Liquidity and Growth: the Role of Counter-cyclical Interest Rates*

Philippe Aghion[†], Emmanuel Farhi[‡], Enisse Kharroubi[§]

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Abstract

In this paper, we use cross-industry, cross-country panel data to test whether industry growth is positively affected by the interaction between the reactivity of real short term interest rates to the business cycle and industry-level measures of financial constraints. Financial constraints are measured, either by the extent to which an industry is prone to being "credit-constrained", or by the extent to which it is prone to being "liquidity-constrained". Our main findings are that: (i) the interaction between credit or liquidity constraints and counter-cyclical real short-term interest rate, has a positive, significant, and robust impact on the average annual growth rate of industry labor productivity; (ii) these interaction effects tend to be more significant in recessions than in expansions.

Keywords: growth, tangibility, liquidity dependence, short term interest rate, counter-cyclicality

JEL codes: E32, E43, E52.

1 Introduction

Macroeconomic textbooks usually draw a clear distinction between long run growth and its structural determinants on the one hand, and macroeconomic policies (fiscal and monetary) aimed at achieving short run stabilization on the other. In this paper we argue instead that stabilization can affect growth in the long

*The views expressed here are those of the authors and do not necessarily represent the views of the BIS.

[†]Harvard University and NBER

[‡]Harvard University and NBER

[§]Bank of International Settlements

run. Specifically, we provide evidence that a counter-cyclical real short-term interest rate, whereby the real short-term interest rate is lower in recessions and higher in booms, has a disproportionately more positive impact on long-run growth in industries that are more prone to being credit-constrained or in industries that are more prone to being liquidity-constrained.

In the first part of the paper, we present a simple model where entrepreneurs borrow from outside investors to finance their investments. The credit market is however imperfect due to the limited pledgeability of the returns from the project to outside investors (as in Holmström and Tirole, 1997). Then once they are initiated, projects may either turn be "fast" and yield full returns within one period after the initial investment has been sunk, or they may turn out to be "slow" and require some reinvestment in order to yield full returns within two periods. The probability of a project being slow, and therefore requiring fresh funds for reinvestment, measures the degree of potential liquidity dependence in the model. However, the actual degree of liquidity dependence will also depend upon the aggregate state of the economy. More precisely, when the economy as a whole is in a boom, then short-run profits are sufficient for entrepreneurs to finance the required reinvestment whenever they need to do so (i.e. whenever their project turns out to slow). In contrast, if the economy is in a slump, then short-run profits are not sufficient anymore to finance reinvestment and the entrepreneur is compelled to downsize and delever her project (and therefore reduce her expected end-of-project returns) in order to generate cash to pay for the reinvestment. Yet, the entrepreneur can avoid downsizing after the project reveals to be slow, if she decides ex ante to invest part of her initial funds in liquid assets. Hoarding liquidity hence reduces the need for ex post downsizing but comes at the expense of reducing the initial size of the project.

A counter-cyclical interest rate then enhances ex ante investment by reducing the amount of liquidity entrepreneurs need to hoard to weather liquidity shocks when the economy is in a slump. The intuition is that hoarding liquidity is costly because of a positive liquidity premium. As a result, the benefit of a lower interest rate in a slump is always larger than the cost of a higher interest rate in a boom. The model then generates two main predictions. First, the lower the fraction of returns that can be pledged to outside investors, the more growth enhancing it is to implement counter-cyclical interest rates. Entrepreneurs with lower pledgeability need to hoard more liquidity ex ante. The benefit of lower interest rates in slumps is therefore larger. Second, the higher the liquidity risk measured by the probability that a project requires refinancing, the more investment enhancing it is to conduct a more counter-cyclical interest rate policy. Entrepreneurs who more likely need to reinvest naturally derive a larger benefit from counter-cyclical interest rates.

In the second part of the paper, we take these predictions to the data. Specifically, we build on the methodology developed in the seminal paper by Rajan and Zingales (1998) and use cross-industry, cross-country panel data to test whether industry growth is positively affected by the interaction between real short-term interest rate cyclicality (i.e. the sensitivity of the real short-term interest rates to the business cycle, computed at the country level) and industry-level measures of financial constraints computed for each corresponding industry using U.S. data. This approach provides a clear and net way to address causality issues. Indeed, any positive correlation one might observe between the counter-cyclicality of interest rates and average long run growth at the aggregate level, might equally reflect the effect of counter-cyclical interest rates on growth or the effect of growth on a country's ability to run counter-cyclical interest rates. However, what makes us reasonably confident that our regression results capture a causal link from counter-cyclical interest rates to industry growth, is the fact that: (i) we look at the effect of a macroeconomic development on industry-level growth; (ii) individual industries are small compared to the overall economy so that we can confidently rule out the possibility that growth at the industry level would affect the cyclical pattern of macroeconomic policy at country level; (iii) our financial constraint variables are computed for US industries and therefore are unlikely to be affected by policies and outcomes in other countries. Financial constraints at the industry level are measured, either by the extent to which the corresponding industry in the US displays low levels of asset tangibility (this measure captures the extent to which the industry is prone to being credit constrained), or by the extent to which the corresponding industry in the US features high labor costs to sales (i.e. the extent to which the industry is prone to being liquidity constrained).

Our main empirical finding is that the interaction between credit or liquidity constraints in an industry and real short-term interest rate counter-cyclicality in the country, has a positive, significant, and robust impact on the average annual growth rate of productivity of such an industry. More specifically, the lower the asset tangibility of the corresponding sector in the United States, the more growth-enhancing it is for an industry, when the real short-term interest rate is more counter-cyclical. Likewise, the more liquidity dependent the corresponding US industry is, the more growth-enhancing it is for an industry, when the real short-term interest rate is more counter-cyclical. These effects are robust to controlling for the interaction between these measures of financial constraints and country-level economic variables such as inflation, financial development, and the size of government which are likely to affect the cyclical pattern of the real short-term interest rate. Moreover, the interaction effects between real short-term interest rate counter-cyclicality and each of these various measures of credit and liquidity constraints, tend to be more significant in recessions than in expansions.

The paper relates to several strands of literature. First, to the literature on macroeconomic volatility and growth. A benchmark paper in this literature is Ramey and Ramey (1995) who find a negative correlation in cross-country regressions between volatility and long-run growth. A first model to generate the prediction that the correlation between long-run growth and volatility should be negative, is Acemoglu and Zilibotti (1997) who point to low financial development as a factor that could both, reduce long-run growth and increase the volatility of the economy. Acemoglu et al (2003) and Easterly (2005) hold that both, high volatility and low long-run growth do not directly arise from policy decisions but rather from bad institutions. Our paper contributes to this debate by showing a significant growth effect of more counter-cyclical monetary policies on industries which are all located in OECD countries with similar property rights and political institutions.[1]

Second, we contribute to the literature on monetary policy design. In our model, the real short-term interest rate operates through a version of the credit channel (see Bernanke and Gertler 1995 for a review of the credit channel literature).[2] But more specifically, our model builds on the macroeconomic literature on liquidity (e.g Woodford 1990 and Holmström and Tirole 1998). This literature has emphasized the role of governments in providing possibly contingent stores of value that cannot be created by the private sector.

[1] See also Aghion et al (2009) who analyze the relationship between long-run growth and the choice of exchange-rate regime; and Aghion, Hemous and Kharroubi (2012) who show that more countercyclical fiscal policies affect growth more significantly in sectors whose US counterparts are more credit constrained.

[2] There are two versions of the credit channel : the "balance sheet channel" and the "bank lending channel". Our model features the balance sheet channel, focusing more on the effect of interest rates on firms' borrowing capacity.

Like in Holmström and Tirole (1998), liquidity provision in our paper is modeled as a redistribution from consumers to firms in the bad state of nature; however, here redistribution happens ex post rather than ex ante. Farhi and Tirole (2012) do the same, however their focus is on time inconsistency and ex ante regulation.

The paper is organized as follows. Section 2 outlays the model. Section 3 develops the empirical analysis. It first details the methodology and the data. Then it presents the main empirical results. Section 4 concludes. Finally, proofs, sample description and estimation details are contained in the Appendix.

2 Model

2.1 Model setup

We consider an economy populated by non-overlapping generations of entrepreneurs living two periods. Entrepreneurs born at time t have utility function $U = \mathbb{E}[c_{t+2}]$, where c_{t+2} is their date-$t+2$ -end-of-life-consumption. They are protected by limited liability and A_t is their endowment at birth at date t. Their technology set exhibits constant returns to scale. At date t, entrepreneurs just born, choose their investment scale $I_t > 0$.

One period after entrepreneurs have invested I_t -at date $t+1$- uncertainty is realized: the aggregate state is either good (G) or bad (B), and the firm is either intact or experiences a liquidity shock. The probability of the good state is μ, and the probability of a firm experiencing a liquidity shock is α. Both events are independent.

At date $t+1$, a cash flow πI_t accrues to the entrepreneur where, depending on the aggregate state, $\pi \in \{\pi_G, \pi_B\}$. This cash flow is not pledgeable to outside investors. If the project is intact, the investment delivers one period after investment -at date $t+1$-; it then yields, besides the cash flow πI_t, a payoff $\rho_1 I_t$, of which ρI_t is pledgeable to investors.[3] If the project is distressed, besides the cash flow πI_t, it yields a payoff two periods after investment -at date $t+2$- if fresh resources $J_{t+1} \leq I_t$ are reinvested. It then delivers at

[3] As usual, the "agency wedge" $\rho_1 - \rho$ can be motivated in multiple ways, including limited commitment, private benefits or incentives to counter moral hazard (see for example Holmström and Tirole 2011).

date $t+2$ a payoff $\rho_1 J_{t+1}$, of which ρJ_{t+1} is pledgeable to investors.

Entrepreneurs differ in the pledgeable return ρ and in the probability α to face a liquidity shock. The pledgeable return is either $\overline{\rho}$ or $\underline{\rho}$ with $\overline{\rho} > \underline{\rho}$. Similarly, the probability of a liquidity shock is either high $\overline{\alpha}$ or $\underline{\alpha}$ with $\overline{\alpha} > \underline{\alpha}$. We take the variable ρ as an inverse measure of credit-constraint and the probability α as a measure of liquidity-constraint. In particular entrepreneurs with a pledgeable return $\underline{\rho}$ feature lower asset tangibility while entrepreneurs with a probability of the liquidity shock $\overline{\alpha}$ face reinvestment needs and hence liquidity needs more frequently (see below).

The interest rate is a key determinant of the collateral value of a project. It plays an important role in determining the initial investment scale I_t as well as the reinvestment scale J_{t+1}. The one period gross rate of interest at the investment date -at date t- is denote R, while R_s is the one period gross rate of interest at the reinvestment date -at date $t+1$- when the aggregate state is s, $s \in \{G; B\}$. Let us now make two assumptions:

- **Assumption 1:** $\overline{\rho} < \min\{R, R_G, R_B\}$

Assumption 1 ensures that entrepreneurs are constrained and must invest at a finite scale. The next assumption determines how easy/difficult reinvestment is, for entrepreneurs facing a liquidity shock.

- **Assumption 2:** $\pi_G > 1$ and $\pi_B + \overline{\rho}/R_B > 1 > \pi_B + \underline{\rho}/R_B$.

Assumption 2 guarantees that cash flows in the good state are enough to cover liquidity needs and reinvest at full scale if a liquidity shock hits ($\pi_G > 1$). However things are different in the bad state. In this case, cash flows alone are not enough to cover liquidity needs ($\pi_B < 1$). Yet, entrepreneurs can issue new securities. We assume that date-$t+1$ cash flows and proceeds from newly issued securities at date $t+1$ are sufficient to cover liquidity needs, but only for an entrepreneurs whose pledgeable return is large equal to $\overline{\rho}$). This is the assumption $\pi_B + \overline{\rho}/R_B > 1$. For entrepreneurs whose pledgeable return is low (equal to $\underline{\rho}$), relying only on current cash flow and proceeds from newly issued securities is not enough to cover liquidity needs ($\pi_B + \underline{\rho}/R_B < 1$). Reinvesting at full scale following a liquidity shock then requires hoarding liquidity, at the investment date.

More specifically, at the investment stage, entrepreneurs can purchase an asset that pays-off $x_0 I_t$ one period later if a liquidity shock happens and the aggregate state is bad. Yet, hoarding liquidity is costly: namely, purchasing such an asset involves setting aside the amount $q(1-\mu)\alpha x_0 I_t/R$ at the investment stage, where $q > 1$. The presence of a positive liquidity premium ($q > 1$) corresponds for example to situations where consumers cannot commit to pay back one period later a firm that would lend them resources. As a result, firms which desire to save have to use a costly storage technology (see Holmström and Tirole 1997).

At the core of the model is a maturity mismatch issue, whereby a long-term project requires occasional reinvestments. Entrepreneurs -in particular those with pledgeable return $\underline{\rho}$- have to compromise between initial investment scale I_t and reinvestment scale J_{t+1} in the event of a liquidity shock. Maximizing the initial investment scale I_t requires minimizing the amount of liquidity hoarded and therefore exhausting reserves of pledgeable income. This in turn forces the entrepreneur to downsize and delever in the event of a liquidity shock. Conversely, maximizing liquidity to mitigate maturity mismatch requires sacrificing initial scale I_t.

2.2 Entrepreneurs' investment

The total cash available to an entrepreneur for reinvestment in the event of a liquidity shock is equal to short-term profits πI_t, plus the amount of liquidity $x_0 I_t$ purchased one period before, plus the proceeds from newly issued securities at the reinvestment stage.[4] More formally, if $J_{t+1} \in [0, I_t]$ denotes the firm's reinvestment at date $t+1$, when a liquidity shock hits and the aggregate state is bad, the entrepreneur can dilute initial investors by issuing new securities against the pledgeable final income ρJ_{t+1}; therefore the reinvestment J_{t+1} must satisfy:

$$J_{t+1} \leq (x_0 + \pi_B) I_t + \frac{\rho}{R_B} J_{t+1} \tag{1}$$

[4] We assume that any potential surplus of cash over liquidity needs for reinvestment is consumed by entrepreneurs. The policy of pledging all cash that is unneeded for reinvestment is always weakly optimal. Pledging less is also optimal (and leads to the same allocation) if the entrepreneur has no alternative use of the unneeded cash to distributing to investors. However, if the entrepreneur can divert (even an arbitrarily small) fraction of the extra cash for her own benefit, then pledging the entire unneeded cash is *strictly* optimal.

This yields:

$$J_{t+1} \leq \min\left\{\frac{x_0+\pi_B}{1-\rho/R_B}, 1\right\} I_t \tag{2}$$

This formula captures two properties: First the larger the pledgeable return ρ the lower the liquidity x_0 needed to ensure full reinvestment, i.e. $J_{t+1} = I_t$. This is exemplified in the assumption $\pi_B + \underline{\rho}/R_B < 1 < \pi_B + \overline{\rho}/R_B$: Only entrepreneurs with a pledgeable return $\underline{\rho}$ need to hold some liquidity x_0. Those with a pledgeable return $\overline{\rho}$ do not need to hold any liquidity: their current profits π_B as well as the new securities they can issue against their (relatively large) final pledgeable output are actually enough to cover their reinvestment needs following a liquidity shock in the bad state. Second a lower interest rate in the bad state R_B facilitates refinancing because this increases the ability to issue claims at the reinvestment date and hence reduces the need to hoard liquidity at the investment date which in turn saves on the cost of liquidity given the positive liquidity premium ($q > 1$).

We are now equipped to determine the size I_t of the project run by an entrepreneur born at date t whose pledgeable return is ρ and whose probability of the liquidity shock is α. Starting with A_t, the entrepreneur needs to raise $I_t - A_t$ from outside investors at the investment date.[5] If no liquidity shock hits, the entrepreneur returns to investors ρI_t one period later. If a liquidity shock hits in the good state, the entrepreneur returns to investors ρI_t two periods later. Finally, if a liquidity shock hits in the bad state, then investors are committed to inject additional funds $x_0 I_t$. The entrepreneur then issues new claims $x_1 I_t$ to investors against the final pledgeable cash flow so that eventually the entrepreneur can return $\rho\left(\pi_B + x_0 + x_1\right) I_t$ to investors at date 2. The size I_t of the entrepreneur's project satisfies:

$$(I_t - A_t) + \alpha\left(1-\mu\right)\left[\frac{x_1 I_t}{R} + q\frac{x_0 I_t}{R}\right] = (1-\alpha)\frac{\rho}{R} I_t + \alpha\left[\mu\frac{\rho}{R R_G} I_t + (1-\mu)\frac{\left(\pi_B + x_0 + x_1\right)\rho}{R R_B} I_t\right] \tag{3}$$

Proposition 1 *If the return ρ_1 to long-term projects is sufficiently large, the equilibrium size I_t of a project run by an entrepreneur born at date t whose pledgeable return is ρ and whose probability of the liquidity shock*

[5] Proposition 4 in the Appendix guarantees that the projects are attractive enough that entrepreneurs will always invest all their net worth.

is α*, satisfies:*

$$\frac{I_t}{A_t} = \frac{R}{R - \left(1 - \alpha + \alpha \frac{\mu}{R_G}\right) + \alpha \left(1 - \mu\right) q\left(\rho\right) x} \tag{4}$$

with $q\left(\overline{\rho}\right) = 1$*,* $q\left(\underline{\rho}\right) = q$ *and* $x = 1 - \pi_B - \frac{\rho}{R_B}$.

Proof. Proposition 4 in the Appendix shows that when the return ρ_1 to long-term projects is sufficiently large, entrepreneurs' optimal liquidity policy satisfies $x_0 + x_1 = 1 - \pi_B$ and $x_0 = \max\{x; 0\}$. Then using this result and simplifying the no-arbitrage condition (3) yields the expression (4) for the size of entrepreneurs' projects. ■

When the return ρ_1 to long-term projects is sufficiently large, entrepreneurs optimally choose to withstand a liquidity shock in the bad state without downsizing. Given that liquidity hoarding is costly, entrepreneurs facing a liquidity shock issue as many claims as possible ex post to finance reinvestment. The maximum amount of claims than can be issued is $\rho I_t / R_B$. If this maximum amount is sufficient to achieve a full scale reinvestment, i.e. if $\pi_B + \rho/R_B > 1$, then entrepreneurs do not hoard any liquidity x_0 and they just issue the amount of claims needed, i.e. $(1 - \pi_B) I_t$. On the contrary, if the maximum amount $\rho I_t / R_B$ falls short of ensuring complete reinvestment, i.e. $\pi_B + \rho/R_B < 1$, then entrepreneurs choose to hoard some liquidity at date 0. How much liquidity is then hoarded? Given that purchasing liquidity is costly, entrepreneurs choose the minimal amount of liquidity that allows to withstand the liquidity shock in the bad state without downsizing, hence the result $x_0 = 1 - \pi_B - \rho/R_B$ when $\rho = \underline{\rho}$.

2.3 Growth and counter-cyclical interest rates.

Entrepreneur's long-term investment drives the dynamics of entrepreneurs wealth. Entrepreneurs' initial endowment A_{t+2} at date $t+2$ is a positive function of entrepreneurs' long-term investment I_t at date t:

$$A_{t+2} = g\left(I_t\right) \tag{5}$$

For simplicity and without any major loss of insight, we take g to be linear, $g\left(I_t\right) = g.I_t$ with $g > 0$. Then, using the expression (4) for entrepreneurs' long-term investment, the growth rate for entrepreneurs whose pledgeable return is ρ and whose probability of the liquidity shock is α, is equal to:

$$\ln A_{t+2} - \ln A_t = \ln g + \ln \frac{R}{R - \left(1 - \alpha + \alpha \frac{\mu}{R_G}\right)\rho + \alpha\left(1-\mu\right) q\left(\rho\right) x} \tag{6}$$

To derive the comparative static of growth with respect to the cyclicality of interest rates, we will consider the effect of changing the spread between the interest rates $\{R_B; R_G\}$ keeping the average interest rate $(1-\mu) R_B + \mu R_G$ constant. For this purpose, it will prove useful to denote R_m the average one period gross interest rate at the reinvestment date: $R_m = (1-\mu) R_B + \mu R_G$; R_G will then be the measure of interest rates cyclicality: a higher interest rate R_G indicates more counter-cyclical interest rates. The growth rate for entrepreneurs whose pledgeable return is ρ and whose probability of the liquidity shock is α, can then be reexpressed as:

$$\ln \frac{A_{t+2}}{A_t} = \ln g + \ln \frac{R}{R - \left(1 - \alpha + \alpha \frac{\mu}{R_G}\right)\rho + \alpha\left(1-\mu\right) q\left(\rho\right)\left[1 - \pi_B - \frac{(1-\mu)\rho}{R_m - \mu R_G}\right]} \tag{7}$$

We now have all the ingredients to derive our two main results. Below is the first one.

Proposition 2 *A counter-cyclical interest rate policy enhances output growth more, the higher the probability of the liquidity shock α.*

Proof. Using the expression (7) for the growth rate of entrepreneurs, we have

$$\frac{\partial \ln \frac{A_{t+2}}{A_t}}{\partial R_G} = \frac{\alpha\rho\mu\left[q\left(\rho\right)\left[\frac{1-\mu}{R_m - \mu R_G}\right]^2 - \left(\frac{1}{R_G}\right)^2\right]}{R - \left(1 - \alpha + \alpha \frac{\mu}{R_G}\right)\rho + \alpha\left(1-\mu\right) q\left(\rho\right)\left[1 - \pi_B - \frac{(1-\mu)\rho}{R_m - \mu R_G}\right]} \tag{8}$$

The right-hand side of this expression is increasing in α given that $R_G \geq R_m$ and $q(\rho) \geq 1$. The positive effect of counter-cyclical interest rate is therefore disproportionately larger for entrepreneurs whose probability of a liquidity shock α is larger. ■

Countercyclical interest rates raise expected growth because the growth benefit derived from a lower interest rate when the aggregate state is bad outweighs the growth loss from a higher interest rate when the aggregate state is good. When the aggregate state is bad, collateral is scarce and entrepreneurs need to issue new claims when hit by a liquidity shock. A lower interest rate then has two effects: it reduces collateral scarcity and it raises the present value of future cash flows, thereby relaxing the constraint limiting the size of entrepreneurs' projects. On the other hand, a higher interest rate when the aggregate state is good, reduces the present value of future cash flows. For given average interest rate, the corresponding growth benefits outweigh the costs and the more so, the more likely the liquidity shock. We now turn to our second result.

Proposition 3 *There exists a threshold q^* for the liquidity premium such that a counter-cyclical interest rate policy benefits disproportionately more to entrepreneurs whose pledgeable return is lower, if and only if the liquidity premium satisfies $q \geq q^*$.*

Proof. Recall that based on the expression (7) for the growth rate of entrepreneurs, we have

$$\frac{\partial \ln \frac{A_{t+2}}{A_t}}{\partial R_G} = \frac{\alpha \rho \mu \left[q\left(\rho\right) \left[\frac{1-\mu}{R_m - \mu R_G} \right]^2 - \left(\frac{1}{R_G} \right)^2 \right]}{R - \left(1 - \alpha + \alpha \frac{\mu}{R_G} \right) \rho + \alpha \left(1-\mu\right) q\left(\rho\right) \left[1 - \pi_B - \frac{(1-\mu)\rho}{R_m - \mu R_G} \right]} \tag{9}$$

As noted above, this expression is positive, i.e. entrepreneurs can manage larger long-term projects when interest rates are more counter-cyclical given that $R_G \geq R_m$, $q\left(\rho\right) \geq 1$. Moreover the benefit from counter-cyclical interest rates for entrepreneurs with pledgeable return $\underline{\rho}$ increases with the liquidity premium q while the benefit that accrues to entrepreneurs with pledgeable return $\overline{\rho}$ is independent of q. There exists hence a threshold q^* such that when the liquidity premium satisfies $q \geq q^*$, then the growth rate of entrepreneurs with a relatively low pledgeable return increases proportionally more than that of entrepreneurs with relatively large pledgeable return, when interest rates are more counter-cyclical. ■

Counter-cyclical interest rates favor larger investments and therefore growth for the reasons highlighted above: when the aggregate state is bad, entrepreneurs need to issue new claims to finance reinvestment. A lower interest rate R_B then raises the value of pledgeable output and as a result, the overall constraint on the size of entrepreneurs' project is relaxed. Moreover this effect is larger for entrepreneurs whose pledgeable return is relatively low, the reason being that a lower interest rate when the aggregate state is bad allows entrepreneurs to reduce the amount of liquidity purchased at the investment stage and therefore to suffer less from the liquidity premium q. The higher the liquidity premium q, the more counter-cyclical interest rates will enhance growth for entrepreneurs with a lower pledgeable return.

Propositions 2 and 3 summarize the key comparative statics of the model, which we now confront to the data.

3 Empirical analysis

3.1 Data and methodology

The analytical framework developed in Section 2 predicts that a counter-cyclical real short-term interest rate should foster growth disproportionately more for entrepreneurs who face either a tighter credit constraint or a tighter liquidity constraint. To test these predictions, we consider a panel of industries observed across different countries. Our goal is to test whether cross country differences in the cyclical pattern of the real short-term interest rate have differential growth effects across industries featuring different degrees of credit or liquidity constraint. In this section, we set the empirical framework we will be working with throughout the empirical part of the paper. We start laying down the baseline regression. We then move on to describing the explanatory variables of the baseline regression. We finally conclude this section detailing the data sources, the econometric methodology and the choice for the estimation period.

3.1.1 The baseline regression

Our empirical framework is as follows. We take as a dependent variable the growth rate of each industry in each country of our sample and use it as our left hand side variable. On the right hand side, we introduce industry and country fixed effects. Industry fixed effects are dummy variables which control for any cross-industry difference in growth that is constant across countries. Similarly country fixed effects are dummy variables which control for any cross-country difference in growth that is constant across industries. Our variable of interest is the interaction between an industry's level of financial constraint -denoted (fc)- and a country real short-term interest rate (counter-) cyclicality -denoted (ccy). Finally, we introduce a control for initial conditions which accounts for standard catch-up effects. Denoting g_{jk} the growth rate of industry j in country k, α_j and α_k, industry and country fixed effects, y_{jk} the initial condition of industry j in country k, and letting ε_{jk} denote an error term, our baseline regression is expressed as follows:

$$g_{jk} = \alpha_j + \alpha_k + \beta.(\text{fc})_j \times (\text{ccy})_k - \delta.y_{jk} + \varepsilon_{jk}. \tag{10}$$

The coefficient of interest is β. A positive and significant estimated coefficient β implies that the more counter-cyclical the real short-term interest rate, the faster industries facing tight financial constraints grow, every thing else equal, compared to industries facing lax financial constraints.

3.1.2 The explanatory variables

Industry financial constraints We consider two different variables for industry financial constraints $(\text{fc})_j$, namely credit constraints and liquidity constraints. Following Rajan and Zingales (1998), we use US firm-level data to measure credit and liquidity constraints in sectors outside the United States. Specifically, we proxy industry credit constraint with asset tangibility for firms in the corresponding sector in the US. Asset tangibility is measured at the firm level as the ratio of the value of net property, plant, and equipment to total assets. We then consider the median ratio across firms in the corresponding industry in the US as the measure of industry-level credit constraint. This indicator measures the share of tangible capital in a firm's total assets and hence the fraction of a firm's assets that can be pledged as collateral to obtain funding. Asset tangiblity is therefore an inverse measure of an industry's credit constraint. Now to proxy for industry liquidity constraints, we use the labor cost to sales ratio for firms in the corresponding sector in the US. An industry's liquidity constraint is therefore measured as the median ratio of labor costs to total sales across firms in the corresponding industry in the US**.** This captures the extent to which an industry needs short-term liquidity to meet its regular payments vis-a-vis its employees. It is a positive measure of industry liquidity constraint.[6]

[6] Liquidity constraints can also be proxied using a cash conversion cycle variable which measures the time elapsed between the moment a firm pays for its inputs and the moment it is paid for its output. Results available upon request are very similar to those obtained using the labor cost to sales ratio as a proxy for liquidity constraint.

Using US industry-level data to compute industry financial constraints, is valid as long as: (a) differences across industries are driven largely by differences in technology and therefore industries with higher levels of credit or liquidity constraints in one country are also industries with higher level levels of credit or liquidity constraints in another country in our country sample; (b) technological differences persist across countries; and (c) countries are relatively similar in terms of the overall institutional environment faced by firms. Under those three assumptions, US-based industry-specific measures are likely to be valid measures for the corresponding industries in countries other than the United States. While these assumptions are unlikely to simultaneously hold in a large cross-section of countries which would include both developed and less developed countries, they are more likely to be satisfied when the focus turns, as is the case in this study, to advanced economies.[7] For example, if pharmaceuticals hold fewer tangible assets or have a lower labor cost to sales than textiles in the United States, there are good reasons to believe it is likely to be the case in other advanced economies as well.[8] Yet, as a robustness check, we test whether the data supports this assumption that the ranking of industries according to a given industry characteristic (e.g. labour cost to sales) is indeed country invariant. As we shall see below, as far as data availability allows, this assumption has significant empirical support.

Country interest rate cyclicality Now, turning to the estimation of real short-term interest rate cyclicality, $(ccy)_k$, in country k, we measure it by the sensitivity of the real short-term interest rate to the domestic output gap, controlling for the one-quarter-lagged real short-term interest rate. We therefore use country-level data to estimate the following country-by-country "auxiliary" equation:

$$rsir_{kt} = \eta_k + \theta_k.rsir_{kt-1} + (\mathrm{ccy})_k.y\_gap_{kt} + u_{kt}, \tag{11}$$

where $rsir_{kt}$ is the real short-term interest rate in country k at time t –defined as the difference between the three months policy interest rate and the 3-months annualized inflation rate-; $rsir_{kt-1}$ is the one quarter

[7] See below for the list of countries in the estimation sample.

[8] Moreover, to the extent that the United States is more financially developed than other countries worldwide, US-based measures are likely to provide the least noisy measures of industry-level credit or liquidity constraints.

lagged real short-term interest rate in country k at time t; y_gap_{kt} measures the output gap in country k at time t -defined as the percentage difference between actual and trend GDP.[9] It therefore represents the country's current position in the cycle; η_k and θ_k are constants; and u_{kt} is an error term. The regression coefficient $(\text{ccy})_k$ is a positive measure of interest rate counter-cyclicality. A positive (negative) regression coefficient $(\text{ccy})_k$ reflects a counter-cyclical (pro-cyclical) real short-term interest rate as it tends to increase (decrease) when the economy improves.

To deepen our analysis of real short-term interest rate counter-cyclicality , and also for the sake of robustness, we shall consider variants of (11). In a first variant, we follow Neumeyer and Perri (2005) and estimate the interest rate cyclicality, as the sensitivity of the real short-term interest rate gap to the output gap:

$$rsir\_gap_{kt} = \eta_k + (\text{ccy})_k.y\_gap_{kt} + u_{kt}, \tag{12}$$

where $rsir\_gap_{kt}$ is the real short-term interest rate gap in country k at time t –defined as the difference between actual and trend real short-term interest-.[10] This alternative has an upside and a downside. On the upside, it allows to get rid of low frequency changes in the real short-term interest rate and focus on the cyclicality pattern at higher frequencies, which is the focus of this study. Moreover, this approach eliminates changes in the real short-term interest rate coming from breaks in the real short-term interest rate trend. This is especially important when countries experience institutional changes like the introduction of the Euro. The downside however is that using estimated variables both on the left and the right hand side does not help in getting precise estimates for interest rate cyclicality.

In a second variant, we estimate interest rate cyclicality using, for each country, four different specifications so as to minimize the estimation root-mean-square error (rmse). These four different specifications are as follows: Specification (13.1) states that the real short-term interest rate reacts exclusively to the contemporaneous output gap; Specification (13.2) states that the real short-term interest rate reacts to the

[9] Trend GDP is estimated applying an HP filter to the log of real GDP. Estimations, available upon request, show that results do not depend on the use of a specific filtering technique.

[10] The trend real short term interest rate gap is estimated applying an HP filter to the real short term interest rate. Using alternative filtering methods (e.g. Baxter-King) does not yield significant differences.

contemporaneous output gap, with some persistence in the real short-term interest rate. In specification (13.3), the real short-term interest rate reacts to the contemporaneous output gap and to the one quarter lagged real effective exchange rate $reer_{kt-1}$. Finally specification (13.4) states that the real short-term interest rate reacts to the contemporaneous output gap and the one quarter lagged real effective exchange rate, with some persistence over time.

$$rsir_{kt} = \eta_k + (\text{ccy})_k.y\_gap_{kt} + u_{kt}, \tag{13.1}$$

$$rsir_{kt} = \eta_k + \theta_k.rsir_{kt-1} + (\text{ccy})_k.y\_gap_{kt} + u_{kt}, \tag{13.2}$$

$$rsir_{kt} = \eta_k + \lambda_k.\ln(reer_{kt-1}) + (\text{ccy})_k.y\_gap_{kt} + u_{kt}, \tag{13.3}$$

$$rsir_{kt} = \eta_k + \theta_k.rsir_{kt-1} + \lambda_k.\ln(reer_{kt-1}) + (\text{ccy})_k.y\_gap_{kt} + u_{kt}, \tag{13.4}$$

There are two additional aspects to take into account when using this approach to measure interest rate cyclicality. First, interest rate cyclicality is not directly observed but obtained as a result from a set of regressions. In other words, interest rate cyclicality is a generated regressor and each country's estimate for real short-term interest rate cyclicality displays some standard deviation. This needs to be taken properly into account in the second stage regression. Second, we face the more traditional issue of endogeneity. Namely, the estimated interest rate cyclicality may equally reflect the reaction of the real short-term interest rate to cyclical fluctuations as it may reflect the reaction of the economy to changes in the real short-term interest rate. Each of these two issues will be dealt with separately in the empirical analysis below. Yet, before we get into the results, let us have some final words about the estimation period, the econometric methodology and the data sources.

3.1.3 Estimation period, econometric methodology and data sources

The dependent variable, the industry growth rate, is computed as the average annual growth rate of the industry over the period 1995-2005. Our dataset providing industry level data stops in 2005. We thus work backwards and choose how long the time span should be, knowing that it needs to end in 2005.[11] In doing so, we face the following trade-off. On the one hand, the time span should allow for meaningful estimates of interest rate counter-cyclicality. This in turn would speak in favor of going back relatively far in the past so as to get a sufficiently long time span. On the other hand, we need to focus on a time period where changes in the real short-term interest rate really affect the economy and agents' choices, in particular their borrowing decisions. This instead would speak in favor of focusing on a relatively recent period to avoid episodes where directed lending was pretty widespread or where market mechanisms were not fundamental drivers in the extension and allocation of credit. Financial crises are an example of such episodes with significant government and central bank intervention in the financial intermediation process. Yet, such interventions are likely to affect the growth performance of industries to an extent which precisely depends on their financial constraints.

Choosing the period 1995-2005 however raises two kind of issues. A first issue is that it lies within the "Great Moderation" period. This means that aggregate fluctuations were relatively modest during that period -both in terms of the overall number of expansion/recession episodes and in their amplitude-. This in turn might raise concerns on the validity of our empirical strategy, given that counter-cyclical interest rates affect the economy essentially by dampening aggregate fluctuations. However, we believe that these concerns are unwarranted. First, our data sample consists of a panel of industries observed over many countries. Hence observing such a panel even for one single recession or expansion episode is enough to test whether a countercylical real short-term interest rate has a larger effect on industries feature tighter financial constraints. Second, the fact that aggregate fluctuations were relatively mild during the period would rather play against finding strong effects of interest rate cyclicality. Following our model, a counter-cyclical interest rate provides a growth impetus to more financially constrained industries because it helps dampening the effects of negative aggregate shocks. Consequently, when the volatility of aggregate shocks is low, the effect of counter-cyclical interest rates on growth in industries facing tighter financial constraints, tends to disappear as financial constraints are less likely to be binding. In other words, the estimations presented below are

[11] Given the significant noise and revisions that can affect industry data, it is wise to stick to relatively old data even when more recent data is available.

likely to underestimate the effect of counter-cyclical interest rates on industry growth.

Focusing on the period 1995-2005 raises a second issue, namely that many European countries have joined the EuroZone in 1999. This could give rise to econometric issues when estimating the cyclicality of the real short-term interest rate as the estimation sample would include an obvious break for these European countries. A couple of remarks can be made here. First, in 1995, it was already pretty clear which countries would join the European Monetary Union and which would not.[12] The convergence process -especially in terms of interest rates- had indeed already started long before 1999 when the EuroZone was formally established with a common central bank. Second, that the nominal short-term interest rate has been common to all EuroZone countries since 1999 has no systematic implication for real short-term interest rate cyclicality. This is because inflation remains country-specific and cycles are far from being perfectly correlated across countries, neither before the EuroZone was set up, nor after. This means that EuroZone countries are still likely to exhibit a significant degree of heterogeneity in the cyclical patterns of their real short-term interest rates, even if the nominal interest rate is unique. And indeed the first-stage results support this view (see section 3.2.1). Third, estimating the cyclicality of the real short-term interest rate by focusing on the difference between the current and the trend real short-term interest rate goes a long way in dealing with the issue of potential breaks in the underlying trend since all the low frequency changes in the real short-term interest rate, including those related to EuroZone membership, get wiped out. Finally, in the Appendix we carry a series of regressions focusing on the period 1999-2005, i.e. excluding the period before the formal establishment of the EuroZone.[13] The qualitative similarity of the results compared to those obtained in the baseline regressions confirms that the move towards a unique EuroArea wide nominal interest rate has not entailed significant differences in how real short-term interest rate cyclicality affect growth in industries that are diversely subject to financial constraints.

Now turning to the estimation methodology, we follow Rajan and Zingales (1998) in using a simple ordinary least squares (OLS) procedure to estimate our baseline equation (10) with a correction for heteroskedas-

[12] Greece for which there was probably the largest doubts on whether the country would ever join the EuroZone, does not belong to our sample.

[13] See table 13 in the appendix for the empirical results of estimating the baseline regression (10) for the period 1999-2005.

ticity bias. In particular, the interaction term between industry-specific characteristics and country-specific monetary counter-cyclicality is likely to be largely exogenous to the dependent variable for three reasons. First, industry specific characteristics are measured over a period -the eighties- prior to the period during which industry growth is computed -1995-2005-. Second, industry specific characteristics pertains to industries in the United States, while the dependent variable involves countries other than the United States. It is hence quite implausible that industry growth outside the United States could affect industry specific characteristics in the United States. Last, interest rate cyclicality is measured at the macroeconomic level, whereas the dependent variable is measured at the industry level, which again reduces the scope for reverse causality as long as each individual industry represents a small share of total output in the domestic economy.

Our data sample focuses on 15 industrial OECD countries, excluding the United States, as not doing so would raise reverse causality problems.[14] Industry-level value added and productivity data are drawn from the European Union (EU) KLEMS data set focusing on manufacturing industries and available on a yearly frequency.[15] The primary source of data for measuring industry-specific characteristics is Compustat, which gathers balance sheets and income statements for US. listed firms. We draw on Rajan and Zingales (1998), Braun (2003), Braun and Larrain (2005), and Raddatz (2006) to compute industry-level indicators for borrowing and liquidity constraints. Finally, macroeconomic variables -such as those used to compute interest rate cyclicality estimates- are drawn from the OECD Economic Outlook data set (2011). Note that interest rate cyclicality indicators are computed using quarterly data while the frequency for other macroeconomic data is annual.

3.2 Empirical results

We can now proceed and describe the empirical results. This section starts with a description of the country-by-country estimates for the cyclical pattern of the real short-term interest rate. Second we turn to the estimation results of the baseline regression and go through a series of robustness checks. Third, we carry

[14] The sample consists of the following countries: Australia, Austria, Belgium, Canada, Denmark, Spain, Finland, France, Germany, Italy, Luxembourg, Netherlands, Portugal, Sweden, and United Kingdom.

[15] See table 1 in the Appendix for the list of industries in the sample.

out an extensive horse race exercise, looking for potential omitted variables. Finally as a last step, we provide some evidence on the source of the growth effect of counter-cyclical real short-term interest rates, looking at expansions and recessions separately.

3.2.1 Country estimates of real short-term interest rate counter-cyclicality

The histograms depicted in Figure 1-3 show the results from the auxiliary regression (11), (12) and (13.1)-(13.4). A few regularities emerge from those histograms. First, Germany, the United Kingdom and Sweden are the countries where the real short-term interest rates is most counter-cyclical. A natural explanation for this, is that in those three countries, the nominal interest rate is either set by an independent national central bank or by a supranational central bank that behaves essentially like a national central bank vis-a-vis the corresponding country. The least counter-cyclical countries in our sample are Finland, Portugal and Spain.[16] Those three countries are all part of the Euro area; moreover, all three are "small economies" in GDP terms compared to the Euro area as a whole, therefore they are unlikely to have much influence on the policy conducted at the Euro Area level.[17]

FIGURE 1, *FIGURE* 2, *FIGURE* 3 *HERE*

Two more remarks on interest rate counter-cyclicality estimates are in order. First, the cross-country correlations between the estimates obtained through the various first-stage equations is very high, ranging between 0.75 and 0.9. Thus using one or another specification to estimate interest rate counter-cyclicality does not introduce large differences in the cross-country distribution of estimated coefficients. Second, the standard errors depicted in Figure 3 are much lower than those depicted in Figures 1 and 2. Allowing the first stage specification to differ across countries therefore significantly improves estimation precision: while half of the country-level estimates for real short-term interest rate counter-cyclicality (7-8 out of 15) are not statistically significant in Figures 1 and 2 at usual confidence levels, this number drops to 3 (out of 15) in

[16] More precisely, Finland, Portugal and Spain are among the five least countercyclical countries for each of the three histograms.

[17] These three countries accounted jointly for 11% of EuroZone GDP in 1995 and 15% in 2005 (source: OECD Economic Outlook).

Figure 3 which confirms that the real short-term interest rate follows different specifications and react to different information sets across countries.[18]

3.2.2 Estimation results of the baseline regressions

We now present the results from the baseline regressions. Table 2 shows the results of estimating the baseline equation (10) where the dependent variable is the average annual growth rate in industry real value added. On the right hand side, in addition to the standard country and industry fixed effects, we include the interaction between industry-level financial constraints and country-level real short-term interest rate counter-cyclicality. Industry-level financial constraints are measured either with asset tangibility (our inverse measure of industry-level credit constraint) or by the labor costs to sales ratio (our measure of industry-level liquidity constraints). The real short-term interest rate counter-cyclicality measure is derived first from (11), then from (12), and finally from (13.1)-(13.4). We expect the interaction between real short-term interest rate counter-cyclicality and asset tangibility to show a significant and negative coefficient: namely, industries with higher asset tangibility draw smaller growth benefits from a more counter-cyclical real short-term interest rate. Conversely, we expect the interaction between real short-term interest rate counter-cyclicality and the labor cost to sales ratio to show a significant and positive coefficient: industries with higher labor cost to sales ratios draw larger growth benefits from a more counter-cyclical real short-term interest rate. Finally, we include the log of industry value added relative to total manufacturing value added at the beginning of the estimation period, thereby controlling for the size of an industry relative to the overall size of the country's manufacturing sector. Here we expect a negative coefficient as relatively larger industries should every thing else equal grow slower.

The first three columns in Table 2 show that industry real value added growth is significantly and negatively correlated with the interaction between asset tangibility and real short-term interest rate counter-cyclicality, as predicted: thus a larger sensitivity of the real short-term interest rate to the output gap raises

[18] Two further remarks are in order. The estimates for real short term interest rate countercyclicality show significant cross-country heterogeneity. And in most countries, the real short term interest rate reacts significantly to the output gap -either positively or negatively- when allowing the first stage specification to differ across countries. These two features do not match with the view that cyclicality estimates can only capture noise given the estimation period.

real value added growth disproportionately more for industries with lower asset tangibility. The three last columns show that industry real value added growth is significantly and positively correlated with the interaction between the labor costs to sales ratio and real short-term interest rate counter-cyclicality: a larger sensitivity of the real short-term interest rate to the output gap tends to raise industry real value added growth disproportionately more in industries with a larger labor costs to sales ratio.

TABLE 2 HERE

It is worth noting, at this point that the correlation between the liquidity constraint measure and the credit constraint measure is around -0.6, which means that credit and liquidity constraints are two distinct channels whereby interest rate counter-cyclicality affects industry growth.

Table 3 below replicates the same regression exercises as in Table 2, but using the average annual growth in industry value added per hour worked as the left hand side variable. Indeed, one might wonder whether the positive effect of counter-cyclical real short-term interest rates on value added growth in more financially/liquidity constrained industries comes from higher growth in value added per hour worked or if it simply reflects higher growth in hours worked. If the latter were true, then the growth effects pointed out above would simply reflect factor accumulation. What Table 3 shows is that the interactions between industry credit or liquidity constraints and the counter-cyclicality of the real short-term interest rate have a positive and significant effect on the growth of industry value added per hour worked. Thus more counter-cyclical real short-term interest rate raises growth disproportionately more in financial constrained industries mainly by inducing a higher growth rate in hourly productivity.[19]

TABLE 3 HERE

[19] In Table 14, we check that none of the countries of the sample is driving on its own, this empirical results by running a series of estimations where each country is withdrawn from the estimation sample one at a time. Results actually show that the interaction between industry financial constraints and real short term interest rate counter-cyclicality does have a significant effect on industry growth, irrespective of which country is excluded from sample estimation. In other words, none of the countries of our sample is critical on its own for the empirical results presented in table 3.

3.2.3 Testing for the assumptions underlying the baseline specification

The previous regressions rely on three implicit assumptions. First we made an identification assumption according to which the US-based measure for industry-level financial constraints is a valid measure of industry-level financial constraints outside the US. Second, we assumed that OLS estimates of real short-term interest rate counter-cyclicality provide a fair assessment of which countries have a relatively more/less counter-cyclical real short-term interest rate? Last, we ruled out the uncertaintly around the estimates of real short-term interest rate counter-cyclicality. In this section we test for these assumptions, one by one.

How good is the US-based measure for industry financial constraints? The identification assumption -that the US-based measure for a given industry-level financial constraint is a valid measure of the same industry-level financial constraint outside the US- boils down to assuming that the ranking of industries according to this financial constraint does not vary across countries. Here, we provide a formal test for this assumption. More specifically, we let $(\text{fc})_{jk}$ denote the labor cost to sales ratio in industry j in country k. We then ask what share of the variance across industries and countries can be accounted for, under the assumption that differences in the labor cost to sales ratio across industries are country invariant. Letting ε_{jk} denote an error term, we estimate the following specification:

$$(\text{fc})_{jk} = \alpha_j + \alpha_k + \varepsilon_{jk}. \tag{14}$$

where $(\text{fc})_{jk}$ is the labor cost to sales ratio in industry j and country k, $\{\alpha_j\}$ is a set of industry dummies and $\{\alpha_k\}$ is a set of country dummies.[20] When the residual ε_{jk} is zero, then the labor cost to sales ratio writes exactly as the sum of a country-specific and an industry-specific component and as a result, differences in the labor cost to sales ratio across industries are country invariant.[21]

[20] Because of data limitations, we cannot run a similar exercise for industry asset tangibility.

[21] Note however that there are alternative specifications which would not fit this model while still implying a country invariant ranking of industries according to the labor cost to sales ratio. For example the specification $(\text{fc})_{jk} = \alpha_j \beta_k + \alpha_k$, where $\{\alpha_j\}$ is a set of industry dummies, $\{\alpha_k\}$ is a set of country dummies and $\{\beta_k\}$ is a set of *positive* or *negative* country dummies also fits the assumption of country invariant ranking of industries. Results presented here therefore provide an under-estimation of how good is the identification assumption given we test for a model that is more restrictive than the identification assumption would imply.

To compute the dependent variable, we take advantage of information on industry-level wage and total labor costs available in the EUKLEMS dataset. We use each of industry wage cost and industry total labor cost as a ratio of total industry sales and consider both the average or the median values over three alternative time periods: 1980-1989; 1990-1999 and 1995-2004 to run regression (14). Results are reported in Table 4 and Table 5. For example, the first column in Table 4 shows that the model specified in equation (14) captures around 70% of the variance of the industry labor cost to sales ratio computed as the median ratio over the period 1980-1989 for each industry in each country of our sample. More generally, our estimation results show that at least two thirds of the variance of the labor cost to sales ratio can be accounted for, assuming specification (14). Moreover, the share of variance accounted for is very comparable when the dependent variable is the industry wage costs to sales ratio. These numbers therefore validate the assumption that the US based measure of financial constraints is valid for industries outside the US: at least two thirds of the cross-country/cross-industry variation is captured under this assumption.

TABLE 4 AND TABLE 5 HERE

Taking into account endogeneity in the first stage. The second assumption underlying the baseline estimations presented above is that interest rate counter-cyclicality can be estimated with standard OLS. This raises the potential concern that the estimated coefficients may reflect the reaction of the real short-term interest rate to the output gap as much as they may reflect the reaction of the output gap to the real short-term interest rate. What makes it even more of an issue is that the output gap is computed using forward values of GDP and future values of GDP are in turn likely to be affected by the current real short-term interest rate. Consequently, OLS estimates for interest rate counter-cyclicality are likely to be biaised downwards as potential output would be underestimated. Hence the need to control for the endogeneity of the output gap. We do this using two alternative methods.

First, we estimate output gaps by computing trend GDP using a one-sided filter. The idea is to estimate a country's location on the business cycle by relying exclusively on backward information for GDP and abstracting from the use of any forward information (as such information is more likely to embed the effect of the real short-term interest rate on the economy).[22] Table 6 runs such estimations where counter-cyclicality in the real short-term interest rate is estimated using output gap measures based on one-sided filters for trend GDP.

TABLE 6 *HERE*

Results are both qualitatively and quantitatively very similar to those in our baseline regressions. Industry labor productivity growth is positively and significantly correlated with the interaction of real short-term interest rate cyclicality and indicators of credit or liquidity constraints. The estimated parameters are larger -in absolute value- than their counterpart in the simple OLS regressions in Table 3. The reason is that the interest rate cyclicality indexes estimated using one-sided filters for the output gap tend to be lower, in absolute value, than those estimated using the usual two-sided filter. This difference is in turn relatively easy to understand: namely, output gaps computed using one-sided filters tend to be more volatile due to the absence of forward information and the fact that the trend is computed using a much higher smoothing parameter. As a result, fluctuations that would be incorporated in the trend with a usual two-sided filter, are considered as part of the cycle with a one-sided filter. This in turn results in a more volatile output gap, and therefore in a lower index for real short-term interest rate cyclicality (in absolute value).

To fix ideas, looking at real short-term interest rate countercyclicality in absolute value, the cross-country average happens to be 50 to 60% lower when estimates are computed using a one-sided filter for the output gap compared to using a two-sided filter. A similar comparison for the standard deviation across countries shows that it is 40-65% lower with a one-sided filter.

Second, we rely on the more traditional instrumental variables approach to estimate the first stage regressions. We instrument the current output gap with four possible instruments. First, we consider past values of the output gap, whenever statistical tests allow for, in other words when past values of the output gap are correlated with the current output but uncorrelated with the real short-term interest rate. Second, we use past values for the slope of the yield curve, i.e. the difference between the nominal long-term (10 year) interest rate and the nominal short-term (3 month) interest rate. The idea here is that the slope of

[22] Trend GDP at time t is then computed with a HP filter for the period $[0, t]$ using a smoothing parameter equal to 400000.

the yield curve can help predict the cycle so that past values, to the extent that they are uncorrelated with the current real short-term interest rate, can be a good instrument for the economy's current location on the cycle. As a third instrument, we use past changes in the real effective exchange rate as they can be thought of as reflecting demand shocks. More specifically, to the extent that a real effective exchange rate depreciation should increase external demand it should raise the output gap in the future. A similar argument can be made for real effective exchange rate appreciation and the resulting negative demand shock. Finally, we use past values of real import prices as a instrument. The idea is that changes in real import prices capture terms of trade shocks that may affect aggregate demand and thereby the economy's output gap.[23]

TABLE 7 HERE

Results from estimating the second stage regression (10) when real short-term interest rate counter-cyclicality is obtained from IV regressions, are provided in Table 7. Two main conclusions can be drawn from this table. First, the interaction between real short-term interest rate counter-cyclicality and industry financial constraints has a positive and significant effect on industry-level productivity growth. Second, the estimated coefficients are lower in absolute value than those obtained with OLS estimates of real short-term interest rate counter-cyclicality. This difference is almost entirely driven by differences in the cross-country distribution of real short-term interest rate countercyclicality indexes. For example, when interest rate cyclicality is estimated using (13.1)-(13.4), then the estimated coefficient for the interaction term is 50-60% larger (in absolute value) compared to the estimated coefficient with OLS (-9.94 vs. -6.17 when asset tangibility is interacted with interest rate cyclicality and 12.40 vs. 8.14 when labor cost to sales is interacted with interest rate cyclicality). In the meantime, the standard deviation in the cross-country distribution of real short-term interest rate countercyclicality is approximately 50% larger for IV estimates of interest rate cyclicality compared with the corresponding OLS estimates. Properly taking into account the endogeneity of the first stage estimates therefore reduces by 10% at most the effect of interest rate countercyclicality. Finally, it appears that interactions using industry labor cost to sales are more significant than those using

[23] Tables 7a and 7b detail the choice of instruments country by country as well as the test diagnostics for the validity of such instruments.

industry asset tangibility. Again, this is in line with the view that lower real short-term interest rates affect primarily those industries with large liquidity needs.

Dealing with the uncertainty around the interest rate cyclicality index A last limitation of the empirical analysis carried out so far, is that interest rate cyclicality cannot be directly observed, it can only be estimated. Yet, in our analysis so far, the index for interest rate cyclicality -obtained from first stage regressions- has been treated as an observed variable whereas in reality all we know are the first and second moments of the distribution of interest rate cyclicality estimates for each country. Because interest rate cyclicality is a generated regressor, it might well be that taking into account the uncertainty around the estimates for interest rate cyclicality could make insignificant the interaction between interest rate counter-cyclicality and financial constraints. To deal with this problem, we adopt the following three-stage procedure:

First, instead of considering the coefficient $(\text{ccy})_k$ estimated in the first stage regression as an explanatory variable for our second stage regression, we start by drawing for each country k an interest rate cyclicality index $(\text{ccy})_{k,i}$ from a normal distribution with mean $(\text{ccy})_k$ and standard deviation $\sigma_{(\text{ccy})_k}$, where $\sigma_{(\text{ccy})_k}$ is the standard error for the coefficient $(\text{ccy})_k$ estimated in the first stage regression. Each draw yields a different vector of interest rate cyclicality indexes. Typically the larger the estimated standard deviations $\sigma_{(\text{ccy})_k}$ the more likely the vector of interest rate cyclicality indexes $(\text{ccy})_{k,i}$ will be different from the vector used in estimations where we abstracted from the standard deviations of the interest rate cyclicality estimates.

Second, for each draw of the interest rate cyclicality index $(\text{ccy})_{k,i}$ we run a separate second stage regression:

$$g_{jk} = \alpha_{j,i} + \alpha_{k,i} + \beta_i (\text{fc})_j \times (\text{ccy})_{k,i} - \delta_i . y_{jk} + \varepsilon_{jk,i} \tag{13}$$

Running this regression yields an estimated coefficient β_i and an estimated standard deviation σ_{β_i}. We repeat this same procedure 10000 times, and thereby end up with a series of 10000 estimated coefficients β_i and standard errors σ_{β_i}.

Third and last, we average across these 10000 draws to obtain an average $\overline{\beta}$ of the estimated coefficients β_i and $\overline{\sigma_\beta}$ of estimated standard errors σ_{β_i}. The statistical significance can eventually be tested on the basis of the averages $\overline{\beta}$ and $\overline{\sigma_\beta}$. The results of this estimation procedure are provided in Table 8. The interaction of interest rate cyclicality and industry financial constraints still has a significant effect on industry growth. Yet, two things are worth noting. First, as was the case for the estimations using IV estimates of interest rate cyclicality, the estimated parameters are somewhat smaller -in absolute value- than their counterpart in the simple OLS regressions in Table 3, although the difference is by no means statistically significant. Second, the interaction effect is also less significant when interest rate counter-cylicality is estimated using the real short-term interest rate gap, which likely reflects the lower precision of such cyclicality estimates. Overall, we can claim that the interaction of industry financial constraints and real short-term interest rate cyclicality has a genuine significant effect on industry growth which does not reflect a bias due to the use of a generated regressor. In other words, the simple OLS regressions do not seem to provide significantly biased results.

TABLE 8 HERE

3.2.4 Competing stories and omitted variables

We have established that interest rate cyclicality enhances growth disproportionately more in sectors that face tighter credit or liquidity constraints. Yet there is a concern that we might be picking up other factors or stories when looking at how industry growth correlates with the cyclicality of the real short-term interest rate and industry financial constraints. The next two tables address this issue. But before we get into the empirical resutls, let us now detail the alternative factors we are thinking about. First, it could be that differences in interest rate counter-cyclicality reflect long-run differences in inflation and interest rates. For example there is evidence that a more countercyclical real short-term interest rate is associated with a higher real interest rate. The question is therefore whether the effect of countercyclical real short-term interest rates on industry growth growth may not simply capture the effects of higher average real interest rates and/or low average inflation. Second, it could be that countercyclical real short-term interest rates reflect fiscal discipline. Here, the story would be that large fiscal deficits may crowd out private investment and the more so in industries with lower asset tangibility or larger labour costs to sales. Third, more counter-cyclical real short-term interest rates could simply reflect a higher degree of financial development in the country, and financial development in turn is known to have a positive effect on growth, particularly for industries that are more dependent on external finance (Rajan and Zingales, 1998). Finally, real short-term interest rate cyclicality may reflect the state of labor market institutions. Thus, a more rigid labour market might prevent the growth of labor intensive industries, and therfore limit the effect of interest rates cyclicality on growth in these industries. Table 9 performs horse-races between the interaction of asset tangibility and real short-term interest rate counter-cyclicality on the one hand and the alternative stories listed above on the other.

TABLE 9 HERE

The first column shows that maintaining low inflation does not help industries with low asset tangibility. Similarly, maintaining high short or long-term real interest rates does enhance productivity growth in industries with low asset tangibility. Finally in countries which experienced large real effective exchange rate appreciation, low asset tangibility industries do not experience disproportionately high productivity growth.[24] Overall, these results confirm that the cyclical pattern of the real short-term interest rate affects industry-level productivity growth significantly even when controlling for these policy variables.

Next, we examine fiscal policy to check whether the effect of interest rate counter-cyclicality may simply reflect differences in government size of fiscal deficits. Columns (v) and (vi) show that this is not the case. Neither having a small government, i.e. a low government expenditure to GDP ratio, nor following a more cautious fiscal policy, i.e. with low fiscal deficits, seem to affect industry-level productivity growth disproportionately more for those industries whose assets are less tangible.

We now turn to financial development. As mentioned above, financial development is known to affect growth and the more so in industries which suffer tighter financial constraints. However, this result has been obtained using a large cross-section of advanced and emerging market economies, where differences in financial development can indeed be very large. It is therefore unclear, once we concentrate attention to advanced

[24] Note that real effective exchange rate appreciation can either result from high nominal interest rates, which would lead to large capital inflows and hence to nominal exchange rate appreciation or from low nominal interest rates which would lead to high inflation relative to trading partners and thereby real exchange rate appreciation.

economies, whether financial development or interest rate counter-cyclicality is more important, given that cross-country differences in financial development are likely to be smaller than those in real short-term interest rate counter-cyclicality. Columns (vii)-(ix) actually show that the significant effect of the interaction between real short-term interest rate counter-cyclicality and industry asset tangibility is not altered when controlling for each of three different country-wide measures of financial development commonly used the literature, namely private credit to GDP, financial system deposits to GDP or private bond market capitalization to GDP. Moreover, none of those three variables shows a significant interaction coefficient with industry-level asset tangibility. This confirms the view that the effect of financial development on industry growth, if any, actually operates through real short-term interest rates counter-cyclicality.[25]

Last, we look at the effect of employment protection on the labor market. The last column of Table 9 shows that the interaction between employment protection and industry asset tangibility is not significant and, if anything, makes the effect of interest rate counter-cylicality become larger.

Table 10 repeats the same exercise, but using labor costs to sales as the measure of industry financial constraint. The basic conclusions are unchanged: controlling for the interaction between labour costs to sales and the policy or institutional variables listed above does not affect the fact that the interaction between labor costs to sales and real short-term interest rate counter-cyclicality has a significant effect on industry growth. Note finally that these results do not imply that the control variables we consider do not matter for industry growth in industries that are more liquidity constrained. It rather means that if they matter, it is primarily through their effects on real short-term interest rate counter-cyclicality.

TABLE 10 *HERE*

3.2.5 Magnitude of the effects

How large are the effects implied by the above regressions? This question can be answered by computing the predicted difference in productivity growth between an industry which both, lies in the first quartile

[25] It is also worth noting that the estimated coefficient for the interaction between asset tangibility and monetary policy countercyclicality is very similar to those estimated in Table 3, where there are no control variables. Controlling for financial development has therefore negligible implications for the magnitude of estimated coefficients.

of the distribution for credit (liquidity) constraints, and is located in a country in the first quartile of the distribution for interest rate counter-cyclicality, and an industry in the third quartile of the distribution for credit (liquidity) constraints and located in a country at the third quartile of the distribution for interest rate counter-cyclicality.[26]

The magnitude of this difference depends upon the method used to estimate real short-term interest rate cyclicality. For example, when real short-term interest rate cyclicality is estimated using (11), then the predicted difference in productivity growth amounts to around 1.2 percentage point for asset tangibility and 1.8 percentage points for labour cost to sales. That the difference in productivity growth be larger when looking at the interaction between interest rate cyclicality and the liquidity constraint, is not too surprising since, as was pointed out above, the real short-term interest rate essentially affects short-term financing conditions. Also, the magnitudes remain relatively similar when real short-term interest rate cyclicality is estimated using (13.1)-(13.4), i.e. allowing the interest rate specification to differ across countries. The difference in productivity growth then amounts to 1.3 percentage point for asset tangibility and 1.7 percentage point for labour cost to sales. As a matter of comparison, in our sample, the median for industry productivity growth is 2.5 per cent while the interquartile difference is 3.9 per cent. This shows that these magnitudes are actually pretty large as they represent 30 to 50% of the interquartile difference in industry productivity growth.

Three short remarks to conclude this assessment exercise. First, these are difference-in-difference (cross-country/cross-industry) effects, which are not interpretable as country-wide effects.[27] Second, the relatively small size of our country sample implies that moving from the first to the third quartile in the distribution of real short-term interest rate counter-cyclicality corresponds to a dramatic change in the dynamics of the interest rate over the cycle. Third, this simple computation does not take into account the possible costs associated with the transition from a situation with low interest rate counter-cyclicality to one with high interest rate counter-cyclicality. Yet, this quantitative exercise suggests that differences in the cyclicality

[26] The presence of industry and country fixed effects prevents evaluating the impact of a change in the cyclical pattern of the real short-term interest rate for a given industry or conversely the effect of a change in industry characteristics in a country with a given cyclical pattern of the real short-term interest rate.

[27] It could be that a more counter-cyclical real short-term interest rate simply redistributes productivity growth across sectors leaving aggregate productivity growth unchanged.

of the real short-term interest rate are an important driver of the observed cross-country/cross-industry differences in value added and productivity growth.

3.2.6 Extending the analysis: Expansions versus recessions

So far, the analysis has been carried out under the assumption that countercyclical interest rates affect industry growth irrespective of whether the aggregate economy faces an expansion or a recession. In this section, we test for this assumption. Our purpose is therefore to check whether the positive effect of interest rate counter-cyclicality on industry-level growth operates mainly when the economy is expanding or when the economy is contracting. To do so, we compute industry growth in expansion periods as the average growth rate of real value added per hour worked for each industry, conditional on the output gap of the country where such industry is located, being above the sample median. Similarly, we compute industry growth in recessions as the average growth rate of real value added per hour worked for each industry, conditional on the output gap of the country where such industry is located, being below the sample median. Table 11 then reports the estimation results using industry growth in expansions as the dependent variable while Table 12 reports the estimation results using industry growth in recessions as the dependent variable, right-hand-side variables being those of the baseline specification (10) in both tables.

Tables 11 and 12 show two important results. First, the interaction between real short-term interest rate counter-cyclicality and financial constraints is never significant when the dependent variable is industry real value added per hour growth in expansion periods. This is true whether interest rate counter-cyclicality is interacted with industry asset tangibility or with industry labor cost to sales. Second, when focusing on recessions, the interaction between industry financial constraints and real short-term interest rate counter-cyclicality becomes positively and significantly correlated with industry productivity growth. Tables 11 and 12 therefore suggest that it is essentially when the economy goes through a recession that a counter-cyclical real short-term interest rate raises growth disproportionately more in industries facing tighter financial constraints.

TABLES 11 *AND* 12 *HERE*

4 Conclusion

In this paper we have developed a simple framework to look at how the interaction between the cyclicality of the real short-term interest rate and industries' credit or liquidity constraints, affects industries' long-term growth. Two main predictions came out of our model, namely: (i) the more credit-constrained an industry, the more growth in that industry, benefits from counter-cyclical interest rates; (ii) the more liquidity-constrained an industry, the more growth in that industry, benefits from more counter-cyclical interest rates; Then, we have successfully confronted these predictions to cross-industry, cross-country OECD data over the period 1995-2005. Moreover, the empirical evidence shows that the growth enhancing effect of counter-cyclical real short-term interest rate comes essentially from higher growth in more financially constrained industries when the economy as a whole faces a recession.

The approach and analysis in this paper could be extended in several directions. First, one could revisit the costs and benefits of monetary unions, i.e. the potential gains from joining the union in terms of credibility versus the potential costs in terms of the reduced ability to pursue counter-cyclical monetary policies. Here, we think for example of countries like Portugal or Spain where interest rates went down after these countries joined the Eurozone but which at the same time were becoming subject to cyclical monetary policies which were no longer set with the primary objective of stabilizing the domestic business cycle or domestic inflation. Second, one could look at the interplay between cyclical interest rates and cyclical fiscal policy: are those substitutes or complements? Third, one could embed our analysis in this paper into a broader framework where interest rate policy would also affect the extent of collective moral hazard among banks as in Farhi and Tirole (2010). There a counter-cyclical interest rates would have ambiguous effects since lowering interest rates during downturns would encourage short-term debt borrowing by banks while raising interest rates in booms would rather curb such incentives. Finally, we would like to test the same predictions on firm-level panel data. However, such data are not available cross-country. The strategy there would be to focus on particular countries, using firm-level measures of credit and liquidity constraints. We are currently exploring such data for France.

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5 Appendix

Proposition 4 *Assuming the gross rate of interest at the investment stage R is sufficiently large, i.e. R satisfies*

$$R > \left[(1-\alpha) + \alpha\frac{\mu}{R_G} + \alpha q\frac{1-\mu}{R_B}\right]\rho + q\left[(1-\alpha)\, E_s R_s + \alpha\left(\mu + (1-\mu)\,\pi_B\right)\right]$$

then, there exists a threshold ρ_1^* which ensures that entrepreneurs are willing to maximize initial investment and interim reinvestment whenever the return on the long-term project satisfies $\rho_1 > \rho_1^*$. When this condition *holds, entrepreneurs' optimal liquidity policy satisfies*

$$x_1 = \frac{\rho}{R_B} + \min\left\{1 - \pi_B - \frac{\rho}{R_B}; 0\right\} \text{ and } x_0 = \max\left\{1 - \pi_B - \frac{\rho}{R_B}; 0\right\}$$

Proof. Consider an entrepreneur whose pledgeable return is ρ and whose probability of the liquidity shock is α. Moreover this entrepreneur purchases $x_0 I$ as liquidity at the investment date and raises $x_1 I$ as claims on final output at the reinvestment date when hit by a liquidity shock and the aggregate state is bad. Then the entrepreneur's expected profit writes as

$$\frac{\Pi_{t+2}}{A_t} = \frac{(1-\alpha) E_s (\rho_1 - \rho + \pi_s) R_s + \alpha\mu (\rho_1 - \rho + (\pi_G - 1) R_G) + \alpha (1-\mu) (\rho_1 - \rho) (x_1 + x_0 + \pi_B)}{R - \left[(1-\alpha) + \alpha \frac{\mu}{R_G} + \alpha \frac{1-\mu}{R_B}\right] \rho + \alpha (1-\mu) (x_1 + q x_0)} R$$

This expression is increasing in x_1 if and only if

$$\begin{aligned} & (\rho_1 - \rho) \left[R - \left[(1-\alpha) + \alpha \frac{\mu}{R_G} + \alpha \frac{1-\mu}{R_B}\right] \rho + (1-\mu) \alpha q x_0\right] \\ > \quad & (1-\alpha) E_s (\rho_1 - \rho + \pi_s) R_s + \alpha\mu (\rho_1 - \rho + (\pi_G - 1) R_G) + \alpha (1-\mu) (\rho_1 - \rho) (x_0 + \pi_B) \end{aligned}$$

Hence a sufficient condition for entrepreneurs to be willing to maximize the claims issued at the reinvestment date when a liquidity shock hits and the aggregate state is bad writes as

$$\rho_1 - \rho > \frac{(1-\alpha) E \pi_s R_s + \alpha\mu (\pi_G - 1) R_G}{\left[R - \left[(1-\alpha) + \alpha \frac{\mu}{R_G} + \alpha \frac{1-\mu}{R_B}\right] \rho - \left[(1-\alpha) E_s R_s + \alpha (\mu + (1-\mu) \pi_B)\right]\right]^+}$$

When this condition holds then the optimal amount of claims issued at the reinvestment date when a liquidity shock hits and the aggregate state is bad satisfies

$$x_1 = \min\left\{1 - \pi_B - x_0; \frac{\rho}{R_B}\right\}$$

When $x_1 = 1 - \pi_B - x_0$ then expected profits are strictly decreasing in x_0 and the entrepreneur then chooses

$x_0 = 0$. On the contrary if $x_1 = \rho/R_B$, then expected profits are increasing in x_0 if and only if

$$\begin{aligned} & \left(\rho_1-\rho\right)\left[R-\left[(1-\alpha)+\alpha\frac{\mu}{R_G}+\alpha\frac{1-\mu}{R_B}\right]\rho+(1-\mu)\,\alpha\frac{\rho}{R_B}\right] \\ > \;& q\left[(1-\alpha)\,E_s\left(\rho_1-\rho+\pi_s\right)R_s+\alpha\mu\left(\rho_1-\rho+\left(\pi_G-1\right)R_G\right)+\alpha\,(1-\mu)\left(\rho_1-\rho\right)\left(\frac{\rho}{R_B}+\pi_B\right)\right] \end{aligned}$$

which can be simplified as

$$\rho_1-\rho > \frac{q\left[(1-\alpha)\,E_s\pi_sR_s+\alpha\mu\left(\pi_G-1\right)R_G\right]}{\left[R-\left[(1-\alpha)+\alpha\frac{\mu}{R_G}+\alpha q\frac{1-\mu}{R_B}\right]\rho-q\left[(1-\alpha)\,E_sR_s+\alpha\left(\mu+(1-\mu)\,\pi_B\right)\right]\right]^+} \tag{14}$$

Hence when (14) holds, we can wrap up the optimal liquidity policy as:

$$x_0 = \max\left\{1-\pi_B-\frac{\rho}{R_B};0\right\} \text{ and } x_1 = \min\left\{1-\pi_B;\frac{\rho}{R_B}\right\}$$

By investing in his long-term project, the entrepreneur gets an expected return

$$\frac{\Pi_{t+2}}{A_t} = \frac{(1-\alpha)\,E_s\left(\rho_1-\rho+\pi_s\right)R_s+\alpha\mu\left(\rho_1-\rho+\left(\pi_G-1\right)R_G\right)+\alpha\,(1-\mu)\left(\rho_1-\rho\right)\left(x_1+x_0+\pi_B\right)}{R-\left[(1-\alpha)+\alpha\frac{\mu}{R_G}+\alpha\frac{1-\mu}{R_B}\right]\rho+\alpha\,(1-\mu)\left(x_1+qx_0\right)}R$$

Otherwise, by investing his net worth at the risk-free rate and rolling it over, the entrepreneur would get a return $R.E_sR_s$. Hence denoting $p = 1$ if $1-\pi_B < \frac{\rho}{R_B}$ and $p = q$ if $1-\pi_B > \frac{\rho}{R_B}$ and the entrepreneur is better-off investing in his long-term project if and only if

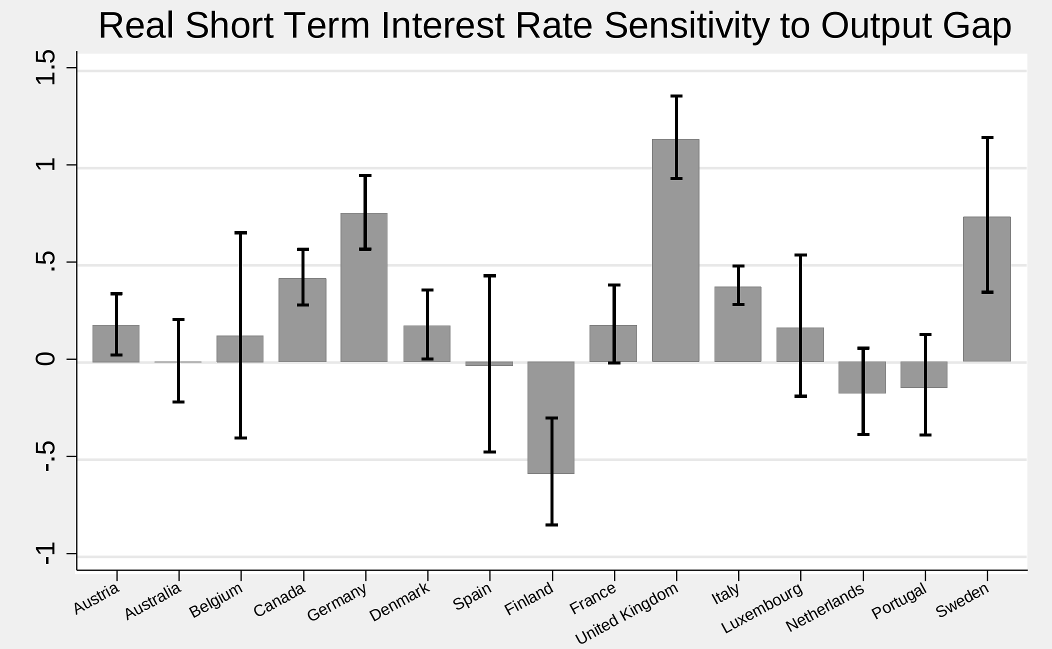
$$\rho_1-\rho > \frac{\left[R-\left[1-\alpha+\alpha\frac{\mu}{R_G}\right]\rho+p\alpha\,(1-\mu)\left(1-\pi_B-\frac{\rho}{R_B}\right)\right]E_sR_s-\left[(1-\alpha)\,E_s\pi_sR_s+\alpha\mu\left(\pi_G-1\right)R_G\right]}{(1-\alpha)\,E_sR_s+\alpha}$$

■

Table1 : List of industries

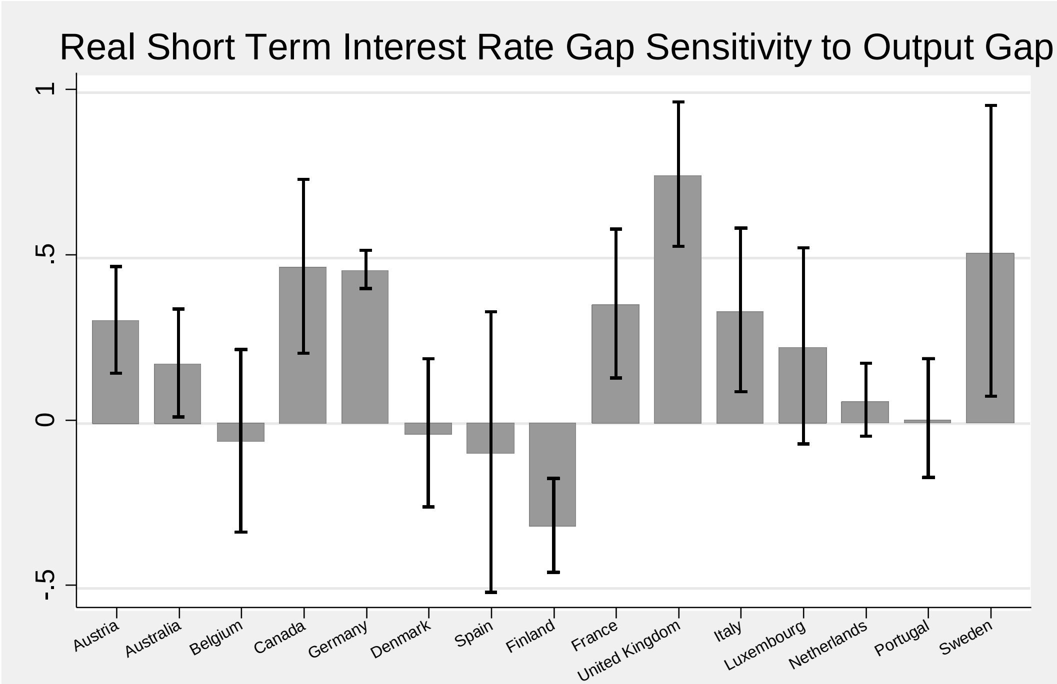
Industry designation	Industry code
FOOD , BEVERAGES AND TOBACCO	15t16
Food and beverages	15
Tobacco	16
TEXTILES, TEXTILE , LEATHER AND FOOTWEAR	17t19
Textiles and textile	17t18
Textiles	17
Wearing Apparel, Dressing And Dying Of Fur	18
Leather, leather and footwear	19
WOOD AND OF WOOD AND CORK	20
PULP, PAPER, PAPER , PRINTING AND PUBLISHING	21t22
Pulp, paper and paper	21
Printing, publishing and reproduction	22
Publishing	221
Printing and reproduction	22x
CHEMICAL, RUBBER, PLASTICS AND FUEL	23t25
Coke, refined petroleum and nuclear fuel	23
Chemicals and chemical products	24
Chemicals excluding pharmaceuticals	24x
Pharmaceuticals	244
Rubber and plastics	25
OTHER NON-METALLIC MINERAL	26
BASIC METALS AND FABRICATED METAL	27t28
Basic metals	27
Fabricated metal	28
MACHINERY, NEC	29
ELECTRICAL AND OPTICAL EQUIPMENT	30t33
Office, accounting and computing machinery	30
Electrical engineering	31t32
Electrical machinery and apparatus, nec	31
Other electrical machinery and apparatus nec	31x
Radio, television and communication equipment	32
Electronic valves and tubes	321
Radio and television receivers	323
Medical, precision and optical instruments	33
Scientific instruments	331t3
Other instruments	334t5
TRANSPORT EQUIPMENT	34t35
Motor vehicles, trailers and semi-trailers	34
Other transport equipment	35
Building and repairing of ships and boats	351
Aircraft and spacecraft	353
Railroad equipment and transport equipment nec	35x
MANUFACTURING NEC; RECYCLING	36t37
Manufacturing nec	36
Recycling	37

Figure 1



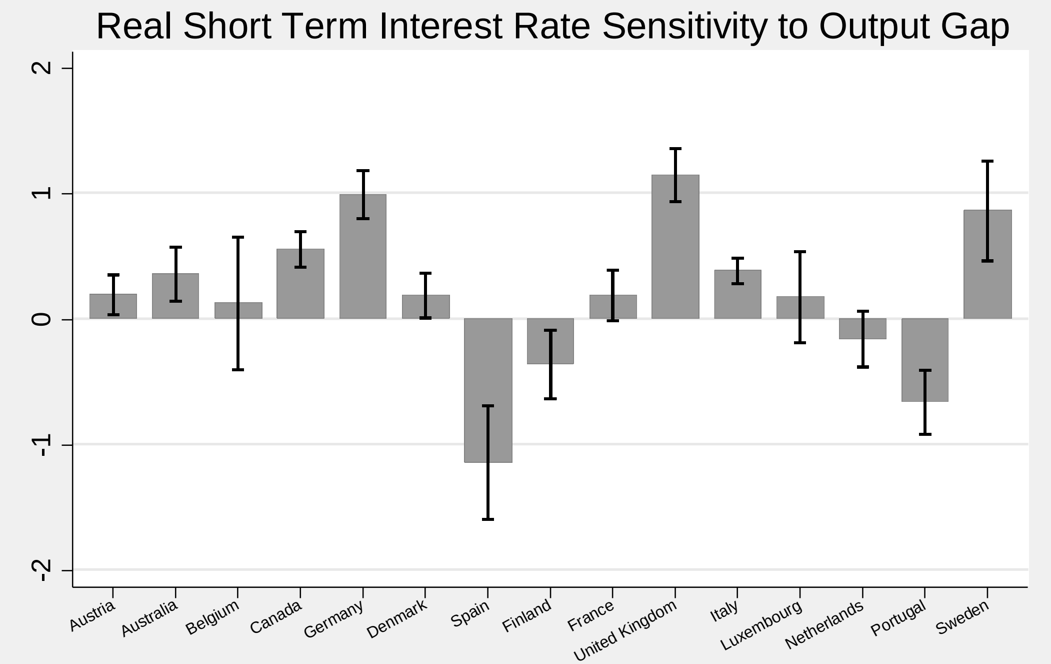
Note: Each bar represents the output gap sensitivity of the real short term interest rate for the period 1995-2005 for each country, controlling for the one quarter lagged real short term interest rate. The black line indicates the confidence interval at the 10% level around the sensitivity estimate for each country.

Figure 2



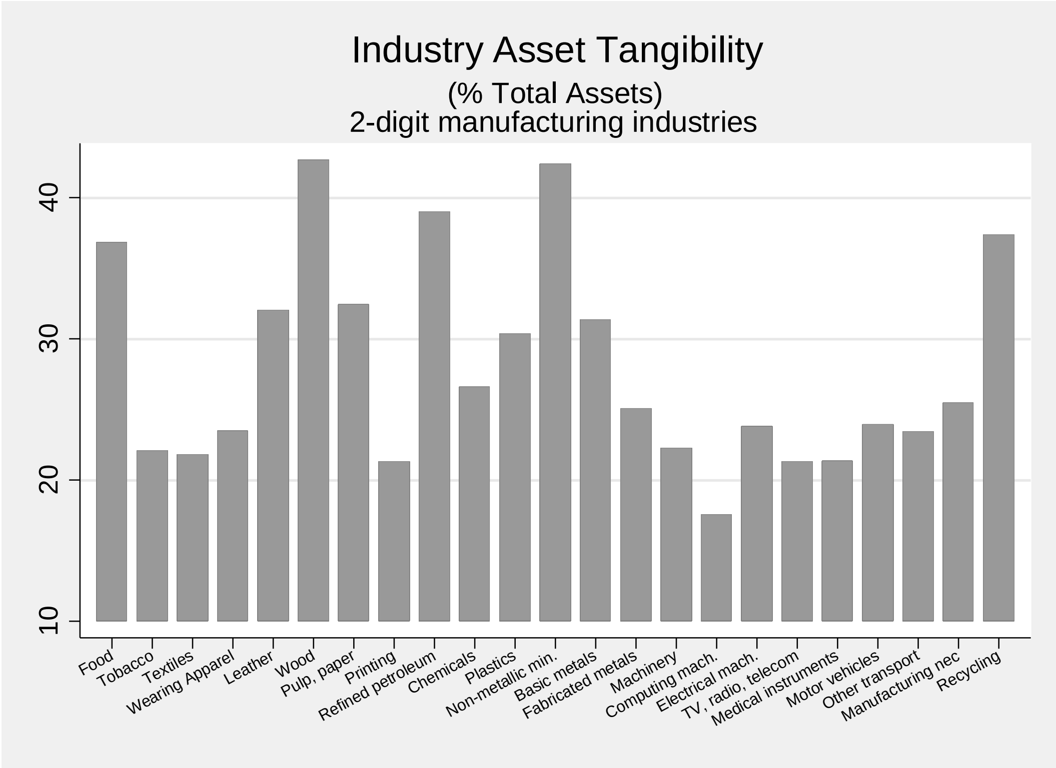
Note: Each bar represents the output gap sensitivity of the real short term interest rate gap for the period 1995-2005 for each country.
The black line indicates the confidence interval at the 10% level around the sensitivity estimate for each country.

Figure 3



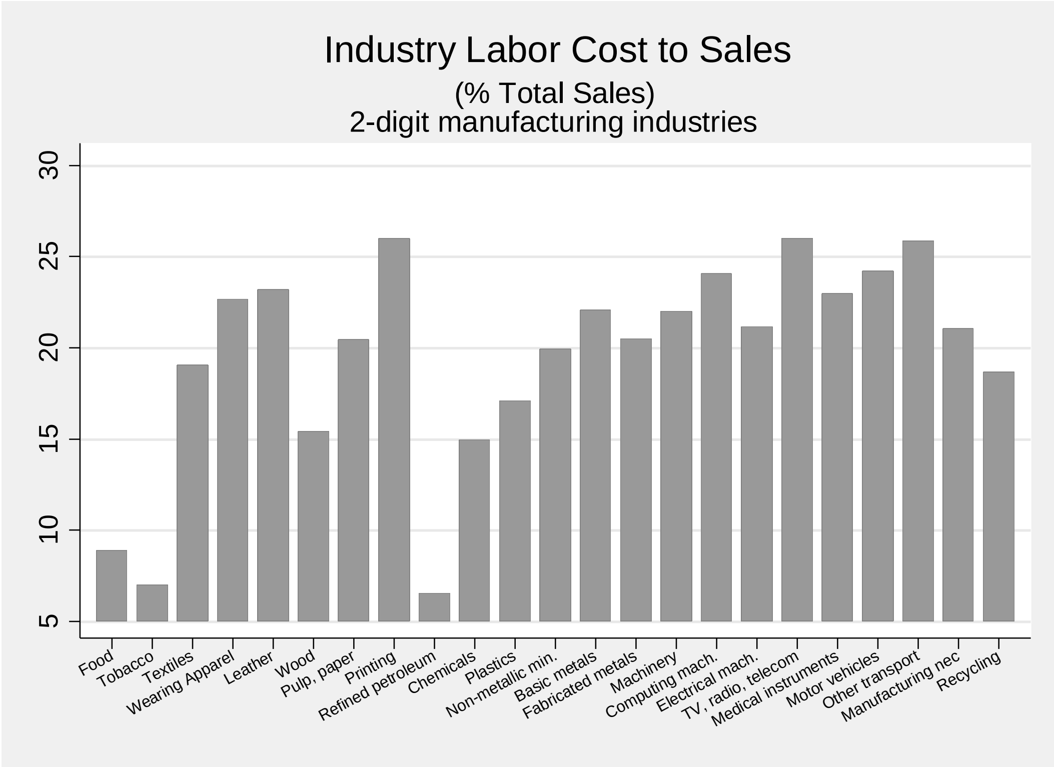
Note: Each bar represents the output gap sensitivity of the real short term interest rate for the period 1995-2005 for each country, based on a minimizing rmse specification. The black line indicates the confidence interval at the 10% level around the sensitivity estimate for each country.

Figure 4



Industry Asset Tangibility
(% Total Assets)
2-digit manufacturing industries
10
20
30
40
Food
Tobacco
Textiles
Wearing Apparel
Leather
Wood
Pulp, paper
Printing
Refined petroleum
Chemicals
Plastics
Non-metallic min.
Basic metals
Fabricated metals
Machinery
Computing mach.
Electrical mach.
TV, radio, telecom
Medical instruments
Motor vehicles
Other transport
Manufacturing nec
Recycling

Figure 5



Industry Labor Cost to Sales
(% Total Sales)
2-digit manufacturing industries
30
25
20
15
10
5
Food
Tobacco
Textiles
Wearing Apparel
Leather
Wood
Pulp, paper
Printing
Refined petroleum
Chemicals
Plastics
Non-metallic min.
Basic metals
Fabricated metals
Machinery
Computing mach.
Electrical mach.
TV, radio, telecom
Medical instruments
Motor vehicles
Other transport
Manufacturing nec
Recycling

Table 2: Baseline regressions, real value added growth

Dependent variable: Real Value Added Growth						
	(i)	**(ii)**	**(iii)**	**(iv)**	**(v)**	**(vi)**
Log of Initial Share in Manufacturing Value Added	**-1.118****	**-1.103***	**-1.120***	**-1.088***	**-1.092***	**-1.090***
	(0.552)	*(0.550)*	*(0.559)*	*(0.558)*	*(0.553)*	*(0.562)*
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality I)	**-16.98*****					
	(4.741)					
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality II)		**-26.86*****				
		(8.712)				
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality III)			**-12.20*****			
			(3.439)			
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality I)				**16.43*****		
				(5.564)		
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality II)					**28.47*****	
					(9.124)	
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality III)						**10.75*****
						(3.978)
Observations	606	606	606	606	606	606
R-squared	0.400	0.400	0.400	0.398	0.399	0.397

Note: The dependent variable is the average annual growth rate in real value added for the period 1995-2005 for each industry in each country. Initial share in manufacturing value added is the ratio of industry real value added to total manufacturing real value added in 1995. Asset Tangibility is the median fraction of assets represented by net property, plant and equipment for US firms in the same industry for the period 1980-1989. Labor Costs to Sales is the median ratio of labor costs to shipments for US firms in the same industry for the period 1980-1989. Real Short term Interest Rate Counter-Cyclicality I is the coefficient of the output gap when the real short term interest rate is regressed on a constant, the output gap and the one quarter lagged real short term interest rate for each country. Real Short term Interest Rate Counter-Cyclicality II is the coefficient of the output gap when the real short term interest rate gap is regressed on a constant, the output gap. Real Short term Interest Rate Counter-Cyclicality III is the coefficient of the output gap in the specification among (13.1)-(13.4) which minimizes the root mean standard error for each country. The interaction variable is the product of variables in parentheses. Standard errors -clustered at the industry level- are in parentheses. All estimations include country and industry dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 3: Baseline regressions, labour productivity growth

Dependent variable: Labor Productivity per hour Growth	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Log of Initial Relative Labor Productivity	**-3.566*****	**-3.580*****	**-3.563*****	**-3.576*****	**-3.575*****	**-3.597*****
	(0.886)	*(0.870)*	*(0.877)*	*(0.859)*	*(0.850)*	*(0.860)*
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality I)	**-14.79*****					
	(5.106)					
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality II)		**-23.44*****				
		(7.648)				
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality III)			**-9.941*****			
			(3.364)			
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality I)				**19.35*****		
				(4.056)		
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality II)					**26.32*****	
					(5.961)	
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality III)						**12.40*****
						(3.261)
Observations	606	606	606	606	606	606
R-squared	0.352	0.353	0.352	0.354	0.352	0.353

Note: The dependent variable is the average annual growth rate in real value added per hour worked for the period 1995-2005 for each industry in each country over the period 1995-2005. Initial Relative Labor Productivity is the ratio of industry value added per hour worked to total manufacturing value added per hour worked in 1995. Asset Tangibility is the median fraction of assets represented by net property, plant and equipment for US firms in the same industry for the period 1980-1989. Labor Costs to Sales is the median ratio of labor costs to shipments for US firms in the same industry for the period 1980-1989. Real Short term Interest Rate Counter-Cyclicality I is the coefficient of the output gap when the real short term interest rate is regressed on a constant, the output gap and the one quarter lagged real short term interest rate for each country. Real Short term Interest Rate Counter-Cyclicality II is the coefficient of the output gap when the real short term interest rate gap is regressed on a constant, the output gap. Real Short term Interest Rate Counter-Cyclicality III is the coefficient of the output gap in the specification among (13.1)-(13.4) which minimizes the root mean standard error for each country. The interaction variable is the product of variables in parentheses. Standard errors -clustered at the industry level- are in parentheses. All estimations include country and industry dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 4: Testing the assumption of country invariant ranking for industry characteristics

Dependent variable: Industry labor cost to sales ratio						
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Statistic	median	average	median	average	median	average
Estimation period	1980-1989		1990-1999		1995-2004	
Observations	458	458	507	507	592	592
R-squared	0.703	0.693	0.693	0.708	0.656	0.669

Note: This table shows the estimation results of a variance decomposition exercise on a panel of industries and countries where the industry labor cost to sales ratio is regressed against a full set of industry and country dummies. In column (i) (resp. (ii)), the dependent variable is the median (resp. average) labor cost to sales for each industry in each country of the sample computed over the period 1980-1989. In column (iii) (resp. (iv)), the dependent variable is the median (resp. average) labor cost to sales for each industry in each country of the sample computed over the period 1990-1999. In column (v) (resp. (vi)), the dependent variable is the median (resp. average) labor cost to sales for each industry in each country of the sample computed over the period 1990-1999.

Table 5: Testing the assumption of country invariant ranking for industry characteristics

Dependent variable: Industry wage bill to sales ratio						
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Statistic	median	average	median	average	median	average
Estimation period	1980-1989		1990-1999		1995-2004	
Observations	466	466	512	512	595	595
R-squared	0.703	0.693	0.696	0.715	0.667	0.681

Note: This table shows the estimation results of a variance decomposition exercise on a panel of industries and countries where the industry wage bill to sales ratio is regressed against a full set of industry and country dummies. In column (i) (resp. (ii)), the dependent variable is the median (resp. average) wage bill to sales ratio for each industry in each country of the sample computed over the period 1980-1989. In column (iii) (resp. (iv)), the dependent variable is the median (resp. average) wage bill to sales ratio for each industry in each country of the sample computed over the period 1990-1999. In column (v) (resp. (vi)), the dependent variable is the median (resp. average) wage bill to sales ratio for each industry in each country of the sample computed over the period 1990-1999.

Table 6: Using one-sided filters to compute the output gap

Dependent variable: Labor Productivity per hour Growth						
	(i)	**(ii)**	**(iii)**	**(iv)**	**(v)**	**(vi)**
Log of Initial Relative Labor Productivity	**-3.576*** *(0.892)*	**-3.567*** *(0.862)*	**-3.594*** *(0.881)*	**-3.612*** *(0.867)*	**-3.595*** *(0.852)*	**-3.578*** *(0.856)*
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality I)	**-31.89*** *(10.55)*					
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality II)		**-51.52*** *(25.59)*				
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality III)			**-21.08*** *(6.277)*			
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality I)				**34.63*** *(10.94)*		
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality II)					**50.95**** *(21.89)*	
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality III)						**18.96*** *(6.336)*
Observations	606	606	606	606	606	606
R-squared	0.353	0.351	0.353	0.353	0.349	0.350

Note: The dependent variable is the average annual growth rate in real value added per hour worked for the period 1995-2005 for each industry in each country over the period 1995-2005. Initial Relative Labor Productivity is the ratio of industry value added per hour worked to total manufacturing value added per hour worked in 1995. Asset Tangibility is the median fraction of assets represented by net property, plant and equipment for US firms in the same industry for the period 1980-1989. Labor Costs to Sales is the median ratio of labor costs to shipments for US firms in the same industry for the period 1980-1989. Real Short term Interest Rate Counter-Cyclicality I is the coefficient of the output gap when the real short term interest rate is regressed on a constant, the output gap –computed with a one-sided HP filter– and the one quarter lagged real short term interest rate for each country. Real Short term Interest Rate Counter-Cyclicality II is the coefficient of the output gap when the real short term interest rate gap is regressed on a constant, the output gap –computed with a one-sided HP filter–. Real Short term Interest Rate Counter-Cyclicality III is the coefficient of the output gap in the specification among (13.1)-(13.4) which minimizes the root mean standard error for each country, the output gap being computed with a one-sided HP filter. The interaction variable is the product of variables in parentheses. Standard errors -clustered at the industry level- are in parentheses. All estimations include country and industry dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 7: Instrumenting the first stage estimations

Dependent variable: Labor Productivity per hour Growth						
	(i)	**(ii)**	**(iii)**	**(iv)**	**(v)**	**(vi)**
Log of Initial Relative Labor Productivity	**-3.553*** *(0.882)*	**-3.552*** *(0.860)*	**-3.558*** *(0.867)*	**-3.568*** *(0.859)*	**-3.545*** *(0.845)*	**-3.606*** *(0.859)*
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality I)	**-10.25** *(4.250)*					
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality II)		**-9.694** *(4.749)*				
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality III)			**-6.171** *(2.494)*			
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality I)				**14.87*** *(2.981)*		
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality II)					**13.50*** *(3.133)*	
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality III)						**8.139*** *(2.397)*
Observations	606	606	606	606	606	606
R-squared	0.351	0.349	0.350	0.353	0.350	0.352

Note: The dependent variable is the average annual growth rate in real value added per hour worked for the period 1995-2005 for each industry in each country over the period 1995-2005. Initial Relative Labor Productivity is the ratio of industry value added per hour worked to total manufacturing value added per hour worked in 1995. Asset Tangibility is the median fraction of assets represented by net property, plant and equipment for US firms in the same industry for the period 1980-1989. Labor Costs to Sales is the median ratio of labor costs to shipments for US firms in the same industry for the period 1980-1989. Real Short term Interest Rate Counter-Cyclicality I is the coefficient of the output gap when the real short term interest rate is regressed for each country on a constant, the one quarter lagged real short term interest rate and the output gap, the latter being instrumented as indicated in table 7a. Real Short term Interest Rate Counter-Cyclicality II is the coefficient of the output gap when the real short term interest rate gap is regressed for each country on a constant and the output gap, the latter being instrumented as indicated in table 7a. Real Short term Interest Rate Counter-Cyclicality III is the coefficient of the output gap in the specification among (13.1)-(13.4) which minimizes the root mean standard error for each country, the output gap being instrumented as indicated in table 7a. The interaction variable is the product of variables in parentheses. Standard errors -clustered at the industry level- are in parentheses. All estimations include country and industry dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 7a: Instruments for IV estimates of real short term interest rate counter-cyclicality

Instrument	Lag	AUS	AUT	BEL	CAN	DEU	DNK	ESP	FIN	FRA	GBR	ITA	LUX	NLD	PRT	SWE
Output gap	1															I-III
	2	I-III			III			III		I-III	I-III		I-III	I-III	I-III	I-III
	3											I-III				
Term premium	0	I	I-III								I-III					
	1	I			I								I-III		III	
	2															
	3			I-III												I-III
	4		I-III			I-III	I-III							I-III		
Log change in REER	1		III	I			I-III							I-III		
	2		I-III	I-III	I-III	I-III		III	I-III	I-III				I-III	I	I-III
	3		I	I-III	I	I-III		I-III	I-III	I-III		I-III			I-III	
	4	I-III				I-III	I		I-III		I-III		I-III			
Real import prices (log)	3											I-III				
	4							I-III								

Note: This table shows the set of instruments used for each country for IV estimation of the output gap sensitivity of the real short-term interest rate. A variable used as an instrument to estimate Real short term interest rate counter-cyclicality I and Real short term interest rate counter-cyclicality II is denoted by I. A variable used as an instrument in the specifications to estimate Real short term interest rate counter-cyclicality I Real short term interest rate counter-cyclicality II and Real short term interest rate counter-cyclicality III is denoted by I-III. Real Short term Interest Rate Counter-Cyclicality I is the coefficient of the output gap when the real short term interest rate is regressed on a constant, the output gap and the one quarter lagged real short term interest rate for each country, the output gap being instrumented as indicated. Real Short term Interest Rate Counter-Cyclicality II is the coefficient of the output gap when the real short term interest rate gap is regressed on a constant, the output gap, the output gap being instrumented as indicated. Real Short term Interest Rate Counter-Cyclicality III is the coefficient of the output gap in the specification among (13.1)-(13.4) which minimizes the root mean standard error for each country, the output gap being instrumented as indicated. The Output gap variable is the log difference between current and trend real GDP. The Term premium variable is the difference between the nominal long term (10 years) interest rate and the nominal short term (3 month) interest rate. The log change in REER variable is the quarter on quarter percentage change in the real effective exchange rate. The real import price variable is the ratio of nominal import price to nominal consumption price. AUS=Australia, AUT=Austria, BEL=Belgium, CAN=Canada, DEU=Germany, DNK=Denmark, ESP=Spain, FIN=Finland, FRA=France, GBR=United Kingdom, ITA=Italy, LUX=Luxembourg, NLD=Netherlands, PRT=Portugal, SWE=Sweden.

Table 7b: test statistics for IV estimates of real short term interest rate counter-cyclicality

	AUS	AUT	BEL	CAN	DEU	DNK	ESP	FIN	FRA	GBR	ITA	LUX	NLD	PRT	SWE
Real short term interest rate counter-cyclicality I															
Hansen J Statistics	**0.691**	**5.177**	**0.83**	**2.297**	**1.272**	**3.959**	**0.11**	**3.864**	**0.731**	**2.859**	**3.087**	**1.738**	**0.849**	**1.260**	**1.69**
(*p. value*)	*(0.88)*	*(0.16)*	*(0.84)*	*(0.32)*	*(0.74)*	*(0.14)*	*(0.74)*	*(0.15)*	*(0.69)*	*(0.24)*	*(0.21)*	*(0.42)*	*(0.84)*	*(0.53)*	*(0.64)*
Under-identification test	**15.26**	**8.859**	**16.43**	**8.07**	**17.59**	**10.6**	**15.58**	**11.01**	**12.22**	**10.44**	**16.9**	**13.15**	**18.79**	**16.62**	**15.93**
(*p. value*)	*(0.00)*	*(0.06)*	*(0.00)*	*(0.04)*	*(0.00)*	*(0.01)*	*(0.00)*	*(0.01)*	*(0.01)*	*(0.02)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
Real short term interest rate counter-cyclicality II															
	AUS	AUT	BEL	CAN	DEU	DNK	ESP	FIN	FRA	GBR	ITA	LUX	NLD	PRT	SWE
Hansen J Statistics	**5.714**	**3.639**	**1.936**	**2.405**	**1.708**	**6.388**	**1.484**	**6.418**	**1.438**	**3.677**	**4.714**	**0.641**	**5.265**	**0.0165**	**2.762**
(*p. value*)	*(0.13)*	*(0.3)*	*(0.59)*	*(0.3)*	*(0.64)*	*(0.04)*	*(0.22)*	*(0.04)*	*(0.49)*	*(0.16)*	*(0.09)*	*(0.73)*	*(0.15)*	*(0.99)*	*(0.43)*
Under-identification test	**18.49**	**8.489**	**16.55**	**10.84**	**19.21**	**10.47**	**14.39**	**12.66**	**13.45**	**12.94**	**15.41**	**13.21**	**19.63**	**16.57**	**15.42**
(*p. value*)	*(0.00)*	*(0.08)*	*(0.00)*	*(0.01)*	*(0.00)*	*(0.02)*	*(0.00)*	*(0.01)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
Real short term interest rate counter-cyclicality III															
	AUS	AUT	BEL	CAN	DEU	DNK	ESP	FIN	FRA	GBR	ITA	LUX	NLD	PRT	SWE
Hansen J Statistics	**0.691**	**0.021**	**0.184**	**0.403**	**0.729**	**1.019**	**1.483**	**3.769**	**0.731**	**2.859**	**3.087**	**1.738**	**2.716**	**3.246**	**0.841**
(*p. value*)	*(0.88)*	*(0.89)*	*(0.98)*	*(0.53)*	*(0.87)*	*(0.31)*	*(0.69)*	*(0.15)*	*(0.69)*	*(0.24)*	*(0.21)*	*(0.42)*	*(0.61)*	*(0.2)*	*(0.84)*
Under-identification test	**15.26**	**5.137**	**13.98**	**12.14**	**15.1**	**7.405**	**14.84**	**10.98**	**12.22**	**10.44**	**16.9**	**13.15**	**19.73**	**3.016**	**16.08**
(*p. value*)	*(0.00)*	*(0.08)*	*(0.01)*	*(0.00)*	*(0.00)*	*(0.02)*	*(0.01)*	*(0.01)*	*(0.01)*	*(0.02)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.39)*	*(0.00)*

Note: This table provides test statistics and p. values relating to the IV estimation of the output gap sensitivity of the real short-term interest rate. Test statistics and p. values are provided for each country and for each specification of the real short-term interest rate regression. Real Short term Interest Rate Counter-Cyclicality I is the estimation where the real short term interest rate is regressed on a constant, the output gap and the one quarter lagged real short term interest rate for each country. Real Short term Interest Rate Counter-Cyclicality II is the estimation where the real short term interest rate gap is regressed on a constant, the output gap. Real Short term Interest Rate Counter-Cyclicality III is the estimation based on the specification among (13.1)-(13.4) which minimizes the root mean standard error for each country. The first two rows provide the Hansen J Statistics and the p. value. This indicates whether variables used as instruments are valid instruments. The two next rows provide the under-identification test statistics and the p. value. This indicates whether variables used as instruments are only weakly correlated with the instrumented variable. AUS=Australia, AUT=Austria, BEL=Belgium, CAN=Canada, DEU=Germany, DNK=Denmark, ESP=Spain, FIN=Finland, FRA=France, GBR=United Kingdom, ITA=Italy, LUX=Luxembourg, NLD=Netherlands, PRT=Portugal, SWE=Sweden.

Table 8: Bootstrapping standard errors

Dependent variable: Labor Productivity per hour Growth						
	(i)	**(ii)**	**(iii)**	**(iv)**	**(v)**	**(vi)**
Log of Initial Relative Labor Productivity	**-3.568*** *(0.879)*	**-3.579*** *(0.864)*	**-3.602*** *(0.856)*	**-3.585*** *(0.858)*	**-3.584*** *(0.85)*	**-3.575*** *(0.848)*
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality I)	**-12.152**** *(5.512)*					
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality II)		**-17.091*** *(8.077)*				
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality III)			**-9.095***** *(2.782)*			
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality I)				**16.465***** *(4.836)*		
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality II)					**20.308**** *(7.529)*	
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality III)						**9.140***** *(2.852)*
Observations	606	606	606	606	606	606
R-squared	0.280	0.280	0.280	0.282	0.280	0.279

Note: The dependent variable is the average annual growth rate in real value added per hour worked for the period 1995-2005 for each industry in each country, for years where the output gap was above the historical median over the period 1995-2005. Initial Relative Labor Productivity is the ratio of industry value added per hour worked to total manufacturing value added per hour worked in 1995. Asset Tangibility is the median fraction of assets represented by net property, plant and equipment for US firms in the same industry for the period 1980-1989. Labor Costs to Sales is the median ratio of labor costs to shipments for US firms in the same industry for the period 1980-1989. Real Short term Interest Rate Counter-Cyclicality I is drawn from a normal distribution whose mean and standard deviation are those of the output gap coefficient when the real short term interest rate is regressed on a constant, the output gap and the one quarter lagged real short term interest rate for each country. Real Short term Interest Rate Counter-Cyclicality II is drawn from a normal distribution whose mean and standard deviation are those of the output gap coefficient when the real short term interest rate gap is regressed on a constant, the output gap. Real Short term Interest Rate Counter-Cyclicality III is drawn from a normal distribution whose mean and standard deviation are those of the output gap coefficient in the specification among (13.1)-(13.4) which minimizes the root mean standard error for each country. Estimation results are based on the average for parameters, standard errors and statistics, computed over 10000 OLS regressions using draws for the real short term interest rate cyclicality indexes. The interaction variable is the product of variables in parentheses. Standard errors -clustered at the industry level- are in parentheses. All estimations include country and industry dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 9: Running horse races with industry asset tangibility

Dependent variable: Labor Productivity per hour Growth	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)
Log of Initial Relative Labor Productivity	**-3.566*****	**-3.551*****	**-3.526*****	**-3.592*****	**-3.588*****	**-3.576*****	**-3.586*****	**-3.538*****	**-3.411*****	**-3.436*****
	(0.894)	*(0.895)*	*(0.902)*	*(0.881)*	*(0.882)*	*(0.879)*	*(0.893)*	*(0.901)*	*(1.026)*	*(1.011)*
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality)	**-12.63****	**-13.75****	**-12.93****	**-15.86*****	**-12.58****	**-14.69*****	**-14.01****	**-15.02*****	**-14.34*****	**-17.78****
	(6.120)	*(6.636)*	*(5.986)*	*(5.231)*	*(4.945)*	*(5.154)*	*(6.544)*	*(5.090)*	*(5.151)*	*(6.853)*
Interaction (Asset Tangibility and Average CPI inflation)	**6.216**									
	(6.399)									
Interaction (Asset Tangibility and Average Real Short term Interest Rate)		**-1.096**								
		(4.118)								
Interaction (Asset Tangibility and Average Real Long term Interest Rate)			**-4.262**							
			(5.964)							
Interaction (Asset Tangibility and Average REER growth)				**3.070**						
				(3.673)						
Interaction (Asset Tangibility and Average Fiscal Balance to GDP)					**186.0**					
					(130.3)					
Interaction (Asset Tangibility and Average Government Expenditures to GDP)						**-46.31**				
						(50.67)				
Interaction (Asset Tangibility and Average Private Credit to GDP)							**-3.992**			
							(14.73)			
Interaction (Asset Tangibility and Average Financial System Deposits to GDP)								**5.394**		
								(5.547)		
Interaction (Asset Tangibility and Average Private Bond Market Cap to GDP)									**-8.838**	
									(8.073)	
Interaction (Asset Tangibility and Average Employment protection)										**-4.494**
										(3.536)
Observations	606	606	606	606	606	606	606	606	573	573
R-squared	0.355	0.352	0.353	0.354	0.354	0.354	0.352	0.354	0.351	0.352

Note: The dependent variable is the average annual growth rate in real value added per hour worked for the period 1995-2005 for each industry in each country, for years where the output gap was above the historical median over the period 1995-2005. Initial Relative Labor Productivity is the ratio of industry value added per hour worked to total manufacturing value added per hour worked in 1995. Asset Tangibility is the median fraction of assets represented by net property, plant and equipment for US firms in the same industry for the period 1980-1989. Real Short term Interest Rate Counter-Cyclicality is the coefficient of the output gap when the real short term interest rate is regressed on a constant and the output gap for each country, controlling for the one quarter lagged real short term interest rate. The interaction variable is the product of variables in parentheses. Standard errors -clustered at the industry level- are in parentheses. All estimations include country and industry dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 10: Running horse races with industry labour cost to sales

Dependent variable: Labor Productivity per hour Growth	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)
Log of Initial Relative Labor Productivity	**-3.599*****	**-3.580*****	**-3.616*****	**-3.613*****	**-3.592*****	**-3.582*****	**-3.643*****	**-3.585*****	**-3.405*****	**-3.441*****
	(0.866)	*(0.864)*	*(0.870)*	*(0.854)*	*(0.859)*	*(0.857)*	*(0.869)*	*(0.857)*	*(0.989)*	*(0.983)*
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality)	**18.06*****	**18.67*****	**17.33*****	**20.85*****	**17.18*****	**19.34*****	**23.89*****	**19.49*****	**19.02*****	**24.36*****
	(4.603)	*(5.825)*	*(4.650)*	*(4.852)*	*(4.262)*	*(4.077)*	*(5.307)*	*(4.106)*	*(4.050)*	*(5.917)*
Interaction (Labor Costs to Sales and Average CPI inflation)	**-3.712**									
	(6.540)									
Interaction (Labor Costs to Sales and Average Real Short term Interest Rate)		**0.718**								
		(4.221)								
Interaction (Labor Costs to Sales and Average Real Long term Interest Rate)			**5.034**							
			(7.003)							
Interaction (Labor Costs to Sales and Average REER growth)				**-3.801**						
				(4.450)						
Interaction (Labor Costs to Sales and Average Fiscal Balance to GDP)					**-179.1**					
					(129.5)					
Interaction (Labor Costs to Sales and Average Government Expenditures to GDP)						**31.98**				
						(71.17)				
Interaction (Labor Costs to Sales and Average Private Credit to GDP)							**-22.80**			
							(16.01)			
Interaction (Labor Costs to Sales and Average Financial System Deposits to GDP)								**-2.320**		
								(6.803)		
Interaction (Labor Costs to Sales and Average Private Bond Market Cap to GDP)									**12.94**	
									(8.704)	
Interaction (Labor Costs to Sales and Average Employment protection)										**6.813***
										(3.884)
Observations	606	606	606	606	606	606	606	606	573	573
R-squared	0.355	0.354	0.355	0.356	0.356	0.355	0.357	0.354	0.353	0.355

Note: The dependent variable is the average annual growth rate in real value added per hour worked for the period 1995-2005 for each industry in each country, for years where the output gap was above the historical median over the period 1995-2005. Initial Relative Labor Productivity is the ratio of industry value added per hour worked to total manufacturing value added per hour worked in 1995. Labor Costs to Sales is the median ratio of labor costs to shipments for US firms in the same industry for the period 1980-1989. Real Short term Interest Rate Counter-Cyclicality is the coefficient of the output gap when the real short term interest rate is regressed on a constant and the output gap for each country, controlling for the one quarter lagged real short term interest rate. Standard errors -clustered at the industry level- are in parentheses. All estimations include country and industry dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 11: Testing for asymmetric effects, the case of expansions

Dependent variable: Average Labor Productivity per hour Growth (above median output gap)						
	(i)	**(ii)**	**(iii)**	**(iv)**	**(v)**	**(vi)**
Log of Initial Relative Labor Productivity	**-3.772***** *(1.268)*	**-3.786***** *(1.278)*	**-3.771***** *(1.262)*	**-3.778***** *(1.244)*	**-3.778***** *(1.241)*	**-3.782***** *(1.244)*
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality I)	**-7.509** *(9.357)*					
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality II)		**-20.45** *(12.29)*				
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality III)			**-4.430** *(4.851)*			
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality I)				**10.95** *(11.78)*		
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality II)					**15.48** *(13.92)*	
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality III)						**3.975** *(5.824)*
Observations	606	606	606	606	606	606
R-squared	0.256	0.259	0.256	0.257	0.257	0.255

Note: The dependent variable is the average annual growth rate in real value added per hour worked for the period 1995-2005 for each industry in each country, for years where the output gap was above the historical median over the period 1995-2005. Initial Relative Labor Productivity is the ratio of industry value added per hour worked to total manufacturing value added per hour worked in 1995. Asset Tangibility is the median fraction of assets represented by net property, plant and equipment for US firms in the same industry for the period 1980-1989. Labor Costs to Sales is the median ratio of labor costs to shipments for US firms in the same industry for the period 1980-1989. Real Short term Interest Rate Counter-Cyclicality I is the coefficient of the output gap when the real short term interest rate is regressed on a constant, the output gap and the one quarter lagged real short term interest rate for each country. Real Short term Interest Rate Counter-Cyclicality II is the coefficient of the output gap when the real short term interest rate gap is regressed on a constant, the output gap. Real Short term Interest Rate Counter-Cyclicality III is the coefficient of the output gap in the specification among (13.1)-(13.4) which minimizes the root mean standard error for each country. The interaction variable is the product of variables in parentheses. Standard errors - clustered at the industry level- are in parentheses. All estimations include country and industry dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 12: Testing for asymmetric effects, the case of recessions

Dependent variable: Average Labor Productivity per hour Growth (below median output gap)						
	(i)	**(ii)**	**(iii)**	**(iv)**	**(v)**	**(vi)**
Log of Initial Relative Labor Productivity	**-3.457***** *(1.121)*	**-3.471***** *(1.109)*	**-3.454***** *(1.110)*	**-3.469***** *(1.131)*	**-3.469***** *(1.122)*	**-3.203***** *(1.120)*
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality I)	**-20.13**** *(8.289)*					
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality II)		**-24.40**** *(10.99)*				
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality III)			**-14.01**** *(5.940)*			
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality I)				**24.32**** *(10.64)*		
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality II)					**33.57**** *(12.85)*	
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality III)						**18.34**** *(7.112)*
Observations	606	606	606	606	606	606
R-squared	0.301	0.298	0.300	0.301	0.300	0.303

Note: The dependent variable is the average annual growth rate in real value added per hour worked for the period 1995-2005 for each industry in each country, for years where the output gap was below the historical median over the period 1995-2005. Initial Relative Labor Productivity is the ratio of industry value added per hour worked to total manufacturing value added per hour worked in 1995. Labor Costs to Sales is the median ratio of labor costs to shipments for US firms in the same industry for the period 1980-1989. Asset Tangibility is the median fraction of assets represented by net property, plant and equipment for US firms in the same industry for the period 1980-1989. Real Short term Interest Rate Counter-Cyclicality I is the coefficient of the output gap when the real short term interest rate is regressed on a constant, the output gap and the one quarter lagged real short term interest rate for each country. Real Short term Interest Rate Counter-Cyclicality II is the coefficient of the output gap when the real short term interest rate gap is regressed on a constant, the output gap. Real Short term Interest Rate Counter-Cyclicality III is the coefficient of the output gap in the specification among (13.1)-(13.4) which minimizes the root mean standard error for each country. The interaction variable is the product of variables in parentheses. Standard errors -clustered at the industry level- are in parentheses. All estimations include country and industry dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 13: Focusing on the post ECB period

Dependent variable: Labor Productivity per hour Growth						
	(i)	**(ii)**	**(iii)**	**(iv)**	**(v)**	**(vi)**
Log of Initial Relative Labor Productivity	**-2.209*** *(1.272)*	**-2.210*** *(1.241)*	**-2.287*** *(1.264)*	**-2.309*** *(1.221)*	**-2.267*** *(1.213)*	**-2.323*** *(1.222)*
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality I)	**-19.13**** *(9.067)*					
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality II)		**-23.19*** *(13.36)*				
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality III)			**-15.75**** *(5.895)*			
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality I)				**24.15***** *(7.772)*		
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality II)					**30.48**** *(12.72)*	
Interaction (Labor Costs to Sales and Real Short term Interest Rate Counter-Cyclicality III)						**16.37***** *(6.072)*
Observations	594	594	594	594	594	594
R-squared	0.250	0.248	0.252	0.252	0.249	0.250

Note: The dependent variable is the average annual growth rate in real value added per hour worked for the period 1999-2005 for each industry in each country. Initial Relative Labor Productivity is the ratio of industry value added per hour worked to total manufacturing value added per hour worked in 1999. Asset Tangibility is the median fraction of assets represented by net property, plant and equipment for US firms in the same industry for the period 1980-1989. Labor Costs to Sales is the median ratio of labor costs to shipments for US firms in the same industry for the period 1980-1989. Real Short term Interest Rate Counter-Cyclicality I is the coefficient of the output gap when the real short term interest rate is regressed on a constant, the output gap and the one quarter lagged real short term interest rate for each country. Real Short term Interest Rate Counter-Cyclicality II is the coefficient of the output gap when the real short term interest rate gap is regressed on a constant, the output gap. Real Short term Interest Rate Counter-Cyclicality III is the coefficient of the output gap in the specification among (13.1)-(13.4) which minimizes the root mean standard error for each country. The interaction variable is the product of variables in parentheses. Standard errors -clustered at the industry level- are in parentheses. All estimations include country and industry dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *).

Table 14: Any country driving the results?

Dependent variable: Labor Productivity per hour Growth															
Country withdrawn:	AUS	AUT	BEL	CAN	DEU	DNK	ESP	FIN	FRA	GBR	ITA	LUX	NLD	PRT	SWE
Log of Initial Relative Labor Productivity	**-3.380*** **	**-3.134*** **	**-3.431*** **	**-3.637*** **	**-3.439*** **	**-3.554*** **	**-3.669*** **	**-3.504*** **	**-3.347*** **	**-3.541*** **	**-3.421*** **	**-3.392*** **	**-4.795*** **	**-3.894*** **	**-3.681*** **
	(0.918)	*(0.675)*	*(0.790)*	*(0.905)*	*(0.936)*	*(0.861)*	*(0.960)*	*(0.842)*	*(0.820)*	*(1.057)*	*(0.888)*	*(1.017)*	*(0.904)*	*(0.977)*	*(0.969)*
Interaction (Asset Tangibility and Real Short term Interest Rate Counter-Cyclicality)	**-14.74*** **	**-14.67*** **	**-14.76*** **	**-14.95*** **	**-12.25** **	**-14.78*** **	**-13.90*** **	**-13.61** **	**-15.01*** **	**-18.54** **	**-15.53*** **	**-14.60*** **	**-15.89*** **	**-15.78*** **	**-14.19** **
	(5.410)	*(5.025)*	*(5.246)*	*(5.068)*	*(5.238)*	*(5.109)*	*(5.120)*	*(5.504)*	*(5.126)*	*(8.651)*	*(4.893)*	*(5.175)*	*(4.986)*	*(5.652)*	*(6.214)*
Observations	564	561	561	594	561	565	561	562	562	561	566	573	564	562	567
R-squared	0.359	0.355	0.355	0.352	0.338	0.346	0.351	0.356	0.366	0.349	0.341	0.350	0.395	0.356	0.377

Note: Each column provides the estimation results for the main specification, withdrawing from the estimation sample one country at a time. The country withdrawn from the sample is indicated on the second row, using its three letters initials. The dependent variable is the average annual growth rate in real value added per hour worked for the period 1995-2005 for each industry in each country. Initial Relative Labor Productivity is the ratio of industry value added per hour worked to total manufacturing value added per hour worked in 1995. Asset Tangibility is the median fraction of assets represented by net property, plant and equipment for US firms in the same industry for the period 1980-1989. Real Short term Interest Rate Counter-Cyclicality is the coefficient of the output gap when the real short term interest rate is regressed on a constant, the output gap and the one quarter lagged real short term interest rate for each country. The interaction variable is the product of variables in parentheses. Standard errors -clustered at the industry level- are in parentheses. All estimations include country and industry dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *). AUS=Australia, AUT=Austria, BEL=Belgium, CAN=Canada, DEU=Germany, DNK=Denmark, ESP=Spain, FIN=Finland, FRA=France, GBR=United Kingdom, ITA=Italy, LUX=Luxembourg, NLD=Netherlands, PRT=Portugal, SWE=Sweden.

Dependent variable: Labor Productivity per hour Growth															
Country withdrawn:	AUS	AUT	BEL	CAN	DEU	DNK	ESP	FIN	FRA	GBR	ITA	LUX	NLD	PRT	SWE
Log of Initial Relative Labor Productivity	**-3.576*** **	**-3.414*** **	**-3.145*** **	**-3.444*** **	**-3.644*** **	**-3.431*** **	**-3.563*** **	**-3.682*** **	**-3.542*** **	**-3.358*** **	**-3.664*** **	**-3.422*** **	**-3.401*** **	**-4.695*** **	**-3.898*** **
	(0.859)	*(0.899)*	*(0.651)*	*(0.762)*	*(0.876)*	*(0.914)*	*(0.836)*	*(0.935)*	*(0.810)*	*(0.787)*	*(1.053)*	*(0.852)*	*(0.988)*	*(0.932)*	*(0.934)*
Interaction (Labor cost to sales and Real Short term Interest Rate Counter-Cyclicality)	**19.35*** **	**19.53*** **	**18.98*** **	**19.78*** **	**19.34*** **	**15.90*** **	**19.36*** **	**18.30*** **	**16.14** **	**19.50*** **	**32.38*** **	**19.02*** **	**19.34*** **	**16.79*** **	**20.77*** **
	(4.056)	*(4.266)*	*(4.017)*	*(4.167)*	*(4.056)*	*(4.067)*	*(4.057)*	*(3.870)*	*(6.115)*	*(4.075)*	*(7.777)*	*(4.224)*	*(4.082)*	*(4.541)*	*(4.828)*
Observations	606	564	561	561	594	561	565	561	562	562	561	566	573	564	562
R-squared	0.354	0.362	0.357	0.357	0.354	0.339	0.348	0.352	0.357	0.368	0.357	0.342	0.352	0.393	0.358

Note: Each column provides the estimation results for the main specification, withdrawing from the estimation sample one country at a time. The country withdrawn from the sample is indicated on the second row, using its three letters initials. The dependent variable is the average annual growth rate in real value added per hour worked for the period 1995-2005 for each industry in each country. Initial Relative Labor Productivity is the ratio of industry value added per hour worked to total manufacturing value added per hour worked in 1995. Labor Costs to Sales is the median ratio of labor costs to shipments for US firms in the same industry for the period 1980-1989. Real Short term Interest Rate Counter-Cyclicality is the coefficient of the output gap when the real short term interest rate is regressed on a constant, the output gap and the one quarter lagged real short term interest rate for each country. The interaction variable is the product of variables in parentheses. Standard errors -clustered at the industry level- are in parentheses. All estimations include country and industry dummies. Significance at the 1% (resp. 5%; 10%) level is indicated by *** (resp. **; *). AUS=Australia, AUT=Austria, BEL=Belgium, CAN=Canada, DEU=Germany, DNK=Denmark, ESP=Spain, FIN=Finland, FRA=France, GBR=United Kingdom, ITA=Italy, LUX=Luxembourg, NLD=Netherlands, PRT=Portugal, SWE=Sweden.