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LABOR MARKET VOLATILITY, SKILLS, AND FINANCIAL GLOBALIZATION

CLAUDIA M. BUCH
University of Tübingen
IAW
and
CESifo

CHRISTIAN PIERDZIOCH
Helmut Schmidt University

We analyze the impact of financial globalization on volatilities of hours worked and wages of high-skilled and low-skilled workers. Using cross-country, industry-level data for the years 1970–2004, we establish stylized facts that document how volatilities of hours worked and wages of workers with different skill levels have changed over time. We then document that the volatility of hours worked by low-skilled workers has increased the most in response to the increase in financial globalization. We develop a dynamic stochastic general equilibrium model of a small open economy that is consistent with the empirical results. The model predicts that greater financial globalization increases the volatility of hours worked, and this effect is strongest for low-skilled workers.

Keywords: Labor-Market Volatility, Skill Levels, Financial Globalization

1. MOTIVATION

Globalization may impose a double burden on low-skilled workers. On one hand, the relative supply of low-skilled labor is increasing worldwide. This suppresses wages of low-skilled workers and/or increases their risk of becoming unemployed. On the other hand, financial globalization may lower the costs of adjusting the volume of low-skilled relative to high-skilled labor inputs,[1] giving rise to an increase in the response of low-skilled employment to a given shock. A considerable amount of research effort has dealt with the implications of globalization for the relative demand for skills worldwide and the relative job market performance of

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low-skilled workers [see, e.g., Feenstra and Hanson (1996), OECD (2007), and Sitchinava (2008)]. The potential differential effect of globalization on the volatilities of employment and income of high- and low-skilled workers, in contrast, has remained largely unexplored. Hence, the impact of financial globalization on the volatilities of the employment and the income of workers with different skills is the focus of this paper.

Lack of evidence on aggregate labor market volatility stands in contrast to a relatively large body of literature on output volatility. This literature shows that, until the outbreak of the recent financial crisis, there had been a decline in output volatility in many industrialized countries. The Great Moderation with regard to output volatility, however, has not necessarily been matched by a decline in employment volatility or in volatility at the household level or firm level.[2] Comin et al. (2009) show an increase in the volatility of employment in U.S. microdata. In the United States, poorly educated households have also witnessed an above-average increase in consumption volatility [Gorbachev (2011)]. Moreover, firm-level studies show that the impact of increased competition on job stability differs for workers with different skill levels [OECD (2007)]. Finally, Di Giovanni and Levchenko (2009) use industry-level data and find a positive link between trade openness and output volatility. Yet, although the implications of trade liberalization in the wake of different adjustment costs for high- and low-skilled workers have been analyzed in earlier literature [see, e.g., Davidson and Matusz (2000)], the link between financial globalization and costly labor market adjustment has, to the best of our knowledge, been relatively unexplored.

As the evolution of wage and employment volatility across industries, countries, and skill levels has remained largely unexplored, we use the EUKLEMS industry-level database to present descriptive statistics on the volatility of hours worked and of wages. Our data cover 21 manufacturing and services industries, 11 countries, and 35 years. Hence, we can study longer-run trends in the data. The database has been constructed to analyze developments in productivity, but it also provides information on hours worked and wages across different skill categories.[3]

In Section 2, we use this database to compute volatilities of hours worked and wages. We employ the multifactor residual model proposed by Pesaran (2006) to decompose macroeconomic and idiosyncratic components of volatility at the industry level. In addition to an unconditional volatility measure, we thus also use a conditional measure that accounts for macroeconomic factors affecting all industries. We report three main stylized facts. First, the volatility of hours worked for high-skilled workers has been higher than the volatility for medium-skilled workers. The volatility of hours worked for low-skilled workers lies in between. Second, the unconditional volatility of wages has been very similar across skill groups. Although differences in the conditional volatilities of wages have been larger, time trends are similar across skill groups. Third, although there has been a negative time trend in the volatility of hours worked for medium-skilled workers, volatility of hours worked for low-skilled workers has tended to increase.

In Section 3, we undertake a formal regression analysis. We find that a greater degree of financial integration increases the volatility of hours worked. This effect is strongest for low-skilled workers. The effect of financial globalization on the volatility of wages is roughly the same for high- and low-skilled workers. Moreover, the volatility of hours worked increases in the volatility of total factor productivity (TFP), and this effect is strongest for high-skilled workers. As regards the effects of TFP volatility on wages, we find similar responses across skill levels. We also control for openness of different sectors for trade, but we find no significant impact.

In Section 4, we show that the results of our formal regression analysis are largely consistent with a more or less standard dynamic stochastic general equilibrium model of a small open economy. To calibrate the model, we use the stylized facts reported in Section 2 and the EUKLEMS data, but the qualitative results are robust to changes in the calibration setup. The model features (i) portfolio adjustment costs to capture the depth of financial globalization, (ii) a heterogeneous workforce to capture the differential effect of financial globalization on high- and low-skilled workers, and (iii) costs of adjusting hours worked to capture in a general way labor market frictions that can differ across high- and low-skilled workers. Different adjustment costs across skill levels generate different responses of high- and low-skilled workers and thus imply that financial globalization has differential effects on high- and low-skilled workers. Intuitively, financial globalization strengthens intertemporal consumption smoothing and thereby dampens fluctuations in the marginal utility of consumption triggered by a shock to TFP. It follows that, in the case of a TFP shock, fluctuations in the marginal utility of labor income are large. This implies that financial globalization lowers the relative importance of adjustment costs for the dynamics of hours worked. Because adjustment costs per unit of labor compensation are higher for low- than for high-skilled workers, our model predicts that low-skilled workers experience a larger increase in the volatility of hours worked than high-skilled workers.

In Section 5, we summarize our results and offer some concluding remarks.

2. DESCRIPTIVE STATISTICS

Before delving into a formal empirical and theoretical analysis of volatility patterns, the following section presents stylized facts on the trends in the volatilities of hours worked and of wages at the industry level. Although the volatility of output is well documented, the stylized facts on the volatilities of hours worked and of wages are less well known, in particular as regards differences across skill groups.

2.1. Industry-Level Data

We use annual industry-level data from the EUKLEMS database, which provides detailed growth-accounting information for European countries, Japan, and the

TABLE 1. Descriptive statistics: Full sample

Variable	Obs	Mean	Std. Dev.	Min	Max
Unconditional volatility (5-year moving average)					
TFP	6,306	0.042	0.034	0.002	0.622
Employment	6,348	0.028	0.019	0.002	0.202
High-skilled employment	6,389	0.061	0.055	0.002	0.437
Medium-skilled employment	6,394	0.036	0.029	0.002	0.310
Low-skilled employment	6,394	0.050	0.043	0.001	0.581
Wages	6,394	0.108	0.051	0.003	0.756
High-skilled wages	6,394	0.112	0.051	0.008	0.761
Medium-skilled wages	6,394	0.108	0.051	0.006	0.753
Low-skilled wages	6,394	0.114	0.051	0.011	0.766
Conditional volatility (5-year moving average)					
TFP	6,306	0.037	0.028	0.003	0.505
Employment	6,348	0.021	0.014	0.002	0.173
High-skilled employment	6,389	0.054	0.046	0.003	0.446
Medium-skilled employment	6,394	0.029	0.022	0.001	0.237
Low-skilled employment	6,394	0.040	0.034	0.003	0.462
Wages	6,394	0.026	0.026	0.002	0.546
High-skilled wages	6,394	0.036	0.029	0.003	0.539
Medium-skilled wages	6,394	0.029	0.027	0.001	0.552
Low-skilled wages	6,394	0.034	0.029	0.002	0.547

United States. The database covers the period 1970–2004, and thereby allows analyzing trends in volatilities of hours worked and wages over a relatively long time range. The database includes information on primary, secondary, and tertiary industries. It also gives consistent measures of hours worked and of wages, in addition to information on productivity and output. Labor income and hours worked can be split into high-, medium-, and low-skilled employment.[4] Because financial globalization may have differential effects on workers with different skill levels, this information is particularly valuable for our purpose.

Restricting the analysis to countries that provide a breakdown of employment by skill levels gives a data set for 21 industries and 11 countries.[5] Details are given at the end of the paper (Appendix A). Table 1 provides summary statistics. Given that information on incomes by skill levels starts only in the 1980s for some countries, two panel data sets are created:

1. *Panel 1 is "short and wide."* It contains data on 11 countries (Austria, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Spain, United Kingdom, United States), 21 sectors, and 21 years (1982–2002). The total cross-section dimension is $N = 231$.
2. *Panel 2 is "long and narrow."* It contains data on four countries (Germany, Italy, United Kingdom, United States) with information on hours worked by skill levels starting from the 1970s ($N = 87$). It runs from 1970 to 2004 ($T = 35$).

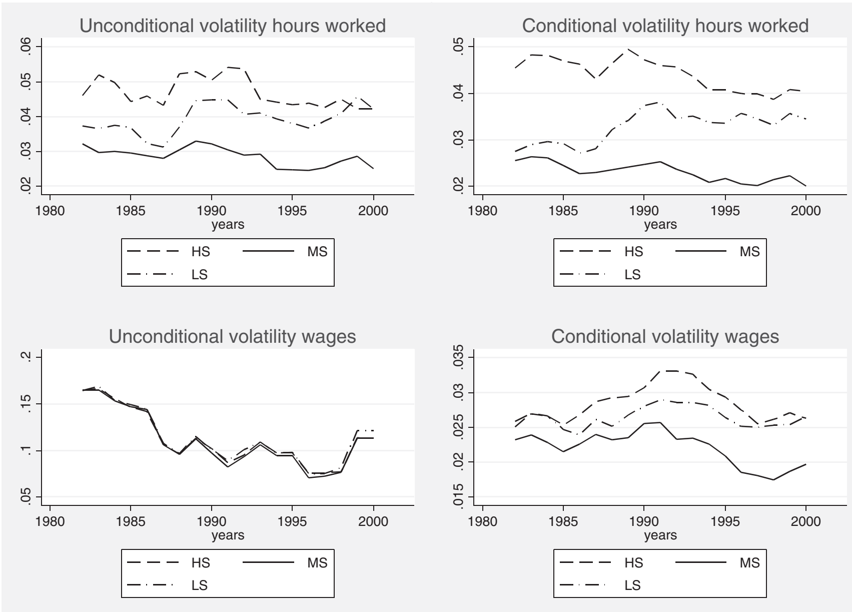

FIGURE 1A. Volatility of hours worked and wages ("short and wide" Panel 1, 1982–2002). This figure plots the median volatility of hours worked and wages for 11 European countries, the United States, and Japan across 22 industries. Three different skill levels—high-skilled, (HS), medium-skilled (MS), and low-skilled (LS)—are distinguished. Volatility is defined as the standard deviation of the growth rate of hours worked and wages over a rolling 5-year window. Unconditional volatility is derived from the growth rates of hours worked and wages. Conditional volatility is derived from the residuals of a regression of these growth rates on time-country and time-industry fixed effects and year dummies. For Figures 1C and 1D, conditional volatilities have been obtained using the multifactor residual model developed by Pesaran (2006) described in the main body of the text ("long and narrow" Panel 2, 1970–2004). Volatility in t is defined for the subsequent period $[t, t+4]$.

2.2. Conditional and Unconditional Volatility

In Figure 1, we present descriptive statistics for the median volatilities of hours worked and of wages across industries and countries. For comparison, we also provide information on the volatility of TFP. To isolate developments at the level of the individual industry from macroeconomic developments, we present conditional and unconditional measures of volatility. The unconditional volatility is the standard deviation of log growth rates over a five-year time interval.

To compute the conditional volatilities, we need to distinguish an idiosyncratic, industry-specific from a macroeconomic, systemic component of growth. From a theoretical point of view, TFP shocks should be important, but variations in hours worked and wages might be driven by a number of other macroeconomic factors as well. Not all of these macroeconomic factors are readily observable.

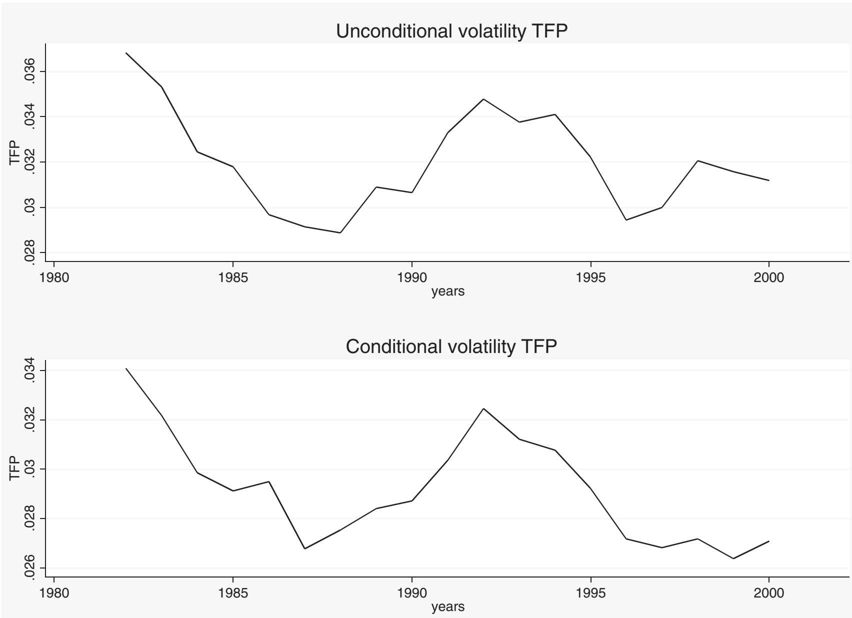

FIGURE 1B. Volatility of TFP ("short and wide" Panel 1, 1982–2002).

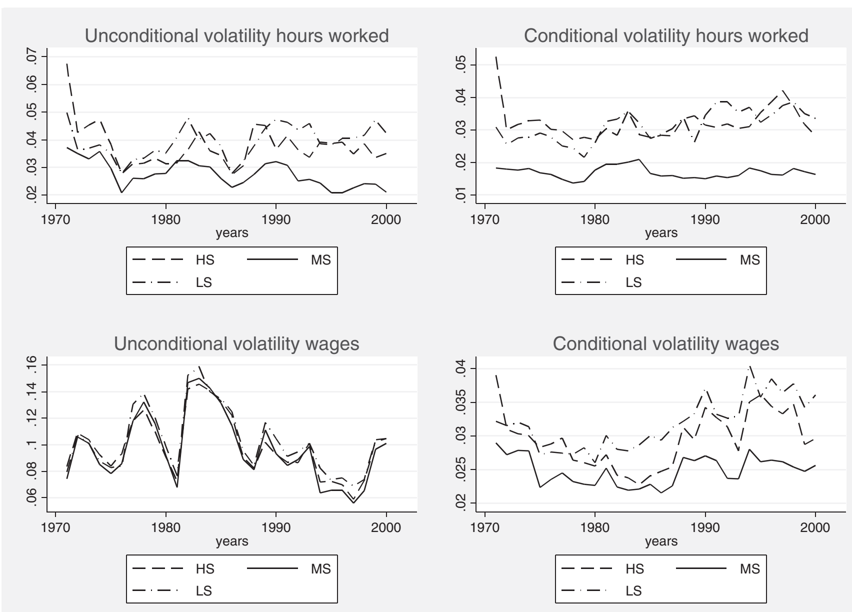

FIGURE 1C. Volatility of hours worked and wages ("long and narrow" Panel 2, 1970–2004).

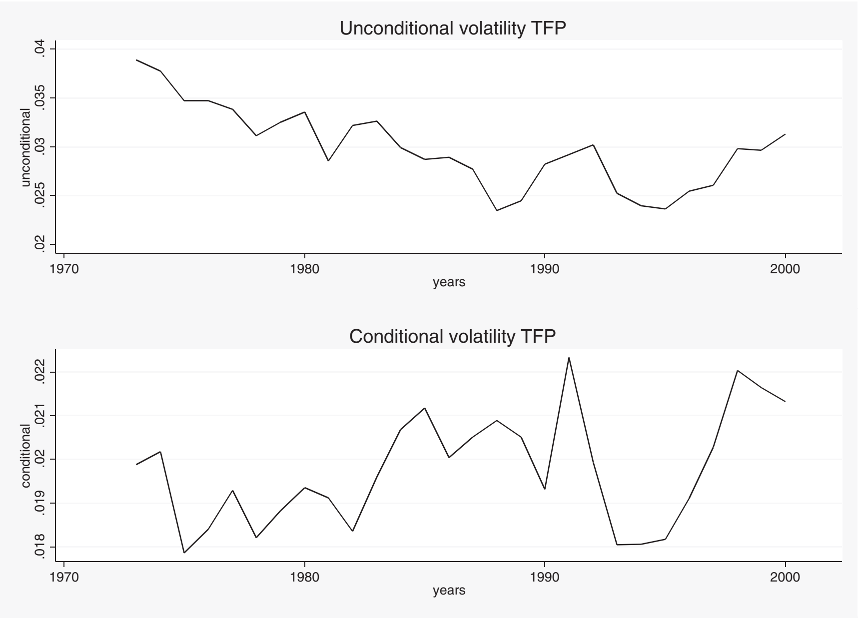

FIGURE 1D. Volatility of TFP ("long and narrow" Panel 2, 1970–2004).

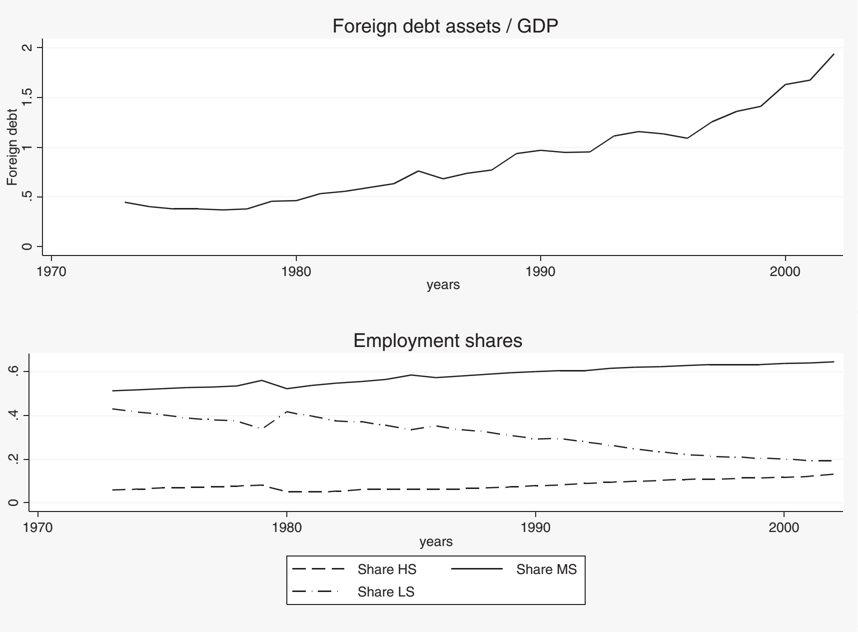

FIGURE 1E. Foreign debt ratio and employment shares (1970–2004).

Instead, some unobserved factors may affect all industries and countries. In order to account for observed and unobserved macroeconomic factors, the multifactor residual model developed by Pesaran (2006) is used. The logic of this model is as follows. Suppose that growth of hours worked (or of wages) is given by

$$\hat{y}_{it} = \alpha_i' d_t + \beta_i' x_{it} + \epsilon_{it}, \qquad \textbf{(1)}$$

where $i = 1, 2, \ldots, N$ is the number of industry–country pairs and $t = 1, 2, \ldots, T$ is the number of years. Equation (1) states that industry-level growth depends on a $k \times 1$ vector of observable macroeconomic factors, d_t, and a vector of observed industry-specific factors, x_{it}. The errors are assumed to have a multifactor structure,

$$\epsilon_{it} = \gamma_i' f_t + u_{it}, \qquad \textbf{(2)}$$

where f_t is an $m \times 1$ vector of unobserved macroeconomic factors and u_{it} are the industry-specific (idiosyncratic) errors, which are assumed to be distributed independent of d_t and x_{it}. The unobserved factors can be correlated with d_t and x_{it}; hence the industry-specific factors are modeled according to

$$x_{it} = A_i' d_t + \Gamma_i' f_t + \nu_{it}, \qquad \textbf{(3)}$$

where A_i and Γ_i are factor-loading matrices and ν_{it} are components of x_{it} that are independent of macroeconomic factors. The heterogeneous factor loadings, α_i and γ_i, can be estimated consistently when both N and T are large.

In most applications, the interest is in the slope coefficient, β_i, in equation (1). Instead, we are interested in the term, u_{it}. This term gives conditional growth in industry i that is uncorrelated with observed and unobserved macroeconomic factors. The key challenge is to isolate developments at the industry level from aggregate developments, while taking into account that some of the macroeconomic factors affecting all industries are unobserved. To extract observed and unobserved factors that affect all industries and countries (d_t, f_t), we thus run a reduced-form regression of income growth on observed and unobserved macroeconomic factors. These regressions are run separately for each of the cross sections, and the residuals from these regressions are retained. A constant term is included to capture the permanent component of income growth. Results are very similar when estimation of equation (1), including industry-specific regressors (x_{it}), includes changes in output, TFP, and relative prices.

The multifactor residual model is applied to the "long and narrow" panel, including four observed macroeconomic factors that affect aggregate volatility (growth in GDP per capita, inflation, energy prices, and trade openness). Following Pesaran (2006), the unobserved macroeconomic factors can be proxied by the sample means of industry-specific variables. We use mean output growth, mean TFP growth, and the mean change in relative prices across industries. The dependent variable is the log growth rate of hours worked or wages.

Because the multifactor residual model requires sufficiently long time series, it cannot be applied to the "short and wide" panel. For this panel, the conditional, industry-specific growth component is obtained by running a pooled regression of the change in log wages and hours worked on a full set of time-country and time-industry fixed effects. The purpose of these regressions is to de-mean growth rates and to purge them from macroeconomic developments affecting all industries and countries. The residuals of these regressions are the conditional, industry-specific growth components.

With a measure of conditional growth of hours worked and of wages at hand, the rolling average standard deviations over a five-year window are computed as

$$\sigma(\hat{u}_{it}) = \frac{1}{5}\sqrt{\sum_{k=0}^{4}\left(\hat{u}_{i,t+k} - \overline{\hat{u}}_{i,t}\right)^2}, \quad (4)$$

where $\hat{u}_{it}$ is the residual, industry-specific component of growth and $\overline{\hat{u}}_{i,t}$ is the corresponding mean. Equation (4) is applied to the volatility of wages and of hours worked at different skill levels. To check the robustness of the regression results reported in the following, a quasi-panel of nonoverlapping volatilities is used.

2.3. Volatility of Hours Worked and Wages

Figure 1 plots volatility, distinguishing the "short and wide" Panel 1 (Figures 1a and 1b) from the "long and narrow" Panel 2 (Figures 1c and 1d). For each of these panels, the conditional and unconditional volatilities of hours worked and wages (Figures 1a and 1c) and of TFP (Figures 1b and 1d) are shown. We also present evidence on the time trends in employment shares and in the ratio of foreign debt to GDP (Figure 1e). These variables will be used as regressors in Section 3, and they are key parameters of the theoretical model in Section 4.[6]

Volatility of hours worked. Figures 1a and 1c show some distinct differences in the level of volatility of hours worked by skill group. Whereas medium-skilled employment is the least volatile employment category throughout (0.036 in the "short and wide" panel; see also Table 1), high- and low-skilled employment are relatively volatile (0.061 and 0.050, respectively). That the volatility of high-skilled hours worked clearly exceeds the volatility of low-skilled hours worked is a feature shared by the "short and wide" panel.

Time trends in volatility of hours worked differ as well across skill groups. For medium-skilled workers, there has been a trend decline in volatility. A "Great Moderation" in the volatility of hours worked is less evident for the other skill groups. In fact, volatility of hours worked for high-skilled workers may even have increased since the 1990s ("long and narrow" panel). Volatility of hours worked for low-skilled workers clearly has increased during the last decade of the sample period (both panels).

These differences in the time trends of volatility of hours worked could be the result of different responses to TFP volatility and to international financial integration. As shown in Figures 1b and 1d, the volatility of TFP has been on a trend decline in the "short and wide" panel, in particular in the 1980s. This trend decline reversed in the 1990s, but continued toward the end of the sample. A trend decline in volatility is also visible in the "long and narrow" panel as far as the unconditional volatility of TFP is concerned. The conditional volatility of TFP shows no clear trend in the "long and narrow" panel. The degree of debt market integration has increased throughout (Figure 1e). Figure 1e also shows different time patterns of employment shares, the most important trend being the decline of low-skilled employment.

Volatility of wages. As regards the volatility of wages, the first observation that can be taken from Figures 1a and 1c is that the unconditional wage volatility has been very similar across skill groups (0.108). To a lesser extent, the conditional volatilities of wages also move relatively closely together. As regards time trends, though, results for conditional and unconditional wage volatility differ. In the late 1980s and the 1990s, unconditional wage volatility declined, thus mirroring the Great Moderation in output volatility (note that Figure 1c starts in the 1970s and thus also shows the high volatility of the 1970s). Toward the end of the sample, though, unconditional wage volatility tended to increase. The conditional volatility of wages has been much smaller, showing that wage volatility is to a large extent driven by macroeconomic developments.

Finally, there are differences in volatility levels for wages and hours worked. The unconditional volatility of wages (0.108) has been higher than the unconditional volatility of hours worked (0.028). Conditional volatilities of wages and hours worked, in contrast, are more similar (0.026 versus 0.021) (Table 1). A large part of macroeconomic volatility affecting all industries is thus absorbed by fluctuations in wages.

In sum, three main stylized facts emerge from the data. First, the volatility of hours worked by high-skilled workers has been higher than the volatility for medium-skilled workers. The volatility of low-skilled workers lies in between. Second, the unconditional volatility of wages has been very similar across skill groups. Third, although there has been a negative time trend in the volatility of hours worked for medium-skilled workers, volatility of hours worked for low-skilled workers has tended to increase.

3. EXPLAINING VOLATILITY: REGRESSION ANALYSIS

We next analyze whether trends in volatility can be explained by trends in productivity at the industry level and by the degree of openness and development of financial markets. For this purpose, we conduct a formal regression analysis to test how financial globalization affects the volatility of hours worked. For the regression analysis, we use the short-and-wide panel because of the greater degree of variation in financial openness and development across these countries. As the dependent variable in the regression equation, we use the conditional volatility of hours worked (or of wages) in each industry–country pair (ij) and year (t),

$$\sigma(\hat{u}_{ijt}) = \alpha_{ijt} + \beta_1 X_{it} + T_t + e_{ijt}, \quad \textbf{(5)}$$

where $\sigma(\hat{u}_{ijt})$ denotes the volatility of hours worked and α_{ijt} denotes country–industry fixed effects. We also include a full set of time fixed effects, T_t. These account for business cycle effects such as changes in monetary policy and other aggregate shocks affecting all countries and industries alike. e_{ijt} denotes the error term.

We estimate equation (5) separately for each skill group (high-skilled, medium-skilled, low-skilled). The list of explanatory variables, X_{it}, contains the volatility of TFP in each industry–country pair. The explanatory variables also include proxies for the degree of international integration of financial markets (the share of cross-border debt assets plus liabilities over GDP) and the state of development of the domestic financial system (deposit money bank assets over GDP). Both measures vary across countries. Hence, we can reasonably assume that financial integration and development are exogenous to the individual industry. Cross-border assets and liabilities over GDP is a commonly used measure of de facto financial openness as compared to de jure financial openness, i.e., the regulatory restrictions applying to cross-border capital flows. In the following, we use a de jure measure of financial openness as an instrument to account for the concern that capital flows might be endogenous.

To account for the possibility that within-group volatility may differ, we include the share of employment in each skill category. We expect a lower volatility if the employment share is high due to higher within-group volatility. Empirically though, these employment shares are nonsignificant.

The regression results are reported in Table 2. We show results for two specifications of the dependent variable, using the five-year moving average of volatility and a quasi-panel that features nonoverlapping observations of volatility. The explanatory power of our model might seem small at first sight, with an adjusted R between 0.05 and 0.10. However, these values are in a range with previous literature and they are not particularly small, given that we are explaining the residual variation in hours worked and wages. Our results are as follows:[7]

- *Volatility of TFP*: Volatility of TFP exerts a positive effect on the volatility of hours worked. Point estimates decline in the skill level; i.e., we find the highest point estimates for high-skilled workers and the lowest for low-skilled workers. For low-skilled workers, TFP volatility is nonsignificant in both regression models.
- *Financial globalization*: Higher cross-border assets and liabilities (debt) have a positive impact on the volatility of hours worked. These results are mostly driven by the hours worked by low-skilled workers.

TABLE 2. Fixed effects regressions: Conditional volatility of hours worked

	5-year rolling average			Quasi-panel		
	HS	MS	LS	HS	MS	LS
TFP volatility	0.135*	0.069*	0.033	0.100	0.044	−0.002
	[0.062]	[0.036]	[0.047]	[0.066]	[0.045]	[0.052]
Foreign assets (debt)/GDP	0.001	0.001	0.009**	−0.001	−0.002	0.013**
	[0.005]	[0.001]	[0.004]	[0.007]	[0.003]	[0.005]
Deposit Money Bank Assets/GDP	0.014***	0.010***	0.012	0.015***	0.011**	0.015
	[0.003]	[0.003]	[0.010]	[0.004]	[0.004]	[0.009]
Share of high-skilled workers	−0.092	—	—	0.115	—	—
	[0.094]	—	—	[0.092]	—	—
Share of low-skilled workers	—	—	0.037	—	—	0.062*
	—	—	[0.035]	—	—	[0.034]
Share of medium-skilled workers	—	−0.015	—	—	−0.018	—
	—	[0.018]	—	—	[0.015]	—
Constant	0.044*	0.019*	0.003	0.052*	0.028***	−0.017
	[0.020]	[0.009]	[0.023]	[0.024]	[0.008]	[0.020]
Observations	5806	5810	5810	1212	1213	1213
R^2	0.047	0.076	0.112	0.048	0.084	0.143
Number of index	251	251	251	251	251	251

Notes: The dependent variable is the conditional volatility of hours worked, computed over a five-year moving window $[t, t+4]$ and, in the quasi-panel model, from nonoverlapping observations of volatility. The explanatory variables are measured in period t. Standard errors have been adjusted for heterogeneity and autocorrelation of unknown form and are clustered at the country level; t-values are reported in brackets. The table reports country–industry fixed effects panel regressions with the cross-section dimensions being determined by the combination of 11 countries and 21 industrial sectors. Time fixed effects are included. *** (**, *) denotes significance at the 1% (5%, 10%) level. HS (MS, LS) denotes high-skilled (medium-skilled, low-skilled) workers.

- *Domestic financial development*: The ratio of domestic money bank assets over GDP is often used as a proxy for the state of development of the domestic financial system. We expect a positive sign because a more developed financial system should be associated with lower transactions costs and thus enhanced access to financial markets for workers. Consistent with these expectations, we find a positive effect, which is significant for high- and medium-skilled workers. Point estimates are roughly the same across workers at different skill levels.

We have run similar regressions using the volatility of wages instead of hours worked as the dependent variable (Table 3). We find a positive and significant impact of TFP volatility with roughly similar point estimates across skill groups. The impact of TFP volatility on the volatility of wages is nonsignificant in the quasi-panel. Also, greater financial globalization leads to more wage volatility with, again, similar effects across skill groups. This volatility-enhancing effect of financial globalization is nonsignificant in the quasi-panel model, and the respective coefficient is small when compared to the coefficient that captures the effect of TFP volatility. Domestic financial development has a negative but nonsignificant impact.

We have used various modifications of our empirical model to check the robustness of our results. To begin with, we reestimated equation (5) using lagged explanatory variables. Because the residuals affect the volatility of hours worked and output, the denominators of the variables foreign assets/GDP and deposit money bank assets/GDP may be correlated with the residuals. Using lagged explanatory variables should mitigate a resulting endogeneity problem. Because we use a five-year window to compute volatilities, simply lagging the explanatory variables by five years would introduce a large wedge between the dependent variable and the explanatory variables. We thus started by shifting the explanatory variables by one year. We then verified that the signs and the significance of the coefficients are similar to the results reported in Tables 2 and 3. Next, we shifted the explanatory variables by one more year. Using this step-by-step procedure, we found that increasing the number of lags weakens the correlation between the dependent variable and the explanatory variables, but that in general results are qualitatively similar to those reported in Tables 2 and 3.

In addition, we used a de facto measure of financial integration in the form of capital controls. Schindler (2008) provides evidence based on the IMF's Annual Report of Exchange Arrangements and Restrictions. However, none of these measures gave reasonable results, neither when used directly as regressors nor as an instrument in regressions using de facto measures of financial openness in the form of actual capital flows. This is partly because our time series for capital controls are relatively short. Partly, however, it could be because what matters for international risk sharing is the actual, not the legal degree of openness.

Measures for trade openness, which address the fact that trade and financial integration often move in parallel, are nonsignificant. However, because we have

TABLE 3. Fixed effects regressions: Conditional volatility of wages

	5-year rolling average			Quasi-panel		
	HS	MS	LS	HS	MS	LS
TFP volatility	0.107**	0.118**	0.105**	0.091	0.101	0.092
	[0.043]	[0.045]	[0.042]	[0.070]	[0.066]	[0.063]
Foreign assets (debt)/GDP	0.011***	0.009**	0.010**	0.008***	0.004	0.007
	[0.003]	[0.003]	[0.004]	[0.003]	[0.004]	[0.004]
Deposit Money Bank Assets/GDP	−0.008	−0.008	−0.007	−0.005	−0.006	−0.006
	[0.007]	[0.005]	[0.008]	[0.009]	[0.006]	[0.008]
Share of high-skilled workers	−0.061	—	—	−0.073	—	—
	[0.041]	—	—	[0.044]	—	—
Share of low-skilled workers	—	—	0.042	—	—	0.047
	—	—	[0.026]	—	—	[0.031]
Share of medium-skilled workers	—	−0.021*	—	—	−0.024	—
	—	[0.011]	—	—	[0.016]	—
Constant	0.028**	0.025***	0.009	0.035***	0.037***	0.004
	[0.010]	[0.008]	[0.016]	[0.009]	[0.009]	[0.020]
Observations	5810	5810	5810	1213	1213	@1213
R^2	0.038	0.059	0.038	0.035	0.059	0.044
Number of cross-sections	251	251	251	251	251	251

Notes: The dependent variable is the conditional volatility of wages, computed over a five-year moving window $[t, t+4]$ and, in the quasi-panel model, from nonoverlapping observations of volatility. The explanatory variables are measured in period t. Standard errors have been adjusted for heterogeneity and autocorrelation of unknown form and are clustered at the country level. t-values are reported in brackets. The table reports country–industry fixed effects panel regressions with the cross-section dimensions being determined by the combination of 11 countries and 21 industrial sectors. Time fixed effects are included. *** (**, *) denotes significance at the 1% (5%, 10%) level. HS (MS, LS) denotes high-skilled (medium-skilled, low-skilled) workers.

information on trade by industries only for the manufacturing sector, sample size also decreases substantially. Measures for total cross-border assets plus liabilities give qualitatively the same results as measures for cross-border debt assets plus liabilities. It would also be interesting to distinguish private and public sector assets and liabilities. Unfortunately, however, the data are not detailed enough to provide such a breakdown. To account for the fact that the dependent variable is the result of a first-stage estimation procedure, we also bootstrapped the standard errors. The main results are unchanged.

Finally, excluding the United States, as a country for which the small-country assumption invoked in many theoretical models is violated, gives qualitatively similar results. We have also checked the sensitivity of our results with regard to excluding other larger countries such as Germany, France, and the United Kingdom. It is interesting to note that all results are stable, with one exception: the positive and significant effects of international assets and liabilities are driven by including the United Kingdom in the sample. It shows the role of the United Kingdom as a financial center. It is worthwhile to mention that this result is not driven by the financial sector itself, which we have excluded from the analysis (but by spillovers to the rest of the economy).

4. EXPLAINING VOLATILITY: THEORY

Next, we turn to the question of whether a more or less standard stochastic dynamic general equilibrium model, which is consistent with the stylized facts laid out in Section 2, is also consistent with the results of our empirical analysis. We present a parsimonious model with the minimal number of components necessary to inspect the mechanism that links labor market volatility and financial integration. Because we want to look at this mechanism in isolation, we deliberately do not add a lot of extra components to our model that might also affect the volatility of the key variables of interest. The nucleus of our model is, thus, fairly standard.

4.1. Structure of the Economy

We consider a stylized small open economy populated by a continuum of infinitely lived households of total measure unity. Each household has a large number of members. A proportion v of household members are high-skilled workers, and a proportion $1 - v$ are low-skilled. This household structure has become fairly standard in macroeconomic models allowing for worker heterogeneity, and it allows focusing on the implications of differences in the costs of adjusting hours worked by high- and low-skilled workers. High- and low-skilled workers do not differ with regard to their access to financial markets, which can be explained through the presence of within-household risk sharing. Our model thus features a heterogeneous workforce, where we simplify our analysis by abstracting, in contrast to the empirical analysis, from workers with a medium-skill level. Households form rational expectations. They maximize the following intertemporal utility function:

$$\mathcal{V} = \mathbf{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\phi v u^s \left(c_t^s, h_t^s \right) + (1-\phi)(1-v)\, u^l \left(c_t^l, h_t^l \right) \right], \tag{6}$$

where $\mathbf{E}_t$ denotes the conditional expectations operator, $0 < \beta < 1$ denotes a discount factor, $0 < \phi < 1$ denotes the weight of high-skilled workers in the utility function, $u(c_t^i, h_t^i)$ denotes the period-utility functions of high-skilled workers ($i = s$) and low-skilled workers ($i = l$), and c_t^i and h_t^i denote consumption and hours worked. The parameter ϕ enters into the equation that governs the ratio of wages of high- and low-skilled workers (that is, the skill premium) in the nonstochastic steady state (Appendix B) and, thus, gives flexibility to match the skill premium in the data. The period-utility function is the same for all household members and takes the form $u^i(c_t^i, h_t^i) = \log c_t^i - \frac{1}{1+\psi}(h_t^i)^{1+\psi}$, where ψ denotes the elasticity of real wages with respect to hours worked (the inverse of the Frisch elasticity of labor supply). Households maximize equation (6) subject to the sequence of budget constraints

$$\begin{aligned} d_{t+1} &= (1+\bar{r})\, d_t - v w_t^s h_t^s - (1-v) w_t^l h_t^l + v c_t^s + (1-v) c_t^l \\ &\quad + \mathrm{AC}_t^d + v \mathrm{AC}_t^s + (1-v)\mathrm{AC}_t^l, \end{aligned} \tag{7}$$

where d_t denotes foreign debt measured in terms of riskless one-period real bonds and w_t^s and w_t^l denote the competitive real wages of high- and low-skilled workers. The real interest rate, $\bar{r}$, is a positive constant, reflecting our assumption that we are looking at the case of a small open economy.

Following Schmitt-Grohé and Uribe (2003, Sect. 4), we model financial globalization in terms of convex portfolio adjustment costs (that is, costs of holding bonds), AC_t^d, that households face when their holdings in internationally traded real bonds differ from their steady-state level. Lower portfolio adjustment costs lead to states of deeper financial globalization. To some extent, the assumption of portfolio adjustment cost is a technical one, ensuring a stationary nonstochastic steady state around which the model can be log-linearized. Invoking this assumption, however, is also justified empirically.[8] There is ample empirical evidence that, even within a highly integrated area such as the European Union, there are quite substantial costs of adjusting cross-border financial positions [European Central Bank (2008), Coeurdacier and Rey (2012)]. Technically, portfolio adjustment costs are of the form $\mathrm{AC}_t^d = (\alpha^d/2)(d_{t+1} - \bar{d})^2$, where $\alpha^d > 0$. The parameter $\bar{d}$ denotes foreign debt in the nonstochastic steady state, which is assumed to be zero for simplicity.

Adjustment costs also arise in the form of costs of adjusting hours worked, which represent in an efficient and stylized manner costs such as recruiting costs, training costs, and costs of reorganizing family life and child care. Recent research by Janko (2008) demonstrates the usefulness of adjustment costs for modeling business-cycle fluctuations. Following Helpman and Itskhoki (2010), who argue that hiring and firing costs can have similar qualitative implications for the adjustment of employment, we do not distinguish hiring and firing costs. Various functional forms have been used in the literature to model costs of adjusting hours worked [Adda and Cooper (2003)]. For simplicity and in analogy to portfolio adjustment costs, we assume that the costs of adjusting hours worked, AC_t^s and AC_t^l, are quadratic and are given by $\mathrm{AC}_t^i = (\alpha^i/2)(h_t^i - h_{t-1}^i)^2/h_{t-1}^i$, for $i = s, l$, where the magnitude of adjustment costs, $\alpha^i \geq 0$, can differ across high- and low-skilled workers. Such differences in the costs of adjusting hours worked can be used to match the volatilities of hours worked of high- and low-skilled workers with the volatilities reported in Section 2. Specifically, adjustment costs for low-skilled workers may be lower than those for high-skilled workers [Davidson and Matusz (2000)], capturing lower search and training costs. This assumption can be justified on the ground that, for high-skilled workers, search costs are significant for both firms and workers. Also, training costs are higher in terms of resources and time than for low-skilled workers. In line with this intuition, the adjustment-cost parameter can be smaller for low- than for high-skilled workers in our model. However, the presence of a skill premium (Appendix B) implies that, as we shall argue in Section 4.3, the wages of high-skilled workers are twice as high in the calibrated nonstochastic steady state as the wages of low-skilled workers, implying that adjustment costs *per unit of labor compensation* are lower for high- than for low-skilled workers.[9]

Profit-maximizing firms hire high- and low-skilled workers to produce output, y_t, according to a CES production function. In recent research, CES production functions have been extensively studied to analyze the skill premium and capital–skill complementarities [Krusell et al. (2000), Polgreen and Silos (2008)]. Mandelman and Zlate (2008) use a CES production function to analyze labor migration in a dynamic stochastic general equilibrium model featuring native and immigrant workers at different skill levels. Stokey (1996) uses a CES production function to analyze the implications of the presence of high-and low-skilled workers for economic growth in an open economy. The CES production function is given by

$$y_t = A_t \left[\gamma^{\frac{1}{\theta}} \left(H_t^s\right)^{\frac{\theta-1}{\theta}} + (1-\gamma)^{\frac{1}{\theta}} \left(\zeta H_t^l\right)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}, \tag{8}$$

where $H_t^s = v h_t^s$, $H_t^l = (1-v) h_t^l$, $0 < \gamma < 1$, $0 < \zeta < 1$ is an efficiency parameter, and $\theta > 0$ governs the elasticity of substitution between high- and low-skilled employment. The efficiency parameter helps in scaling the skill premium in the nonstochastic steady state, and it governs the relative responses of high- and low-skilled hours worked to a TFP shock. TFP, A_t, evolves according to a first-order autoregressive process,

$$\log A_t = \rho \log A_{t-1} + \epsilon_t, \tag{9}$$

where $0 \leq \rho < 1$ and the serially uncorrelated shocks are distributed as $\epsilon_t \sim \mathcal{N}(0, \sigma_\epsilon^2)$.

4.2. Optimization

The first-order conditions for the households' utility-maximization problem and the firms' profit-maximization problem are given by

$$\phi \frac{\partial u_t^s}{\partial c_t^s} - \lambda_t = 0, \tag{10}$$

$$(1-\phi)\frac{\partial u_t^l}{\partial c_t^l} - \lambda_t = 0, \tag{11}$$

$$\phi \frac{\partial u_t^s}{\partial h_t^s} + \lambda_t w_t^s - \lambda_t \alpha^s \frac{h_t^s - h_{t-1}^s}{h_{t-1}^s} + \frac{\alpha^s}{2}\beta \mathbf{E}_t \lambda_{t+1} \frac{(h_{t+1}^s)^2 - (h_t^s)^2}{(h_t^s)^2} = 0, \tag{12}$$

$$(1-\phi)\frac{\partial u_t^l}{\partial h_t^l} + \lambda_t w_t^l - \lambda_t \alpha^l \frac{h_t^l - h_{t-1}^l}{h_{t-1}^l} + \frac{\alpha^l}{2}\beta \mathbf{E}_t \lambda_{t+1} \frac{(h_{t+1}^l)^2 - (h_t^l)^2}{(h_t^l)^2} = 0, \tag{13}$$

$$-\beta (1+\bar{r})\, \mathbf{E}_t \lambda_{t+1} + \lambda_t \left(1 - \alpha^d d_{t+1}\right) = 0, \tag{14}$$

$$\frac{\partial y_t}{\partial H_t^s} - w_t^s = 0, \tag{15}$$

$$\frac{\partial y_t}{\partial H_t^l} - w_t^l = 0, \tag{16}$$

where λ_t denotes the Lagrange multiplier on equation (7). Equations (10) and (11) are the optimality conditions for consumption. Equations (12) and (13) are the optimality conditions for labor supply. Equation (14) gives the optimality condition for foreign debt. Equations (15) and (16) are the optimality conditions for hiring high- and low-skilled workers. In addition to equations (10) and (16), the usual transversality condition holds.

The optimality conditions given in equations (10) and (11) show that households pool consumption across high- and low-skilled household members, implying that consumption growth is the same for high- and low-skilled workers. The optimality conditions given in equations (12) and (13) govern the intertemporal labor supply of high- and low-skilled household members. In the special case $\alpha^s = \alpha^l = 0$, the optimality conditions degenerate to the simple static case, in which the intratemporal marginal utility of income from supplying one additional unit of labor matches the intratemporal marginal disutility from supplying an additional unit of labor. Adjustment costs add an additional layer of complexity to the static conditions as households smooth out labor supply over time to minimize these costs.

Equation (14), in combination with equations (10) and (11), links optimizing households' consumption smoothing to portfolio adjustment costs: if households' foreign debt position is positive, they can increase their current consumption by one unit net of portfolio adjustment costs. Households must balance the marginal utility of the resulting increase in consumption with the present value of the value of repaying $1 + \bar{r}$ next period. In technical terms, equation (14) ensures that consumption growth is positive (consumption is below its steady-state value) when foreign debt is positive, forcing the model to revert to the stationary nonstochastic steady state. Finally, equations (15) and (16) give firms' profit-maximization conditions.

4.3. Calibration

To simulate the model, we log-linearize its equations around a nonstochastic steady state (Appendix B and Appendix C).[10] We then calibrate its structural parameters on the (annual) EUKLEMS data as follows. The discount factor assumes the value $\beta = 0.96$, which implies an annual real interest rate of approximately 4.12%. As for the elasticity of wages with respect to hours, ψ, we follow other researchers who have assumed a value of 0.2 [for example, Gali et al. (2007)]. Using a somewhat higher value of 0.33, a value assumed by Mandelman and Zlate (2008) for U.S. workers, hardly affects our simulation results.

The elasticity of substitution between high- and low-skilled workers is a key parameter. For the United States, one of the countries covered by our data, Krussell et al. (2000) estimate a value of $\theta = 1.67$ for the elasticity of substitution between high- and low-skilled workers, based on annual data for the period 1963–1992. Crifo-Tillet and Lehmann (2004) and Lindquist (2004) use this estimate to calibrate dynamic stochastic general equilibrium models. Yet, adding 10 more years of data and using alternative data sets, Polgreen and Silos (2008) find that the estimate reported by Krussell et al. (2000) may be at the lower bound of empirically plausible values. Polgreen and Silos (2008) report values in the range from $\theta = 1.67$ to $\theta = 9.05$.

Because it is unclear a priori whether their estimates apply to the EUKLEMS data, we use the firms' first-order conditions to gain further insights into the magnitude of the parameter θ. Equations (C.7) and (C.8) (see Appendix C) show that wages should be equal to output, hours worked, and a TFP shock, where the coefficient on hours is given by $-1/\theta$. Accordingly, we use the EUKLEMS data to estimate a regression equation (including a constant) for wages on hours worked (all variables in logs), where we control for output and capital. We also estimate a dynamic regression equation that features lagged explanatory variables. Estimates vary between $\theta = 4$ and $\theta = 10$ for high-, medium-, or low-skilled workers. Because the volatilities of wages of high- and low-skilled are roughly the same in the EUKLEMS data (0.112 and 0.114 when unconditional volatilities are being used), we set $\theta = 7$, a value that lies in the middle of the range of our empirical estimates.[11] We verified, however, that calibrating the parameter θ to assume much smaller values yields similar simulation results (results are available upon request).

With regard to the contribution of high- and low-skilled workers to households' utility, we set $\phi = 0.70$ to match volatilities observed in the EUKLEMS data, a value slightly higher than the one used by Lindquist (2004). Concerning the proportion of high- and low-skilled workers, υ, our data imply that, across countries and sectors, the share of high-skilled workers is 12.68%, the share of medium-skilled workers is 56.96%, and the share of low-skilled workers is 30.35%. Because our model features only high- and low-skilled workers, we arbitrarily assume that one-half of the group of medium-skilled workers belong to the group of high-skilled workers, and the other half belong to the group of low-skilled workers. This gives an approximate proportion of $\upsilon = 0.42$ of high-skilled workers.

We calibrate the parameters γ and ζ to match roughly the skill premium implied by the EUKLEMS data, which is on average 2.08 when computed for high- and low-skilled workers across countries and sectors. To match this value, we set $\gamma = 0.55$ and $\zeta = 0.45$. Finally, because adjustment costs may be higher for high- than for low-skilled workers, we scale the adjustment-cost parameter in the case of high-skilled workers so that $\alpha^s = 1$, and then calibrate the costs of adjusting hours worked for low-skilled workers as $\alpha^l = 0.80$. These values are close to values assumed by other researchers [Janko (2008)]. For our calibration, the ratio of volatilities of hours worked by high- and low-skilled workers is then only slightly smaller than its empirical counterpart. The presence of a skill premium implies that, for our calibration, adjustment costs are lower for high- than for low-skilled workers when expressed in units of labor compensation. Even if the parameter that governs the absolute magnitude of adjustment costs is larger for high- than for low-skilled workers, $\alpha^s > \alpha^l$, the presence of a steady-state skill premium, $\bar{w}^s > \bar{w}^l$ (a bar denotes the nonstochastic steady state), thus implies that adjustment costs per labor compensation can be higher for low- than for high-skilled workers.

Using the EUKLEMS data again, we assume, based on estimation results for an AR(1) model, that the parameters $\rho = 0.75$ and $\sigma_\epsilon^2 = (0.04)^2$ describe the stochastic process that governs TFP. Finally, we set portfolio adjustment costs at $\alpha^d = 0.01$. Given these parameters, the model approximately matches output volatility. In Section 4.4, however, we will analyze the implications for volatilities of a variation of portfolio adjustment costs over a range of other numerical values.

Table 4 summarizes the calibrated parameters. The summary statistics in Table 5 show that the calibrated model performs well in matching key summary statistics of the EUKLEMS data. The skill premium in the nonstochastic steady state comes close to the empirical skill premium. The ratio of hours worked by high- and low- skilled workers in the nonstochastic steady state is roughly the same as in our data. The ratio of standard deviations of hours worked is slightly smaller than in the data. The ratio of standard deviations of wages almost exactly matches its empirical counterpart. The standard deviations of hours worked and wages are somewhat smaller than the (unconditional) standard deviations implied by the EUKLEMS data, but to approximately the same extent for high- and low-skilled workers. Also, the simulated standard deviations are close to the conditional

TABLE 4. Calibrated parameters

Parameter	Value	Description
υ	0.42	Proportion of high-skilled household members
ϕ	0.70	Weight of high-skilled workers in the utility function
ψ	0.42	Elasticity of hours worked to real wages
β	0.96	Discount factor
γ	0.55	Parameter in the CES production function
θ	7.0	Parameter that governs substitution elasticity
ζ	0.45	Productivity of low-skilled workers
α^s	1.0	Adjustment costs (high-skilled workers)
α^l	1.0	Adjustment costs (low-skilled workers)
α^d	0.0	Adjustment costs (foreign debt)
ρ	0.75	Autocorrelation of TFP
$\sigma^2\epsilon$	0.04	Standard deviation of TFP shocks

standard deviations. Finally, the standard deviation of output implied by the model is close to the empirical standard deviation implied by the data.

4.4. Model Predictions

The impulse response functions shown in Figure 2 illustrate the response of key macroeconomic variables to a unit shock to TFP. An increase in TFP raises the marginal productivities of high- and low-skilled workers, leading to an increase in output and hours worked. Firms hire mainly high-skilled workers because costs

TABLE 5. Summary statistics from the model and the data

Statistic	Simulated model	EUKLEMS data
Skill premium (steady state)	2.21	2.08
Ratio of hours worked	0.77	0.78
Ratio of std. dev. of hours worked	1.13	1.22
Ratio of std. dev. of wages	0.99	0.98
Std. dev. of skilled hours	0.03	0.06
Std. dev. of unskilled hours	0.03	0.05
Std. dev. of skilled wages	0.06	0.11
Std. dev. of unskilled wages	0.06	0.11
Std. dev. of output	0.09	0.10

Notes: The skill premium is defined as the wage of high-skilled workers divided by the wage of low-skilled workers. The ratio of hours worked is defined as hours worked by high-skilled workers divided by hours worked by low-skilled workers. The ratio of standard deviations (std. dev.) of hours worked is defined as the standard deviation of hours worked by high-skilled workers divided by the standard deviation of hours worked by low-skilled workers. The ratio of standard deviations of wages is defined in an analogous way. Numbers for the EUKLEMS data are unconditional standard deviations.

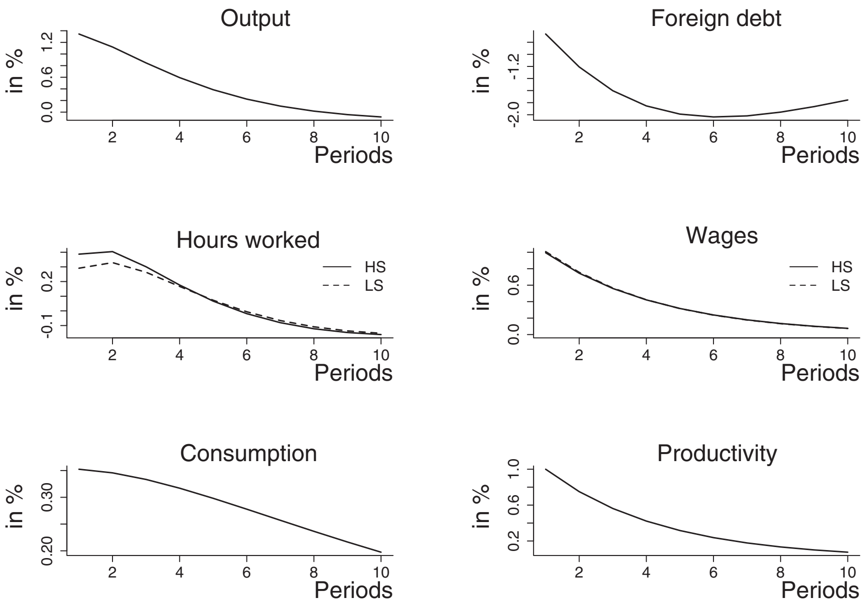

FIGURE 2. Impulse response functions. This figure shows the response of key macroeconomic variables to a unit shock to TFP. Fluctuations in macroeconomic variables are measured in terms of deviations from the non-stochastic steady state. HS = High-skilled workers, LS = Low-skilled workers.

of adjusting hours worked per labor compensation are lower for high- than for low-skilled workers. In line with our empirical results, the model thus predicts that the volatility of TFP has a stronger effect on hours worked by high-skilled workers than on hours-worked by low-skilled workers. The magnitude of the differential in hours worked is determined by the elasticity of hours worked with respect to wages, ψ, and by the elasticity of substitution, θ. A high elasticity of substitution strengthens the effect of different adjustment costs on the differential in hours worked and, at the same time, dampens the transmission of differential adjustment in hours worked onto the wage differential.

Wages increase more or less in tandem across skill groups because of the relatively high elasticity of substitution between production factors. This prediction of our model is in line with our empirical results as well, according to which the volatility of TFP has similar effects across wages of workers at different skill levels.

Finally, consumption increases by less than output because households smooth consumption over time. To smooth consumption, households accumulate foreign assets. Hence, foreign debt decreases and, because of portfolio adjustment costs, foreign debt eventually returns to its stationary steady-state value.

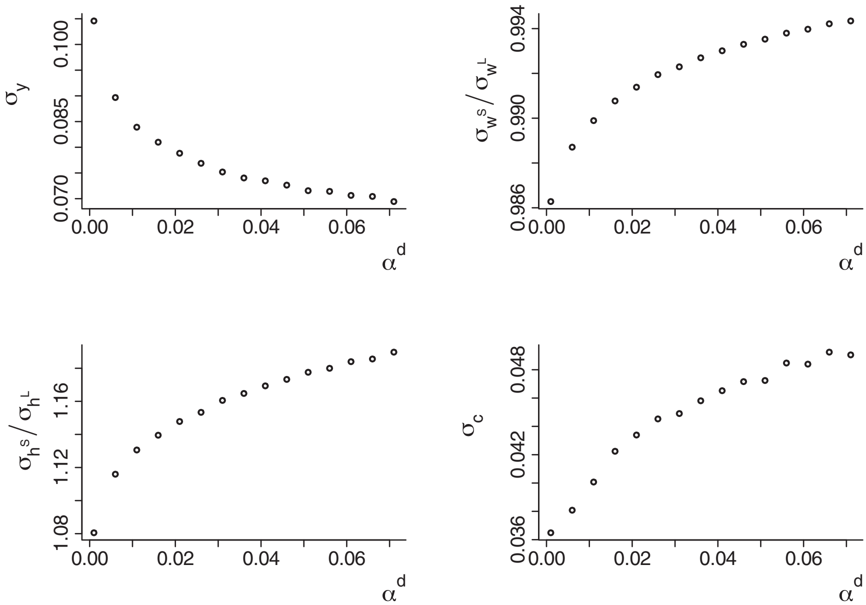

FIGURE 3. Financial globalization and volatility. This figure shows the simulated volatility of output (σ_y), the ratio of the simulated volatilities of wages of high- and low-skilled workers (σ_w^s/σ_w^l), the ratio of the simulated volatilities of hours worked of high- and low-skilled workers (σ_h^s/σ_h^l), and the simulated volatility of consumption (σ_c) as a function of portfolio adjustment costs (α^d).

We can also use the model to analyze the implications of financial globalization (i.e., of a decline in the adjustment costs of cross-border positions) on the volatility of hours worked and wages. Figure 3 plots the volatilities of output and consumption together with the ratios of the volatilities of hours worked and wages of high- and low-skilled workers. As one moves from right to left, portfolio adjustment costs, α^d, decrease and, thus, financial globalization increases.

Financial globalization gives rise to an increase in output volatility. The increase in output volatility hardly affects the ratio of wage volatilities of high- and low-skilled workers because of the assumed relatively high elasticity of substitution between production factors. The volatilities of hours worked increase. Consistent with our empirical results, the amplifying effect of financial globalization on the volatility of hours worked tends to be stronger for low-skilled than for high-skilled workers. In other words, in response to financial globalization, TFP shocks generate a higher volatility of output and trigger more additional hires and fires of low-skilled workers than of high-skilled workers. Finally, portfolio adjustment costs, α^d, enter the model through equation (14). Lower portfolio adjustment costs reduce the expected rate of change in consumption, reflecting better opportunities for international risk sharing and consumption smoothing. The volatility of consumption thus gets smaller.[12]

The implications of consumption smoothing and, thus, financial globalization for the volatility of hours worked become clear when one inserts equation (10) into equation (12) and equation (11) into equation (13). Combining the households' optimality conditions in this way reveals that fluctuations in hours worked reflect changes in the marginal utility of income and changes in adjustment costs. Because financial globalization strengthens consumption smoothing and, thus, stabilizes the marginal utility of consumption, fluctuations in the marginal utility of income resulting from changes in wages become more important for fluctuations in hours worked relative to adjustment costs for both high- and low-skilled workers. When adjustment costs per labor compensation are higher for low- than for high-skilled workers, however, any change in the magnitude of fluctuations in the marginal utility of income brought about by financial globalization result in a comparatively larger increase in the volatility of hours worked in the case of low- than in the case of high-skilled workers.

5. SUMMARY AND CONCLUDING REMARKS

The impact of globalization and in particular of trade integration on relative wages across skill groups has been extensively analyzed in the previous literature. We have studied the impact of globalization on workers at different skill levels from a different angle. We ask how financial globalization affects volatilities of hours worked and wages of workers at different skill levels. Based on a large industry-level data set, we have identified general patterns in the unconditional and conditional volatilities of hours worked and of wages across time and across skill groups. The conditional volatilities account for macroeconomic shocks affecting all countries and industries and thus allow a more precise analysis of volatility trends at the industry level. Our paper has three main findings.

First, labor market volatility differs for workers with different skills, both in terms of levels and in terms of time trends. These differences are most distinct for the volatility of hours worked, which has been higher for high-skilled than for medium-skilled workers. We have documented a negative time trend in the volatility of hours worked for medium-skilled workers. The volatility of hours worked by low-skilled workers, though, has increased since the 1990s. The unconditional volatility of wages has been relatively high and similar across skill groups, suggesting that changes in wages absorb a substantial amount of macroeconomic volatility. Accounting for these macroeconomic factors reveals differences in the conditional volatilities of wages. Time trends, however, are similar across skill groups.

Second, we have analyzed the determinants of the volatility of hours worked and of wages by means of a formal regression analysis. We find that a higher volatility of TFP increases the volatility of hours worked (for high-skilled workers) and of wages (across all skill groups). A higher degree of financial globalization increases the volatility of hours worked, and this effect is stronger for low-skilled workers than for high-skilled workers. Hence, low-skilled workers benefit the least from a decline in the volatility of TFP, and volatility for these workers has increased the most in response to the increase in financial globalization and development.

Third, we have developed a dynamic stochastic general equilibrium model of a small open economy that is consistent with the general patterns in the data. We have used the model to trace out the implications of financial globalization for the volatility of hours worked and wages across skill groups. The model predicts that the effect of financial globalization on the volatility of hours worked should be larger for low-skilled workers than for high-skilled workers. The model also predicts that financial globalization should have similar effects on the volatilities of wages of high- and low-skilled workers. These results are largely in line with our empirical findings.

The results reported in this paper should be viewed as a first step toward a deeper exploration of the implications of financial globalization for labor market volatility. More research is required to fully understand whether financial globalization may impose a "double burden" on low-skilled workers. For example, our theoretical model could be extended to include capital and investment and labor market frictions other than costs of adjusting hours worked. Finally, it would also be interesting to analyze a multisector model in which high-skilled workers and low-skilled workers were concentrated in different industries.

NOTES

1. Abowd and Kramarz (2003), as well as Kramarz and Michaud (2010), show that the hiring and firing costs tend to be higher for skilled workers in France. Blatter et al. (2012) report similar qualitative evidence for Switzerland.
2. See Davis and Kahn (2008) for a recent survey.
3. See www.euklems.net. Timmer et al. (2007) provide a detailed description of the database and of methodological issues. Dew-Becker and Gordon (2007) use this database to study the link between employment growth and productivity.
4. Note that the definition of high-skilled employment is consistent across countries, denoting workers with a bachelors degree. Definitions of medium- and low-skilled employment might differ across countries but are consistent over time within countries. We capture systematic cross-country differences by including country fixed effects.
5. Our data include manufacturing and services sectors, but we exclude financial services, because we want to analyze the impact of financial openness. Including the financial sector yields similar results, which are available upon request.
6. Work by Campbell and Hercovitz (2005) is complementary to ours. They present empirical evidence showing a decline in the volatility of hours worked by U.S. households, which mirrors the Great Moderation in output volatility. However, their volatility measure differs from ours because they do not distinguish conditional and unconditional volatility and because they use aggregate data rather than data disaggregated at the industry level.
7. Details on the data sources and definitions are given at the end of the paper (Appendix A).
8. Schmitt-Grohé and Uribe (2003) discuss various modeling approaches that can be used to ensure stationarity of the non-stochastic steady state. See also Kim and Kose (2003) and Atolia and Buffie (2011).

9. Empirical evidence from France supports our assumption that adjustment costs differ across workers with different skills. Abowd and Kramarz (2003) find that adjustment costs are highest in absolute terms for managers, engineers, professionals, and middle-level managers, but lowest relative to total compensation of these workers.

10. We coded the model and all simulations using the free software R Release 2.15.0 [R Development Core Team (2012)]. Some of the matrix operations required to solve the model were carried out using the R package "Matrix." See Bates and Maechler (2009). The computation of volatilities (Section 2) and the formal regression analysis (Section 3) were coded in Stata Release 9.1.

11. Broersma (2008) estimates the elasticity of substitution between workers of different skill levels using the EUKLEMS data. However, the focus of his study differs from that of ours, because he is interested in the complementarity between labor and capital and because he assumes a Cobb–Douglas production function.

12. Although financial integration affects the volatility of hours worked by low-skilled workers relative to that of high-skilled workers in our model, this shift in volatilities does not automatically imply welfare losses due to less smooth consumption. Although the volatility of consumption may be considered a more direct measure of volatility facing private households, we did not use consumption data in our empirical analysis, because reliable time series information on consumption by workers across different industries and countries is, to the best of our knowledge, not available.

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A: DATA APPENDIX

The main data source is EUKLEMS. All data are freely available on the Internet and can be downloaded from www.euklems.net. See Timmer et al. (2007) for details on the data definitions and original sources.

Wages: Average wages per employee are obtained by dividing total labor compensation by the number of employees in a specific category (LAB/H_EMP). Labor compensation by skill group is obtained by LAB $\times$ (LAB/100) for high-skilled workers and corresponding measures for medium- and low-skilled workers. Nominal values are converted into constant U.S. dollars by (i) converting values in national currency into U.S. dollars using the Summers–Heston exchange rate series, adjusting for euro conversion rates, and (ii) deflating by the U.S. output price index in each sector. In the EUKLEMS database, definitions of high-skilled, medium-skilled, and low-skilled are consistent over time for each country but might differ across countries. See Timmer et al. (2007, pp. 28–29) for details. Systematic differences across countries that do not vary over time are picked up by country fixed effects. Moreover, data definitions should be most consistent for high-skilled workers (bachelor's degree level).

Hours worked (H_EMP): Hours worked by skill group are given by H_EMP $\times$ (H_HS/100) for high-skilled workers and corresponding measures for medium- and low-skilled workers. According to Timmer et al. (2007), information on the skill levels of workers included in EUKLEMS is usually obtained from national labor force surveys, sometimes together with a earnings survey. Hence, data may not be fully comparable across countries but they should be comparable over time as well as between industries for a given country.

Total factor productivity (TFPva_I): TFP growth, value-added-based.

International financial integration: (i) Cross-border debt assets plus liabilities/GDP, (ii) Total cross border assets plus liabilities/GDP. Source: Lane/Milesi-Ferretti.

Domestic financial development: Deposit money bank assets/GDP. Source: World Bank, Financial Structures Database, November 2008 update.

Trade: (i) OECD Stan: Data on import–export ratios, the export share of production, and the import penetration ratio by industry, 1980–2004, for the following manufacturing sectors: Food, Textiles, Wood, Pulp & Paper, Chemicals, Nonmetallic mineral products, Basic metals, Machinery, Transport equipment. (ii) World Trade Flows: Data on bilateral import volumes obtained from Feenstra et al. (2005). SITC4 industry classification codes were converted into ISIC codes (Version 3) using industry concordances kindly provided by Julian di Giovanni and used in di Giovanni and Levchenko (2008). For the years before 1990, we use West German data to match the data to EUKLEMS.

List of countries: The EUKLEMS database contains information on 27 European countries, plus Japan and the United States. However, due to incomplete time series and missing observations, in particular concerning a breakdown of employment by skill, we use only the following 11 countries: AUT = Austria, DNK = Denmark, ESP = Spain, FIN = Finland, FRA = France, GER = Germany, ITA = Italy, JPN = Japan, NLD = Netherlands, UK = United Kingdom, USA = United States—SIC based.

List of industries: The EUKLEMS database contains industry-level data at different levels of aggregation. We use data at the 2-digit level, and we drop the sectors agriculture, fishing, and extraterritorial organizations due to missing and incomplete observations. Hence, we use data for the following sectors (sector codes based on NACE): 15t16 = Food, Beverages, and Tobacco; 17t19 = Textiles, Leather, and Footwear; 20 = Wood, Products of Wood, and Cork; 21t22 = Pulp, Paper, Printing, and Publishing; 23t25 = Chemicals, Rubber, Plastic, and Fuels; 26 = Other Nonmetallic Mineral Products; 27t28 = Basic Metals and Fabricated Metals; 29 = Machinery N.E.C.; 30t33 = Electrical and Optical Equipment; 34t35 = Transport Equipment; C = Mining and Quarrying; E = Electricity, Gas, and Water Supply; F = Construction; G = Wholesale and Retail Trade; H = Hotels and Restaurants;

I = Transport, Storage, and Communications; K = Real Estate, Renting, and Business Activities; L = Public Administration and Defense, Social Security; N = Health and Social Work; O = Other Services.

In some countries, industry classifications changed in the mid-1990s. Where available, the EUKLEMS database uses conversion tables provided by the national statistical offices. The change in the American classification system (from SIC87 to NAICS97) was more far-reaching than the most recent change in the European system.

Inflation: Change in the price level of consumption (CP) is the PPP over GDP divided by the exchange rate times 100. The PPP of GDP or any component is the national currency value divided by the real value in international dollars. The PPP and the exchange rate are both expressed as national currency units per U.S. dollar. From Penn World Table 6.1 (PWT 6.1).

Energy price index: Growth in HWWI World energy price index, U.S. dollar-based, 2000 = 100.

B: STEADY STATE

In the steady state of the model outlined in Section 4, equations (12) and (13) give the result $\frac{\bar{h}^s}{\bar{h}^l} = (\frac{\bar{w}^s}{\bar{w}^l})^{\frac{1}{\psi}} (\frac{1-\phi}{\phi})^{\frac{1}{\psi}} \equiv B^{\frac{1}{\psi}}$, where a bar denotes a variable in the nonstochastic steady state. This result, together with the steady-state versions of equations (15) and (16), yields

$$\frac{\bar{w}^s}{\bar{w}^l} = \left(\frac{\gamma}{1-\gamma}\right)^{\frac{\psi}{\psi\theta+1}} \left(\frac{1}{\zeta^{\frac{\theta-1}{\theta}}}\right)^{\frac{\psi\theta}{\psi\theta+1}} \left(\frac{1-\phi}{\phi}\right)^{-\frac{1}{\psi\theta+1}} \left(\frac{v}{1-v}\right)^{-\frac{\psi}{\psi\theta+1}}. \quad \textbf{(B.1)}$$

Equation (B.1) determines the skill premium in a nonstochastic steady state. The skill premium is determined by the parameters of the CES production function (γ, θ), the elasticity of labor supply with respect to wages (ψ), the weight of high- and low-skilled labor in households' utility function (ϕ), and the relative supply of high- and low-skilled labor (v). Using the skill premium and equations (10) and (11), which imply $\frac{\bar{c}^s}{\bar{c}^l} = \frac{\phi}{1-\phi}$, in the steady-state version of equation (7) gives

$$\bar{h}^l = \left[\frac{v + (1-v)\frac{1-\phi}{\phi}}{vB^{\frac{\psi+1}{\psi}} + (1-v)\frac{1-\phi}{\phi}}\right]^{\frac{1}{\psi+1}}. \quad \textbf{(B.2)}$$

The ratio of the steady-state versions of equations (12) and (13) then determines $\bar{h}^s$, the production function determines $\bar{y}$, equations (15) and (16) determine $\bar{w}^s$ and $\bar{w}^l$, and equations (12) and (13) determine $\bar{c}^s$ and $\bar{c}^l$. Finally, the steady-state version of equation (14) gives $\beta(1+\bar{r}) = 1$.

C: LOG-LINEARIZED EQUATIONS AND EQUILIBRIUM

The log-linear approximations (around the nonstochastic steady state) of the first-order conditions, the budget constraint, and the production function are given by

$$\hat{c}^s = \hat{c}^l, \tag{C.1}$$

$$[-\psi \bar{w}^s - \alpha^s(1+\beta)]\hat{h}^s - \bar{w}^s(\hat{c}^s - \hat{w}^s) + \alpha^s \hat{h}^s_{t-1} + \alpha^s \beta \mathbf{E}_t \hat{h}^s_{t+1} = 0, \tag{C.2}$$

$$[-\psi \bar{w}^l - \alpha^l(1+\beta)]\hat{h}^l - \bar{w}^l(\hat{c}^l - \hat{w}^l) + \alpha^l \hat{h}^l_{t-1} + \alpha^l \beta \mathbf{E}_t \hat{h}^l_{t+1} = 0, \tag{C.3}$$

$$\mathbf{E}_t \hat{c}^s_{t+1} - \hat{c}^s_t = \alpha^d \bar{c}^s \hat{d}_{t+1}, \quad \hat{d}_t \equiv \frac{d_t}{\bar{c}^s}, \tag{C.4}$$

$$\hat{d}_{t+1} = (1+\bar{r})\hat{d}_t - v(\bar{h}^s)^{\psi+1}(\hat{w}^s_t + \hat{h}^s_t) - (1-v)\frac{1-\phi}{\phi}\bar{h}^{l\,\psi+1}(\hat{w}^l_t + \hat{h}^l_t)$$
$$+ v\hat{c}^s_t + (1-v)\frac{1-\phi}{\phi}\hat{c}^l_t, \tag{C.5}$$

$$\hat{y}_t = \hat{A}_t + \alpha_1 \hat{h}^s_t + \alpha_2 \hat{h}^l_t, \quad \alpha_1 = \frac{\bar{w}^s \bar{H}^s}{\bar{y}}, \alpha_2 = \frac{\bar{w}^l \bar{H}^l}{\bar{y}}, \tag{C.6}$$

$$\frac{\theta-1}{\theta}\hat{A}_t + \frac{1}{\theta}\hat{y}_t - \frac{1}{\theta}\hat{h}^s_t = \hat{w}^s_t, \tag{C.7}$$

$$\frac{\theta-1}{\theta}\hat{A}_t + \frac{1}{\theta}\hat{y}_t - \frac{1}{\theta}\hat{h}^l_t = \hat{w}^l_t, \tag{C.8}$$

where a circumflex denotes percentage deviations from the nonstochastic steady state.

Equations (C.1)–(C.8) together with equation (9) constitute a set of nine linear equations that can be solved for the rational-expectations equilibrium paths of the nine unknowns $\{\hat{c}^s_t, \hat{c}^l_t, \hat{w}^s_t, \hat{w}^l_t, \hat{d}_t, \hat{h}^s_t, \hat{h}^l_t, \hat{y}_t, \hat{A}_t\}$ that are consistent with households' utility maximization, firms' profit maximization, and a competitive equilibrium in goods and labor markets. We use the method developed by King and Watson (2002) to compute the rational-expectations solution of the model.