctions with seller discretion: evidence from German treasury auctions | Jörg Rocholl |
| 16 | 2005 | Consumption, wealth and business cycles: why is Germany different? | B. Hamburg,<br>M. Hoffmann, J. Keller |
| 17 | 2005 | Tax incentives and the location of FDI: evidence from a panel of German multinationals | Thiess Buettner<br>Martin Ruf |
| 18 | 2005 | Monetary Disequilibria and the Euro/Dollar Exchange Rate | Dieter Nautz<br>Karsten Ruth |
| 19 | 2005 | Berechnung trendbereinigter Indikatoren für Deutschland mit Hilfe von Filterverfahren | Stefan Stamfort |
| 20 | 2005 | How synchronized are central and east European economies with the euro area? Evidence from a structural factor model | Sandra Eickmeier<br>Jörg Breitung |
| 21 | 2005 | Asymptotic distribution of linear unbiased estimators in the presence of heavy-tailed stochastic regressors and residuals | J.-R. Kurz-Kim<br>S.T. Rachev<br>G. Samorodnitsky |

| | | | |
|---|---|---|---|
| 22 | 2005 | The Role of Contracting Schemes for the Welfare Costs of Nominal Rigidities over the Business Cycle | Matthias Paustian |
| 23 | 2005 | The cross-sectional dynamics of German business cycles: a bird's eye view | J. Döpke, M. Funke S. Holly, S. Weber |
| 24 | 2005 | Forecasting German GDP using alternative factor models based on large datasets | Christian Schumacher |
| 25 | 2005 | Time-dependent or state-dependent price setting? – micro-evidence from German metal-working industries – | Harald Stahl |
| 26 | 2005 | Money demand and macroeconomic uncertainty | Claus Greiber Wolfgang Lemke |
| 27 | 2005 | In search of distress risk | J. Y. Campbell, J. Hilscher, J. Szilagyi |
| 28 | 2005 | Recursive robust estimation and control without commitment | Lars Peter Hansen Thomas J. Sargent |
| 29 | 2005 | Asset pricing implications of Pareto optimality with private information | N. R. Kocherlakota Luigi Pistaferri |
| 30 | 2005 | Ultra high frequency volatility estimation with dependent microstructure noise | Y. Aït-Sahalia, P. A. Mykland, L. Zhang |
| 31 | 2005 | Umstellung der deutschen VGR auf Vorjahres-preisbasis – Konzept und Konsequenzen für die aktuelle Wirtschaftsanalyse sowie die ökono-metrische Modellierung | Karl-Heinz Tödter |

| | | | |
|---|---|---|---|
| 32 | 2005 | Determinants of current account developments in the central and east European EU member states – consequences for the enlargement of the euro erea | Sabine Herrmann<br>Axel Jochem |
| 33 | 2005 | An estimated DSGE model for the German economy within the euro area | Ernest Pytlarczyk |
| 34 | 2005 | Rational inattention: a research agenda | Christopher A. Sims |
| 35 | 2005 | Monetary policy with model uncertainty: distribution forecast targeting | Lars E.O. Svensson<br>Noah Williams |
| 36 | 2005 | Comparing the value revelance of R&D report-ing in Germany: standard and selection effects | Fred Ramb<br>Markus Reitzig |
| 37 | 2005 | European inflation expectations dynamics | J. Döpke, J. Dovern<br>U. Fritsche, J. Slacalek |
| 38 | 2005 | Dynamic factor models | Sandra Eickmeier<br>Jörg Breitung |
| 39 | 2005 | Short-run and long-run comovement of GDP and some expenditure aggregates in Germany, France and Italy | Thomas A. Knetsch |
| 40 | 2005 | A“wreckers theory” of financial distress | Ulf von Kalckreuth |
| 41 | 2005 | Trade balances of the central and east European EU member states and the role of foreign direct investment | Sabine Herrmann<br>Axel Jochem |
| 42 | 2005 | Unit roots and cointegration in panels | Jörg Breitung<br>M. Hashem Pesaran |
| 43 | 2005 | Price setting in German manufacturing: new evidence from new survey data | Harald Stahl |

| | | | |
|---|---|---|---|
| 1 | 2006 | The dynamic relationship between the Euro overnight rate, the ECB's policy rate and the term spread | Dieter Nautz<br>Christian J. Offermanns |
| 2 | 2006 | Sticky prices in the euro area: a summary of new micro evidence | Álvarez, Dhyne, Hoeberichts<br>Kwapil, Le Bihan, Lünnemann<br>Martins, Sabbatini, Stahl<br>Vermeulen, Vilmunen |
| 3 | 2006 | Going multinational: What are the effects on home market performance? | Robert Jäckle |
| 4 | 2006 | Exports versus FDI in German manufacturing: firm performance and participation in inter-national markets | Jens Matthias Arnold<br>Katrin Hussinger |
| 5 | 2006 | A disaggregated framework for the analysis of structural developments in public finances | Kremer, Braz, Brosens<br>Langenus, Momigliano<br>Spolander |
| 6 | 2006 | Bond pricing when the short term interest rate follows a threshold process | Wolfgang Lemke<br>Theofanis Archontakis |
| 7 | 2006 | Has the impact of key determinants of German exports changed?<br>Results from estimations of Germany's intra euro-area and extra euro-area exports | Kerstin Stahn |
| 8 | 2006 | The coordination channel of foreign exchange intervention: a nonlinear microstructural analysis | Stefan Reitz<br>Mark P. Taylor |
| 9 | 2006 | Capital, labour and productivity: What role do they play in the potential GDP weakness of France, Germany and Italy? | Antonio Bassanetti<br>Jörg Döpke, Roberto Torrini<br>Roberta Zizza |
| 10 | 2006 | Real-time macroeconomic data and ex ante predictability of stock returns | J. Döpke, D. Hartmann<br>C. Pierdzioch |

| | | | |
|---|---|---|---|
| 11 | 2006 | The role of real wage rigidity and labor market frictions for unemployment and inflation dynamics | Kai Christoffel<br>Tobias Linzert |
| 12 | 2006 | Forecasting the price of crude oil via convenience yield predictions | Thomas A. Knetsch |
| 13 | 2006 | Foreign direct investment in the enlarged EU: do taxes matter and to what extent? | Guntram B. Wolff |
| 14 | 2006 | Inflation and relative price variability in the euro area: evidence from a panel threshold model | Dieter Nautz<br>Juliane Scharff |
| 15 | 2006 | Internalization and internationalization under competing real options | Jan Hendrik Fisch |
| 16 | 2006 | Consumer price adjustment under the microscope: Germany in a period of low inflation | Johannes Hoffmann<br>Jeong-Ryeol Kurz-Kim |
| 17 | 2006 | Identifying the role of labor markets for monetary policy in an estimated DSGE model | Kai Christoffel<br>Keith Küster<br>Tobias Linzert |
| 18 | 2006 | Do monetary indicators (still) predict euro area inflation? | Boris Hofmann |
| 19 | 2006 | Fool the markets? Creative accounting, fiscal transparency and sovereign risk premia | Kerstin Bernoth<br>Guntram B. Wolff |
| 20 | 2006 | How would formula apportionment in the EU affect the distribution and the size of the corporate tax base? An analysis based on German multinationals | Clemens Fuest<br>Thomas Hemmelgarn<br>Fred Ramb |

| | | | |
|---|---|---|---|
| 21 | 2006 | Monetary and fiscal policy interactions in a New Keynesian model with capital accumulation and non-Ricardian consumers | Campbell Leith<br>Leopold von Thadden |
| 22 | 2006 | Real-time forecasting and political stock market anomalies: evidence for the U.S. | Martin Bohl, Jörg Döpke<br>Christian Pierdzioch |
| 23 | 2006 | A reappraisal of the evidence on PPP: a systematic investigation into MA roots in panel unit root tests and their implications | Christoph Fischer<br>Daniel Porath |
| 24 | 2006 | Margins of multinational labor substitution | Sascha O. Becker<br>Marc-Andreas Mündler |
| 25 | 2006 | Forecasting with panel data | Badi H. Baltagi |
| 26 | 2006 | Do actions speak louder than words? Household expectations of inflation based on micro consumption data | Atsushi Inoue<br>Lutz Kilian<br>Fatma Burcu Kiraz |
| 27 | 2006 | Learning, structural instability and present value calculations | H. Pesaran, D. Pettenuzzo<br>A. Timmermann |
| 28 | 2006 | Empirical Bayesian density forecasting in Iowa and shrinkage for the Monte Carlo era | Kurt F. Lewis<br>Charles H. Whiteman |
| 29 | 2006 | The within-distribution business cycle dynamics of German firms | Jörg Döpke<br>Sebastian Weber |
| 30 | 2006 | Dependence on external finance: an inherent industry characteristic? | George M. von Furstenberg<br>Ulf von Kalckreuth |
| 31 | 2006 | Comovements and heterogeneity in the euro area analyzed in a non-stationary dynamic factor model | Sandra Eickmeier |

| | | | |
|---|---|---|---|
| 32 | 2006 | Forecasting using a large number of predictors: is Bayesian regression a valid alternative to principal components? | Christine De Mol<br>Domenico Giannone<br>Lucrezia Reichlin |
| 33 | 2006 | Real-time forecasting of GDP based on a large factor model with monthly and quarterly data | Christian Schumacher<br>Jörg Breitung |
| 34 | 2006 | Macroeconomic fluctuations and bank lending: evidence for Germany and the euro area | S. Eickmeier<br>B. Hofmann, A. Worms |
| 35 | 2006 | Fiscal institutions, fiscal policy and sovereign risk premia | Mark Hallerberg<br>Guntram B. Wolff |
| 36 | 2006 | Political risk and export promotion: evidence from Germany | C. Moser<br>T. Nestmann, M. Wedow |
| 37 | 2006 | Has the export pricing behaviour of German enterprises changed? Empirical evidence from German sectoral export prices | Kerstin Stahn |
| 38 | 2006 | How to treat benchmark revisions? The case of German production and orders statistics | Thomas A. Knetsch<br>Hans-Eggert Reimers |
| 39 | 2006 | How strong is the impact of exports and other demand components on German import demand? Evidence from euro-area and non-euro-area imports | Claudia Stirböck |
| 40 | 2006 | Does trade openness increase firm-level volatility? | C. M. Buch, J. Döpke<br>H. Strotmann |

**Series 2: Banking and Financial Studies**

| | | | |
|---|---|---|---|
| 1 | 2005 | Measurement matters – Input price proxies and bank efficiency in Germany | Michael Koetter |
| 2 | 2005 | The supervisor's portfolio: the market price risk of German banks from 2001 to 2003 – Analysis and models for risk aggregation | Christoph Memmel<br>Carsten Wehn |
| 3 | 2005 | Do banks diversify loan portfolios? A tentative answer based on individual bank loan portfolios | Andreas Kamp<br>Andreas Pfingsten<br>Daniel Porath |
| 4 | 2005 | Banks, markets, and efficiency | F. Fecht, A. Martin |
| 5 | 2005 | The forecast ability of risk-neutral densities of foreign exchange | Ben Craig<br>Joachim Keller |
| 6 | 2005 | Cyclical implications of minimum capital requirements | Frank Heid |
| 7 | 2005 | Banks' regulatory capital buffer and the business cycle: evidence for German savings and cooperative banks | Stéphanie Stolz<br>Michael Wedow |
| 8 | 2005 | German bank lending to industrial and non-industrial countries: driven by fundamentals or different treatment? | Thorsten Nestmann |
| 9 | 2005 | Accounting for distress in bank mergers | M. Koetter, J. Bos, F. Heid<br>C. Kool, J. Kolari, D. Porath |
| 10 | 2005 | The eurosystem money market auctions: a banking perspective | Nikolaus Bartzsch<br>Ben Craig, Falko Fecht |
| 11 | 2005 | Financial integration and systemic risk | Falko Fecht<br>Hans Peter Grüner |

| | | | |
|---|---|---|---|
| 12 | 2005 | Evaluating the German bank merger wave | Michael Koetter |
| 13 | 2005 | Incorporating prediction and estimation risk in point-in-time credit portfolio models | A. Hamerle, M. Knapp, T. Liebig, N. Wildenauer |
| 14 | 2005 | Time series properties of a rating system based on financial ratios | U. Krüger, M. Stötzel, S. Trück |
| 15 | 2005 | Inefficient or just different? Effects of heterogeneity on bank efficiency scores | J. Bos, F. Heid, M. Koetter, J. Kolatri, C. Kool |
| 01 | 2006 | Forecasting stock market volatility with macroeconomic variables in real time | J. Döpke, D. Hartmann C. Pierdzioch |
| 02 | 2006 | Finance and growth in a bank-based economy: is it quantity or quality that matters? | Michael Koetter Michael Wedow |
| 03 | 2006 | Measuring business sector concentration by an infection model | Klaus Düllmann |
| 04 | 2006 | Heterogeneity in lending and sectoral growth: evidence from German bank-level data | Claudia M. Buch Andrea Schertler Natalja von Westernhagen |
| 05 | 2006 | Does diversification improve the performance of German banks? Evidence from individual bank loan portfolios | Evelyn Hayden Daniel Porath Natalja von Westernhagen |
| 06 | 2006 | Banks' regulatory buffers, liquidity networks and monetary policy transmission | Christian Merkl Stéphanie Stolz |
| 07 | 2006 | Empirical risk analysis of pension insurance – the case of Germany | W. Gerke, F. Mager T. Reinschmidt C. Schmieder |

| | | | |
|---|---|---|---|
| 08 | 2006 | The stability of efficiency rankings when risk-preferences and objectives are different | Michael Koetter |
| 09 | 2006 | Sector concentration in loan portfolios and economic capital | Klaus Düllmann<br>Nancy Masschelein |
| 10 | 2006 | The cost efficiency of German banks: a comparison of SFA and DEA | E. Fiorentino<br>A. Karmann, M. Koetter |

## Visiting researcher at the Deutsche Bundesbank

The Deutsche Bundesbank in Frankfurt is looking for a visiting researcher. Among others under certain conditions visiting researchers have access to a wide range of data in the Bundesbank. They include micro data on firms and banks not available in the public. Visitors should prepare a research project during their stay at the Bundesbank. Candidates must hold a Ph D and be engaged in the field of either macroeconomics and monetary economics, financial markets or international economics. Proposed research projects should be from these fields. The visiting term will be from 3 to 6 months. Salary is commensurate with experience.

Applicants are requested to send a CV, copies of recent papers, letters of reference and a proposal for a research project to:

Deutsche Bundesbank
Personalabteilung
Wilhelm-Epstein-Str. 14

D - 60431 Frankfurt
GERMANY