Monetary Policy, Financial Regulations and Industry Growth*

Philippe Aghion† and Enisse Kharroubi‡

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Abstract

This paper investigates the interplay between cyclical monetary policy and financial regulations on industry growth. We lay down a model where firms are endowed with long-term -productivity enhancing- projects whose returns are not fully pledgeable and subject to aggregate productivity shocks. In this model, lower pledgeability firms grow disproportionately faster when real short term interest rates are more countercyclical or when credit provision is more countercyclical. Moreover, the growth effect of countercyclical interest rates is reduced when the financial sector is more constrained in its ability to provide credit. The paper then tests these predictions using cross-country, cross-industry OECD data over the period 1999-2005.

Keywords: Productivity growth, interest rates, credit, countercyclicality, financial regulation.

JEL Classification: E32, E44, G21

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†Harvard University and NBER

‡Bank for International Settlements

1 Introduction

In this paper, we analyze how growth is affected by the interplay between monetary policy and financial regulations. In particular, we investigate whether bank capital adequacy rules –insofar as they affect banks' lending supply - can dampen or amplify the effects of cyclical interest rate policy on growth. Conversely, can the introduction of countercyclical capital buffers for banks –insofar as this leads to a less procyclical or more countercyclical credit supply- provide another source of macroeconomic stabilization besides interest rate policy to foster long run growth? We start answering these questions building a growth model where entrepreneurs can raise capital from financiers to invest in long-term -productivity enhancing- projects. They are however subject to productivity shocks which may either alleviate financial frictions -when the shock is positive- or tighten financial frictions -when the shock is negative-. Financiers then respond to negative shocks on future productivity by asking entrepreneurs to downsize their long-term projects. Moreover, downsizing is larger for projects whose returns are less pledgeable. Cutting the short-term interest rate following the realization of a negative shock then reduces the need for entrepreneurs to downsize, and the more so for projects whose returns are less pledgeable. Counter-cyclical real short-term interest rates, i.e. interest rates which correlate positively with productivity shocks, therefore raise productivity growth and the more so for projects whose returns are less pledgeable. Second, we investigate how the supply of credit affects the effect of cyclical interest rates, focusing on credit scarcity and credit cyclicality. We identify credit scarcity with the tightness in bank capital to asset ratio and credit cyclicality with the extent of cyclical capital buffers. In the first case, we show that credit scarcity affects the differential effect of countercyclical interest rates on growth. When credit is low, neither high pledgeable nor low pledgeable firms need to downsize their long-term project following a negative productivity shock. In this case, counter-cyclical interest rates have no effect on growth. However, when credit is high, low pledgeable firms need to downsize their long-term project following a negative productivity shock. In this case, cutting the short term rate raises growth for low pledgeable firms, but has no effect on high pledgeable firms. The differential growth effect of countercyclical interest rates is therefore larger when credit is more abundant, i.e. when the capital to asset ratio for banks is relatively lower. Last, we study the effect of credit cyclicality. As is the case for interest rates, procyclical credit is found to hurt disproportionately more low pledgeability firms. When entrepreneurs can raise a large amount of credit for initial investment, they are more likely to face downsizing if a negative shock hits one period later. As a result, lower pledgeability firms downsize more, thereby growing more slowly when credit is more procyclical.

With these three predictions at hand, we turn to the data. The empirical analysis builds on the methodology developed in the seminal paper by Rajan and Zingales (1998), making use of cross-industry, cross-country panel data regressions. Namely, we test whether industry growth is positively affected by the interaction between on the one hand industry-level measures of financial constraints (computed for each corresponding industry in the United States) and on the other hand interest rate cyclicality or financial sector regulations (computed at the country level). We favor this approach because it provides a clear and net way to deal with causality issues. By looking at the effect of macroeconomic policies/regulations observed at the country level on growth at the industry level and acknowledging that individual industries are small compared to the total economy, we can confidently rule out reverse causality. To the extent that macroeconomic policy/regulations can affect industry growth, the opposite (industry growth affecting macroeconomic policy/regulations) is much less likely to hold. Using this methodology, we provide a contribution to two different debates. A first debate is whether monetary policy should or should not adapt to the business cycle, and more specifically whether interest rate setting along the cycle may affect long run growth.

The conservative view argues that monetary policy should focus exclusively on inflation because pursuing other goals –e.g. financial stability- is a straightforward recipe to jeopardize price stability. An alternative view is that inflation is not anymore a sufficient statistic to evaluate critical developments in the economy, like overheating or credit booms, so that monetary policy decisions should also reflect the economy's position in the business and financial cycles. We provide empirical evidence showing that countercyclical interest rates, inducing lower real short-term interest rates in recessions but higher real short-term interest rates in expansions, are more growth-enhancing for sectors that face either tighter credit constraints or tighter liquidity constraints. This part of the analysis therefore vindicates the view that lowering nominal interest rates and also by engaging in further easing when cutting interest rates reaches a limit may yield significant benefits.[1] Second, there is a debate on optimal financial regulation. Recent influential work by Admati et al. (2013) advocates higher minimum capital ratios for financial institutions.[2] Moreover, the idea to introduce countercyclical capital buffers also lies at the top of the banking reform agenda (see Drehmann et al. 2010). We investigate these two aspects, looking at cross-country differences in bank capital to asset ratios and credit to non financial firms countercyclicality, assuming such differences can help understand the would-be effects of changes in regulation. First, while acknowledging that a higher capital ratio for banks would help mitigate systemic risks stemming from the financial system, we show that it can adversely affect the growth-enhancing effects of countercyclical interest rates.[3] A tighter regulation, insofar as it leads banks to choose to hold more capital, is therefore likely to

[1] This draws on Aghion, Farhi and Kharroubi (2012). This analysis also shows that the benefits of monetary policy stabilisation come equally from bad and good states. This means that raising interest rates in good times is as important as cutting them in bad times. See Aghion, Farhi and Kharroubi (2012) for more details.

[2] See also Macroeconomic Assessment Group (2010, 2011) for extensive studies of the impact of higher capital requirements on growth.

[3] Cecchetti and Li (2008) confirm that optimal monetary policy implies cutting interest rates more aggressively during a downturn to counteract the pro-cyclical effect of prudential capital regulation.

reduce the growth benefits of countercyclical interest rates.[4] Second, we show that countercyclical credit provision enhances growth more in sectors with tighter liquidity constraints, this coming on top of the growth-enhancing effect of countercyclical interest rates. Introducing countercyclical capital buffers, insofar as this leads bank credit to be more countercyclical (less procyclical) can therefore help undo the detrimental effects of higher bank capital ratio on growth.[5] Overall, our analysis suggests that there is a trade-off between on the one hand mitigating the risks and consequences of financial crises and financial instability with higher bank capital, and on the other hand ensuring that countercyclical monetary policy is effective in enhancing growth in more liquidity constrained sectors. Yet, escaping this trade-off is still possible by adopting (i) more countercyclical interest rates and (ii) more countercyclical capital buffers.[6]

The paper is organized as follows. The next section describes the main elements of the analytical framework. Section 3 details how interest rate cyclicality and credit supply regulations affect growth in our analytical model. Then section 4 turns to the empirical analysis and describes the empirical methodology and the data used. Section 5 presents the main empirical findings. Finally conclusions are drawn in section 6. The appendix provides more details on the data and the estimation results.

[4]See Cecchetti and Kohler (2012) for an analytical model on the substitutability and potential coordination issues between policy makers choosing capital adequacy ratios and those setting interest rates.

[5]We use the cyclicality of credit provision to understand the would-be effects of introducing counter-cyclical capital buffers. In practise the cyclicality of credit provision depends essentially on: the cyclicality of monetary policy and the cyclicality of bank capital ratio. Cross-country differences in credit provision cyclicality can therefore be interpreted as difference in capital ratio cyclicality once monetary policy counter-cyclicality has been controlled for. Note however that there may be other reasons to cross-country differences in credit cyclicality like the extent to which financial intermediaries' balance sheets are marked-to-market (see Adrian and Shin 2010).

[6]Another important policy implication is that countries where monetary policy is mildly countercyclical or acyclical would not undergo larges losses to raising bank capital requirements. A genuine trade-off only exists for countries where monetary policy is significantly counter-cyclical.

2 The analytical framework

2.1 Timing and Technologies

We consider a single good economy with a unit mass of entrepreneurs and financiers which lasts for three periods: 0; 1 and 2. Agents derive utility from consumption at date 2. Entrepreneurs are risk neutral and derive utility from their *expected* date-2 consumption. Financiers also value date-2 consumption, but they are risk averse. A financier's utility in state s writes as $u_\alpha(\{c_s\}_s) = c_s - \alpha |c_s - E_s c_s|$ where c_s denotes the date-2 consumption in state s and α is a positive parameter which scales financiers' risk aversion. Timing is as follows. At date 0, entrepreneurs invest in a long-term project and can borrow from financiers. At date 1, a state of nature $s \in \{h, l\}$ realizes, the date-0 probability of state l being q. Entrepreneurs may then need to downsize their long term project (see below). At date 2, entrepreneurs reap the output of their long-term projects, pay back financiers and all agents consume.

2.1.1 Financiers

Financiers have access to a short term storage technology which returns r_0 at date 1 for each unit stored at date 0 and r_s at date 2 for each unit stored at date 1 when state s takes place at date 1. The central bank controls the interest rates r_0 and r_s and sets them in advance, agents therefore take their decisions knowing current and future interest rates.

2.1.2 Entrepreneurs

Entrepreneurs have access to a long term technology: investing one at date 0 produces y_s at date 2 when state s happens at date 1 ($y_h > y_l$). If need be, a long term project can still be liquidated -partly or totally- at date 1. To obtain one unit of capital at date 1, an entrepreneur needs to liquidate λ units of date-0 investment. Output from long term projects cannot be fully pledged to financiers and ρ_s denotes the pledgeable return in state s.[7] Entrepreneurs are hetegeneous in the pledgeable return ρ_s: some have a low pledgeable return $\underline{\rho_s}$ and others have a high pledgeable return $\overline{\rho_s}$, with $\overline{\rho_s} > \underline{\rho_s}$. Finally entrepreneurs' long term projects are assumed to be illiquid, have positive NPV but are financially constrained, i.e.

$$\lambda r_0 > 1 \text{ and } y_s > r_0 r_s \text{ and } \lambda \rho_s < r_s \tag{1}$$

2.2 Financial constraints

2.2.1 Entrepreneurs' profits and pledgeability constraint

Let us consider an entrepreneur investing I at date 0 and agreeing to a repayment L_s at date 1 and D_s at date 2 when state s happens at date 1. As the entrepreneur agrees to a repayment L_s at date 1 when state s happens, she needs to liquidate λL_s units of date-0 investment and the project's size drops from I at date 0 to $I - \lambda L_s$ at date 1. At date 2, the long-term project therefore pays $(I - \lambda L_s)\, y_s$ but only $(I - \lambda L_s)\, \rho_s$ can be pledged to financiers. Moreover the entrepreneur has to meet date-2 repayment obligations D_s. The entrepreneur's final profit is then simply the difference between final output $(I - \lambda L_s)\, y_s$ and date-2 repayment obligations D_s:

$$\pi_s = (I - \lambda L_s)\, y_s - D_s \tag{2}$$

[7] A variety of models can be used to provide micro-foundations to the wedge between the total return and the pledgeable return $y_s - \rho_s$. For instance, assuming the standard ex ante moral hazard problem, the pledgeable return writes as $\rho_s = y_s - \frac{b}{1-p}$, where b is the private benefit to shirking and $1-p$ is the probability of failure under shirking.

Turning to the entrepreneur's pledgeability constraint, financiers make sure that final pledgeable output $(I - \lambda L_s)\,\rho_s$ covers date-2 repayment obligations D_s:

$$(I - \lambda L_s)\,\rho_s \geq D_s \tag{3}$$

2.2.2 Financiers' break-even constraint

Financiers face an individual rationality condition on lending to entrepreneurs. Assuming an entrepreneur starts at date 0 with w and given that the opportunity cost of capital between 0 and 2 in state s is $r_0 r_s$, financiers break-even condition writes as

$$E_s u_\alpha \left(\{L_s r_s + D_s\}_s \right) \geq E_s u_\alpha \left((I - w)\, r_0 r_s \right) \tag{4}$$

Financiers lend to the entrepreneur at date 0 an amount $(I - w)$. Since the return between date 0 and date 2 is $r_0 r_s$ in state s, financiers require a flow of repayment which generates a welfare at least equal to $E_s u_\alpha (I - w)\, r_0 r_s$. Given the sequence of repayments (L_s, D_s), financiers reap at date 2 an amount $L_s r_s + D_s$ when state s happens at date 1. An investor's utility from the flow of repayments is therefore $E_s u_\alpha \left(\{L_s r_s + D_s\}_s \right)$ and this needs to be at least as large as what financiers would get otherwise, which is $E_s u_\alpha (I - w)\, r_0 r_s$.

2.2.3 Financiers' lending constraint

Financiers faces a lending constraint which limits their ability to lend to entrepreneurs at date 0. We denote $(i - 1)\, w$ financiers' maximum lending capacity to an entrepreneur endowed with w as initial wealth $(i > 1)$. A drop in the parameter i therefore represents a tightening in the lending constraint since financiers with a given capital can lend less to entrepreneurs which means that financiers' capital as a ratio of total lending assets is higher. Conversely, an increase in the parameter i represents a weaker lending constraint since financiers with a given capital can lend more to entrepreneurs, financiers' capital as a ratio of total lending assets being then lower. As a result of this lending constraint for financiers, an entrepreneur with initial wealth w cannot invest more than iw:

$$I \leq iw \tag{5}$$

Last, denoting $E_\alpha r_s = E_s u_\alpha \left(\{r_s\}_s\right)$, we assume that the parameter i satisfies

$$\frac{r_0 E_\alpha r_s}{r_0 E_\alpha r_s - \rho_h} > i \tag{6}$$

Condition (6) ensures that constraining financier's capacity to lend to entrepreneurs to $(i-1)\,w$ is meaningful for entrepreneurs, i.e. that the constraint (5) will be binding at the equilibrium. In what follows the parameter i will serve two purposes. Besides scaling the extent to which financiers face a tight lending constraint, it will scale credit cyclicality as we will allow financiers' maximum lending capacity to depend on the state of nature s which hits the economy.

2.3 The equilibrium

The problem for an entrepreneur consists in choosing date-0 investment I and a repayment sequence $\{L_s; D_s\}_s$ which maximize expected profits derived from (2) subject to the date-0 constraint on financiers' loan supply (5), the date-1 pledgeability constraint for entrepreneurs (3) and the date-0 individual rationality constraint (4) for financiers:

$$\max_{I;\{L_s;D_s\}_s} \pi = E_s\left(I-\lambda L_s\right)y_s - E_sD_s$$
$$\text{s.t.}\begin{cases} I \leq iw \\ \rho_s I \geq D_s + \lambda \rho_s L_s \\ E_s u_\alpha\left(\{L_s r_s + D_s\}_s\right) \geq E_s u_\alpha\left(\left(I-w\right)r_0 r_s\right) \end{cases} \quad (7)$$

To solve this problem ,we can first note that financiers' break-even condition necessarily holds with equality at the equilibrium. Denoting $P_s = L_s r_s + D_s$ and $E_s u_\alpha\left(\{P_s\}_s\right) = E_\alpha P_s$, the problem hence writes as

$$\max_{I;\{L_s;P_s\}_s} \pi = E_s y_s I - E_s\left(\lambda y_s - r_s\right)L_s - E_s P_s$$
$$\text{s.t.}\begin{cases} I \leq iw \\ P_s \leq \left(r_s - \lambda\rho_s\right)L_s + \rho_s I \\ E_\alpha P_s = \left(I-w\right)r_0 E_\alpha r_s \end{cases}$$

It is then optimal for entrepreneurs to equate total repayments across states of nature: $P_l = P_h = \left(I-w\right)r_0 E_\alpha r_s$. The intuition for this is pretty simple: Providing full insurance to financiers helps entrepreneurs reduce their average total repayment -which is what they care about-. Note that the gain for entrepreneurs to insuring financiers against fluctuations in final consumption increases with financiers' risk aversion and/or with the uncertainty in interest rates r_s. The problem hence boils down to

$$\max_{I;\{L_s\}_s} \pi = \left(E_s y_s - r_0 E_\alpha r_s\right)I - E_s\left(\lambda y_s - r_s\right)L_s$$
$$\text{s.t.}\begin{cases} I \leq iw \\ \left(r_s - \lambda\rho_s\right)L_s \geq \left(I-w\right)r_0 E_\alpha r_s - \rho_s I \end{cases} \quad (8)$$

We can now determine optimal early repayments $\{L_s\}_s$. Given conditions (1) which state that the long-term project is illiquid, has positive NPV but is financially constrained, entrepreneurs want to minimize early repayments L_s and given condition (6) which states that the constraint on financiers' ability to lend is binding, i.e. $(i-1)\, r_0 E_\alpha r_s < \rho_h i$, entrepreneurs do not have to delever in state h since downsizing would then be negative! We therefore have $L_h = 0$. Let us now restrict to the case where the central bank can only partly offset the productivity shock which affects the return to long-term projects, i.e. interest rates $\{r_h; r_l\}$ satisfy

$$\underline{\rho_l} i < (i-1)\, r_0 E_\alpha r_s < \overline{\rho_l} i \tag{9}$$

This inequality implies that the central bank can cut the interest rate r_l in state l low enough to avoid downsizing for high tangibility entrepreneurs but not for low tangibility entrepreneurs. Then under (9), entrepreneurs choose date-1 repayments which satisfy

$$L_h^* = 0 \text{ and } L_l^*(\rho_l) = \frac{[(I-w)\, r_0 E_\alpha r_s - \rho_l I]^+}{r_l - \lambda \rho_l} \tag{10}$$

Turning to investment, expected profits π increase with investment I when $L_l^*(\rho_l) = 0$ given that $E_s y_s > r_0 E_\alpha r_s$. Moreover when $L_l^*(\rho_l) > 0$, entrepreneurs' expected profits still increase with investment I when $\frac{E_s y_s - r_0 E_\alpha r_s}{r_0 E_\alpha r_s - \rho_l} > q \frac{\lambda y_l - r_l}{r_l - \lambda \rho_l}$. Assuming this holds -$E_s y_s$ is sufficiently large-, optimal investment is always $I^* = iw$. We can then write net investment n in state s as the difference between date-0 investment and date-1 downsizing. For an entrepreneur with tangibility ρ_l in state l, this writes as

$$\frac{n(s, \rho_l)}{w} = i - \mathbf{1}[s = l]\, \lambda \frac{[(i-1)\, r_0 E_\alpha r_s - \rho_l i]^+}{r_l - \lambda \rho_l}$$

3 The dynamic model

We now embed the previous model in an OLG framework where entrepreneurs and financiers live for two periods and every period brings a new generation of entrepreneurs and financiers. Net investment for entrepreneurs born at date t then determines the initial wealth w_{t+1} for entrepreneurs born at date $t+1$. When state s_{t+1} happens at date $t+1$, we have

$$w_{t+1} = n\left(s_{t+1}, \rho_l\right) \tag{11}$$

Then based on (11), we can write the expected growth rate between date t and date $t+1$ as

$$g\left(\rho_l\right) = \frac{w_{t+1}}{w_t} = i - q\lambda \frac{E_s\left[\left(i-1\right) r_s E_\alpha r_s - \rho_l i\right]^+}{r_l - \lambda \rho_l} \tag{12}$$

3.1 Growth and cyclical interest rates

We want to tackle the question of how the cyclicality of interest rates $(r_l; r_h)$ affects entrepreneurs' growth. And in particular, we want to understand whether these effects are larger for entrepreneurs with a high or a low tangible return. To do so, let us denote $r_h = E_s r_s + \frac{\sigma}{1-q}$ and $r_l = E_s r_s - \frac{\sigma}{q}$. A countercyclical (procyclical) interest rate policy is exemplified as an increase (a decrease) in the parameter σ, keeping the average interest rate $E_s r_s$ unchanged. It is then straightforward to see that high tangibility entrepreneurs do not benefit from countercyclical interest rates, i.e. $\frac{\partial g(\overline{\rho_l})}{\partial \sigma} = 0$ since $g\left(\overline{\rho_l}\right) = i$. On the contrary, using (12) and assuming $\sigma \geq 0$, low tangibility entrepreneurs grow at a rate

$$g\left(\underline{\rho_l}; \sigma\right) = i - q\lambda \left(i-1\right) E_s r_s \frac{E_s r_s - \frac{\rho_l}{E_s r_s} \frac{i}{i-1} - 2\alpha\sigma}{E_s r_s - \lambda \underline{\rho_l} - \frac{\sigma}{q}} \tag{13}$$

and they grow faster with more countercyclical interest rates, i.e. $\frac{\partial g(\underline{\rho_l};\sigma)}{\partial\sigma} > 0$, if and only if

$$\left(E_s r_s - \lambda\underline{\rho_l}\right) 2\alpha q > E_s r_s - \frac{\underline{\rho_l}}{E_s r_s}\frac{i}{i-1} \tag{14}$$

When (14) holds, lower tangibility entrepreneurs benefit more from countercyclical interest rates since

$$\left.\frac{\partial g}{\partial\sigma}\right|_{\rho_l=\overline{\rho_l}} = 0 \qquad \text{and} \qquad \left.\frac{\partial g}{\partial\sigma}\right|_{\rho_l=\underline{\rho_l}} > 0 \tag{15}$$

A countercyclical interest rate policy affects growth only insofar as the entrepreneur needs to downsize the long-term project. As a result, such policy has no effect on high tangibility entrepreneurs who never downsize their long-term project. But low tangibility entrepreneurs have to downsize their long term project when state l takes place. Cutting the interest rate r_l then has two opposite effects on how much low tangibility entrepreneurs need to downsize. These two effects can be traced back to financiers' individual rationality condition. There is a first effect related to the LHS of the IR condition: when the central bank cuts the interest rate, financiers get a lower return on liquidations so they ask for larger liquidations to ensure they do not lose money. Following this first effect, countercyclical interest rates tend to increase liquidations and thereby reduce growth. Yet, there is second effect related to the RHS of the IR condition: when the central bank cuts the interest rate, this relaxes the participation constraint because financiers' who are risk averse derive a lower welfare outside the relationship with the entrepreneur. Hence this allows for a reduction in entrepreneurs' repayments and in particular in the early repayments. How large this effect is, depends on financiers risk aversion: the more risk averse they are, the larger the relaxation effect of countercyclical interest rates on financiers' participation constraint and the more likely counter-cyclical interest rates are growth-enhancing. When financiers have maximin preferences, i.e. $2\alpha q = 1$, counter-cyclical interest rates are always beneficial to entrepreneurs' growth because (14) always holds. A countercyclical interest rate policy then raises net investment for entrepreneurs with low tangibility, but does not affect net investment for entrepreneurs with high tangibility.[8]

3.2 Financiers' lending capacity and the growth effect of cyclical interest rates

Consider now the case where the constraint limiting financiers' ability to lend can take two values $i \in \{i_h; i_l\}$ with $i_h > i_l$. Moreover assume entrepreneurs do not have delever when $i = i_l$:

$$(i_l - 1)\, r_h r_s < \rho_s i_l \tag{16}$$

Then when financiers' lending constraint is tight, entrepreneurs' investment i is low and given (16) all entrepreneurs can abstract from downsizing their long-term projects. Net investment therefore does not respond to changes in interest rates and this holds irrespective of entrepreneurs' pledgeable return:

$$i = i_l \colon \ \left.\frac{\partial g}{\partial \sigma}\right|_{\rho_l = \overline{\rho_l}} = \left.\frac{\partial g}{\partial \sigma}\right|_{\rho_l = \underline{\rho_l}} = 0 \tag{17}$$

However, when financiers' lending constraint is relaxed, i.e. $i = i_h$, entrepreneurs' initial investment is larger and then pledgeability makes a difference: Entrepreneurs with low tangibility have to delever in state l and countercyclical interest rates under condition (14) reduce downsizing and thereby raise growth as explained above. But countercyclical interest rate do not affect net

[8] To be comprehensive, it is necessary to point out that the growth effect of countercyclical interest rates is non-monotonic w.r.t. tangibility: It is actually zero when tangibility is high and strictly positive when tangibility is low. However, conditional on being strictly positive, the growth effect of countercyclical interest rates increases with tangibility as can be checked for in (13). Which of the comparative statics applies in practise is what we will find out in the data in the next section.

investment for high tangibility entrepreneurs as they do not need to downsize:

$$i = i_h\colon \ \left.\frac{\partial g}{\partial \sigma}\right|_{\rho_l=\overline{\rho_l}} = 0 \qquad \text{and} \qquad \left.\frac{\partial g}{\partial \sigma}\right|_{\rho_l=\underline{\rho_l}} > 0 \tag{18}$$

The differential effect of countercyclical interest rates on growth between entrepreneurs with high tangibility and entrepreneurs with low tangibility is therefore amplified when financier's lending capacity i is higher. Put differently, the constraint on the supply of credit tends to mute the differential growth effect of countercyclical interest rates in this economy.[9]

3.3 Growth and cyclical lending capacity

Consider lastly the case where the constraint limiting financiers' ability to lend depends on the state of nature s. Financiers' ability to lend may therefore fluctuate between the two values $i \in \{i_h; i_l\}$ with $i_h > i_l$. Moreover let us assume that entrepreneurs do not have to delever when $i = i_l$ while low tangibility entrepreneurs have to delever when state l hits and $i = i_h$. We therefore assume that i_l and i_h satisfy respectively

$$\begin{gathered} (i_l - 1)\, r_l r_s < \rho_s i_l \\ \underline{\rho_l} i_h < (i_h - 1)\, r_h r_l < \overline{\rho_l} i_h \end{gathered} \tag{19}$$

[9] As was the case for the growth effect of countercyclical interest rates w.r.t. tangibility, the growth effect of countercyclical interest rates w.r.t. the credit supply is actually non monotonic: it is zero when the credit supply is low and strictly positive when the credit supply is large. However conditional on a large credit supply, the growth effect of countercyclical interest rates actually decreases with the credit supply.

Denoting financiers' average ability to lend as $E_s i_s = (1-q)\, i_h + q i_l$, we can now write the expected growth rate between date t and date $t+1$ for an entrepreneur with tangibility ρ_l in state l, as

$$g\left(\rho_l; \{i_s\}_s\right) = E_s i_s - (1-q)\, q\lambda \frac{\left[(i_h - 1)\, r_h E_\alpha r_s - \rho_l i_h\right]^+}{r_l - \lambda \rho_l} \tag{20}$$

To determine the how the cyclicality of credit affects entrepreneurs' growth, we can vary the parameter i_h taking as given average credit $E_s i_s$: a higher (lower) parameter i_h represents more procyclical (countercyclical) credit. Based on (20), a more procyclical credit does not affect the expected growth rate for high tangibility entrepreneurs which depends only on average credit. However a more procyclical credit affects negatively the expected growth rate for low tangibility entrepreneurs, given that downsizing in state l goes up:

$$\left.\frac{\partial g}{\partial i_h}\right|_{\rho_l = \overline{\rho_l}} = 0 \qquad \text{and} \qquad \left.\frac{\partial g}{\partial i_h}\right|_{\rho_l = \underline{\rho_l}} = -\,(1-q)\, q\lambda \frac{r_h E_\alpha r_s - \underline{\rho_l}}{r_l - \lambda \rho_l} < 0 \tag{21}$$

Pro-cyclical credit therefore cuts growth disproportionately more for low tangibility entrepreneurs, the reason being that procyclical credit leaves low tangibility entrepreneurs exposed to the combination of a good state where they borrow large amounts followed by a bad state where they need to downsize significantly because large previous borrowing. Countercylical credit is then beneficial because it avoids this kind of costly development.

This analytical framework therefore yields three key predictions. First, countercyclical real short term interest rates tend to increase growth disproportionately for entrepreneurs with lower tangibility. Second, the differential effect of countercyclical real short term interest rates is amplified (dampened) when financier's lending supply is larger (lower), i.e. when financiers' capital constraint is weaker (tighter). Last, real interest rates being given, a countercyclical credit supply tends to increase growth disproportionately for entrepreneurs with lower tangibility. We now turn to the empirical part to test this predictions in the data.

4 Data and Empirical Methodology

4.1 Baseline specification

The empirical framework makes use of industry-level data to test for the cross-sectional predictions derived above. Specifically, we use the average annual growth rate of real value added in industry j in country k as our dependent variable. As explanatory variables, we introduce industry and country fixed effects $\{\alpha_j; \beta_k\}$ to control for unobserved heterogeneity across industries and across countries. The variable of interest, $\mathsf{ic_j} \times \mathsf{mp_k}$, is the interaction between industry j's intrinsic characteristics $\mathsf{ic_j}$ and the cyclicality of real short term interest rates in country k $\mathsf{mp_k}$. Finally, we control for initial conditions by including the ratio of value added in industry j in country k to value added in manufacturing in country k at the beginning of the period. Denoting y_{jk}^t (y_k^t) real value added in industry j (in manufacturing) in country k at time t and ε_{jk} the error term, our main estimation equation can then be expressed as:

$$\frac{1}{n}\left[\ln y_{jk}^{t+n} - \ln y_{jk}^{t}\right] = \alpha_j + \beta_k + \gamma.\mathsf{ic_j} \times \mathsf{mp_k} - \delta \ln\left(y_{jk}^t / y_k^t\right) + \varepsilon_{jk} \qquad (22)$$

Using a similar approach, we can also estimate the effect on industry labour productivity growth, defined as real value added per worker (or per hour worked).

4.1.1 Interest rate cyclicality

The cyclical pattern of interest rates in country k is estimated as the marginal change in the real short term interest rate following a change in the domestic output gap.[10] We hence estimate the following equation:

$$rsir_{kt} = \eta_k + \theta_k rsir_{kt-1} + \mathsf{mp_k}.z_{kt} + u_{kt} \tag{23}$$

where $rsir_{kt}$ is the real short-term interest rate in country k at time t, z_{kt} is the output gap in country k at time t, η_k and θ_k are parameters to estimate and u_{kt} is a residual.[11] The estimated coefficient $\mathsf{mp_k}$ therefore measures interest rate cyclicality in country k: a positive (negative) regression coefficient $\mathsf{mp_k}$ reflects a countercyclical (procyclical) monetary policy, as the central bank tends to make short-term credit more (less) costly in expansions and less (more) costly in recessions. A larger coefficient therefore indicates a more countercyclical policy. As a complement to equation (23), we also use an alternative approach which allows the interest rate specification to differ across countries.[12]

4.1.2 Financial sector regulations

We now turn to the analysis of the effect of financial sector regulations. Here we adopt a similar approach to that used above and estimate the extended specification as follows:

$$\frac{1}{n}\left[\ln y_{jk}^{t+n} - \ln y_{jk}^{t}\right] = \alpha_j + \beta_k + \gamma_i.\mathsf{ic_j} \times \mathsf{mp_k} + \gamma_f.\mathsf{ic_j} \times \mathsf{fsc_k} - \delta \ln\left(y_{jk}^{t}/y_{k}^{t}\right) + \varepsilon_{jk} \tag{24}$$

[10] The real short term interest rate is the difference between the nominal interest rate and the annualized quarter-on-quarter CPI inflation.

[11] Throughout the paper, the output gap is computed as the percentage difference actual and trend GDP, trend GDP being estimated applying an HP filter on the log of the real GDP. The smoothing parameter is adapted according to the data frequency.

[12] More precisely, we choose for each country the specification which minimizes the root mean square error (RMSE). The appendix provides two histograms reflecting the estimation results of the country-by-country "auxiliary" regression (23).

where $\mathsf{fsc_k}$ is the indicator for financial sector regulations in country k, other notation being unchanged. As explained above, we look at two different dimensions of the financial sector, namely capital and cyclicality. First, we compute the average bank capital to asset ratio for each country k -denoted $\mathsf{car_k}$- and use this as our index for financial sector regulations $\mathsf{fsc_k}$ in equation (24). Second, we consider the cyclicality of credit to non-financial firms. Specifically, we estimate for each country the following equation:

$$pc_{kt} = \eta_k + \mathsf{rp_k}.z_{kt} + u_{kt} \tag{25}$$

where pc_{kt} represents the cyclical component of private credit to non-financial firms to GDP in country k at time t, η_k is a constant, z_{kt} is the output gap in country k at time t and u_{kt} is a residual.[13] The estimated coefficient $\mathsf{rp_k}$ therefore measures credit cyclicality in country k: a positive (negative) regression coefficient $\mathsf{rp_k}$ reflects procyclical (countercyclical) credit, as the deviation from trend credit tends to be larger (lower) in expansions and lower (larger) in recessions.

4.1.3 The relationship between interest rate cyclicality and financial sector regulations

Finally, we want to investigate the interplay between cyclical macroeconomic policy and financial sector regulations. For that purpose, we run the following additional set of estimations. First, we include the interaction of industry liquidity/credit constraints and financial sector regulations. Second we include the interaction of industry liquidity/credit constraints, financial sector regulations and interest rate cyclicality to check whether the effects of interest rate cyclicality and financial

[13] The cyclical component pc_{kt} is estimated using an HP filter on the log of the private credit to non-financial firms to GDP. This trend/cycle decomposition is helpful to focus on the higher frequency changes in private credit to GDP and abstract from the lower frequency changes which likely reflect more structural factors like financial deepening.

sector regulations on growth are either independent of each other or complementary to each other. This is equation (26).

$$\begin{aligned}\frac{1}{n}\left[\ln y_{jk}^{t+n} - \ln y_{jk}^{t}\right] = \alpha_j + \beta_k + \gamma_m.\mathsf{ic_j} \times \mathsf{mp_k} + \gamma_f.\mathsf{ic_j} \times \mathsf{fsc_k} \\ +\gamma_{mf}.\mathsf{ic_j} \times \mathsf{mp_k} \times \mathsf{fsc_k} - \delta \ln\left(y_{jk}^t / y_k^t\right) + \varepsilon_{jk}\end{aligned} \tag{26}$$

4.2 Industry characteristics and estimation methodology

We follow Rajan and Zingales (1998) in using firm-level data pertaining to the United States. We aim at to capture two sets of constraints affecting firms: borrowing constraints, on the one hand, and liquidity constraints, on the other. We use asset tangibility as a proxy for borrowing constraints, measured as the median ratio, across firms in a given industry, of the value of net property, plant and equipment to total assets. As for liquidity constraints, we consider the median ratio, across firms in a given industry, of labour costs to total sales. The first measure gives an indication of the difficulty an industry has in raising external finance and as such can be considered as a proxy for industry borrowing constraints. The second measure gives an indication of an industry's need for short-term financing. Industries with a larger ratio of labour costs to sales actually have larger payments to make on a regular basis and should therefore have greater needs for short-term refinancing.

This methodology, which consists in using US firm data to compute industry characteristics, is predicated on the assumptions that (i) differences across industries are driven largely by differences in technology; (ii) technological differences persist over time across countries; and (iii) countries are relatively similar in terms of the overall institutional environment faced by firms. Under these three conditions, the US-based industry-specific measure is likely to be a valid measure for industries in countries other than the United States. We believe that these assumptions are satisfied especially given our restriction to a set of rich countries that all belong to the Organisation for Economic Co-operation and Development (OECD). For example, if pharmaceuticals require proportionally more external finance or have lower labour costs than do textiles in the United States, this is likely to be the case in other OECD countries as well. 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 borrowing or liquidity constraints.

Following Rajan and Zingales (1998), we estimate equations (22), (24) and (26) with a simple ordinary least squares (OLS) procedure, correcting for heteroskedasticity bias when needed. In particular, the interaction term between industry-specific characteristics and interest rate cyclicality/financial sector regulations is likely to be largely exogenous to the dependent variable. There are two reasons for assuming this. First, our variable for industry-specific characteristics pertains to industries in the United States, whereas the dependent variable involves other countries. Hence, reverse causality, whereby industry growth outside the United States could affect industry-specific characteristics in the United States, seems quite implausible. Second, interest rate cyclicality and financial sector regulations are measured at a macro 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 the total output in the domestic economy.

4.3 Data sources

Our data sample focuses on 14 industrial OECD countries. The sample does not include the United States, as doing so would be a source of reverse causality problems.[14] Our data come from various sources. Industry-level real value added and labour productivity data are drawn

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

from the European Union (EU) KLEMS data set and are restricted to manufacturing industries.[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 the industry-level indicators for borrowing and liquidity constraints. Finally, macroeconomic variables used to compute monetary policy cyclicality are drawn from the OECD (2008) Economic Outlook data set. We use quarterly data for monetary policy variables. We choose to concentrate on a more recent period (1999–2005), during which monetary policy was essentially conducted through short-term interest rates, to make sure that our auxiliary regression captures the bulk of monetary policy decisions.[16] Finally, the data for bank capital ratios come from Bankscope, while data on credit to non-financial firms come from the Bank for International Settlements (Dembiermont at al (2013)).[17]

5 Empirical results

5.1 Baseline regressions

The empirical results in Table 1 show that growth in industry real value added is significantly and negatively correlated with the interaction of industry asset tangibility and interest rate counter-cyclicality: a larger sensitivity to the output gap of the real short-term interest rate tends to raise growth in industry real valued added disproportionately for industries with lower asset tangibility. A similar but opposite type of result holds for the interaction between interest rate cyclicality and the ratio of industry labour costs to sales: a larger sensitivity of the real short-term interest rate to the output gap raises growth in industry real valued added disproportionately for industries with a

[15] See appendix for the list of industries in the sample.

[16] Starting in 1999 also allows focusing on post ECB period for Euro Zone countries.

[17] Such data can be obtained at the following address: http://www.bis.org/statistics/credtopriv.htm

higher ratio of labour costs to sales. These results are consistent with the view that a countercyclical interest rate policy raises growth disproportionately in sectors that are more liquidity dependent or that face larger difficulties in raising capital, by easing the process of refinancing. Note that these two results extend to the case where interest rate cyclicality is estimated using a rule that is allowed to differ across countries.[18] We now repeat the same estimation exercise, but moving the focus to growth in labour productivity (see Table 2). Our basic conclusion is unchanged, as results obtained for value added growth extend to labour productivity growth without difficulty.

[Insert table 1 and table 2 here]

At this point, it is worth making two remarks. First, the correlation between the measures of liquidity and borrowing constraints is around –0.6. Liquidity and borrowing constraints are therefore two distinct channels through which interest rate countercyclicality affects industry growth. Second, as was the case for regressions using fiscal policy cyclicality, estimated coefficients for the interaction terms are very stable whether the dependent variable is value added growth or labour productivity growth. This confirms that interest rate cyclicality is a source of long-run growth as it essentially affects labour productivity.[19]

5.2 Magnitude of the effects

How large are the effects implied by the regressions? To get a sense of the magnitudes involved in these regressions, we compute the difference in growth between, on the one hand, an industry at the

[18] Ideally, we would like to measure monetary policy counter-cyclicality by means of estimating a Taylor rule. The problem however with such estimation is that short term nominal interest rates and inflation rates are not stationary over the period 1999-2005 that we consider for our estimation.

[19] A discrepancy between results for real value added and results for labour productivity growth would have implied that macroeconomic policy cyclicality essentially operates through employment, which cannot constitute a source of growth in the long-run.

third quartile (75th percentile) in terms of borrowing or liquidity constraints located in a country at the third quartile in terms of monetary policy cyclicality and, on the other hand, an industry at the first quartile (25th percentile) in terms of borrowing or liquidity constraints located in a country at the first quartile in terms of fiscal or monetary policy or financial sector regulations.[20,21]

As it turns out, the approximate gain in labour productivity growth ranges between 0.5 and 1.5 percentage points, the latter figure being obtained when the liquidity dependence indicator is considered. Note that these magnitudes are fairly large, especially when compared with the corresponding figures in Rajan and Zingales (1998). According to their results, the gain in growth in real value added registered when moving from the 25th to the 75th percentile, both in a country's level of financial development and in an industry's level of external financial dependence, is roughly equal to 1 percentage point per year.

However, the following considerations are worth pointing out here. First, these are difference-in-difference (cross-country or cross-industry) effects, which are not directly interpretable as countrywide effects. Second, we are just looking at manufacturing sectors, which represent no more than 40% of the total GDP of the countries in our sample. Third, irrespective of the indicator for countercyclicality considered, there is a high degree of dispersion across countries in our sample. Hence, moving from the 25th to the 75th percentile in macroeconomic policy corresponds to a radical change in the design of monetary policy along the cycle, which, in turn, is unlikely to take place in any individual country over a short period of time. Fourth, this simple computation

[20] In this case, we compute the difference in growth between on the one hand an industry at the first quartile in terms of asset tangibility located in a country at the third quartile in terms of fiscal policy counter-cyclicality and on the other hand an industry at the third quartile in terms of asset tangibility located in a country at the first quartile in terms of fiscal policy counter-cyclicality.

[21] Given our difference-in-difference specification, it is impossible to infer the economic magnitudes of the estimated coefficients differently. In particular, the presence of industry and country fixed effects precludes investigating the impact of a change in the cyclical pattern of fiscal policy for a given industry or conversely the effect of a change in industry characteristics (asset tangibility or labour cost to sales) in a country with a given cyclical pattern of fiscal policy. Both these effects are absorbed with our country and industry dummies.

does not take into account the possible costs associated with the transition from a steady state with low policy countercyclicality to a steady state with high policy countercyclicality. Yet, the above exercise suggests that differences in monetary policy cyclicality is an important driver of the observed cross-country, cross-industry differences in growth performance.

5.3 Financial sector regulations and their interplay with the cyclicality of interest rates

So far we have looked at the effects of interest rate cyclicality. We now investigate the potential interactions with financial sector regulations (bank capital ratios and credit cyclicality). As noted above, the idea is that the transmission of the interest rate policy to the real economy could depend on the regulations affecting the banking/financial sector. Thus, one may wonder whether high capital ratios are an obstacle to a rapid and swift transmission of policy stimuli, or instead a guarantee that banks are sound and safe, which in turn could ease transmission of monetary policy to the real economy.[22] Similarly, credit cyclicality cannot be examined independently of the cyclicality of interest rates, as the former is likely to reflect (be influenced by) the latter, hence the importance of investigating the interaction between monetary policy cyclicality and financial sector regulations.

Table 3 regresses labour productivity growth on the interaction between industry asset tangibility (ratio of labour costs to sales) and interest rate cyclicality, but adds the interaction between industry asset tangibility (ratio of labour costs to sales) and the average bank capital to asset ratio as an extra explanatory variable. As the table shows, once we control for interest rate cyclicality,

[22] Bech, Gambacorta and Kharroubi (2012) provides evidence that policy stimuli are less effective when the economy experiences a downturn associated with a financial crises, which presumably implies that banks then face significant problems.

a higher bank capital to asset ratio has no differential effect across sectors with different asset tangibility, irrespective of the particular method used to compute interest rate cyclicality (columns (i) and (ii)). The empirical evidence is similar for the interaction with industry labour cost to sales (columns (iii) and (iv)), thus confirming that cross-country differences in bank capital to asset ratio do not have systematically different effects across sectors according to their financial constraint.[23] The conclusion to be drawn is, therefore, that imposing higher capital to asset ratios on banks would not have detrimental effects on sectors with relatively intangible assets or relatively high labour cost.

[Insert table 3 here]

Yet, one may ask whether the effect of bank capital to asset ratios just comes on top of the effect of monetary policy countercyclicality or whether bank capital to asset ratios actually affect the relationship between monetary policy countercyclicality and growth. Could it be, for instance, that high capital ratios reduce the effectiveness of monetary policy in promoting growth in sectors with the lowest asset tangibility?

Table 4 answers this question. It tests whether the relationship between industry growth and the interaction between industry asset tangibility (ratio of labour costs to sales) and interest rate cyclicality is different between countries with relatively high bank capital to asset ratios and countries with relatively low bank capital to asset ratios. To do so, we build a dummy variable which equals one for countries with bank capital to asset ratios above the sample median. We then estimate whether there is a significant extra effect of the interaction between industry asset tangibility (ratio of labour costs to sales) and monetary policy cyclicality on growth when the dummy variable

[23] Performing the same regression exercise using real value added growth as the dependent variable provides identical results.

equals one.

Table 4 shows that the growth-enhancing effect of a countercyclical monetary policy on sectors with lower asset tangibility (higher ratio of labour costs to sales) is dampened in countries where the bank capital to asset ratio is above the sample median. In other words, high bank capital to asset ratios tend to reduce the benefit of a more countercyclical monetary policy in sectors that are more prone to be credit-constrained or liquidity-constrained. As is clear from the estimated coefficients, the interaction of industry asset tangibility (ratio of labour costs to sales) and interest rate cyclicality is not significant for countries with a bank capital to asset ratio above the sample median, which would suggest that monetary policy simply becomes ineffective when banks maintain a large capital to asset ratio. This suggests that a high bank capital to asset ratio limits the ability of the financial system to respond to changes in interest rates and reduces the effectiveness of the interest rate policy transmission channel. This result also implies that the implications of high bank capital to asset ratios actually depends on the cyclical pattern of interest rates. For example, in countries where real short-term interest rates are a-cyclical, maintaining a high capital to asset ratio for banks does not have any significant implications. This may even be positive for industries with low tangibility (high labour cost to sales) if the real short-term interest rate is procyclical.

[Insert table 4 here]

We now turn to the extent to which the cyclicality of credit provision could complement or substitute for the cyclicality of interest rates in enhancing growth in more credit-constrained or liquidity-constrained sectors. We focus on credit to non-financial corporations and ask the two questions raised for bank capital to asset ratios. First, does countercyclical credit affect industries according to their asset tangibility (their labour costs to sales ratio)? Second, does the effect of monetary policy countercyclicality on industry growth get affected by cross-country differences in credit cyclicality?

Table 5 and table 6 provide respectively an answer to each of these two questions. There are essentially two takeaways from these estimations. First, the cyclicality of credit does not affect industries according to the tangibility of assets, neither directly nor indirectly, i.e. through the cyclicality of interest rates. Second, the cyclicality of credit does affect industry growth according to their labour costs to sales ratio: industries with a larger labour costs to sales ratio get hurt disproportionately when credit to non-financial firms becomes more procyclical. Yet, there is no interaction between interest rate and credit countercyclicality. In other words, interest rate and credit countercyclicality play similar but independent roles: raising growth disproportionately for industries with a larger labour costs to sales ratio.

[Insert table 5 and table 6 here]

6 Conclusion

We have analyzed the extent to which the interest rate policy over the business cycle in combination with financial sector regulations can affect industry growth, focusing bank capital ratios and credit cyclicality. Following the Rajan and Zingales (1998) methodology, we have interacted these policy measures at the country level with industry-level financial and liquidity constraints (measured by asset tangibility and the ratio of labour costs to sales in US industries) to assess the impact of this interaction on output growth at the industry level. We have derived three main results. First, a more countercyclical interest rate policy significantly enhances output growth in more financially/liquidity-constrained industries, that is, in industries whose US counterparts display lower asset tangibility or a larger ratio of labour costs to sales. Second, a higher bank capital to asset ratio tends to reduce the benefits of countercyclical interest rates for industries with low asset tangibility (high labour cost to sales). Third, more countercyclical credit to non-financial firms tends to raise growth disproportionately in industries with larger labour costs to sales ratios.

This new approach to the study of growth versus interest rate policy and financial sector regulations suggests at least two avenues for future research. First, the evidence on the effect of countercyclical interest rate policy on growth calls for going beyond the debate between supply side and demand side economists. While demand considerations can affect the market size for potential innovations, our effects are fundamentally supply side-driven, as they operate through their influence on innovation incentives.[24] Second, the evidence produced in this paper on the effects of bank capital and the cyclicality of credit to non-financial firms on growth suggests non-trivial trade-offs for regulatory policy: in particular, higher capital adequacy ratios, insofar as they become binding, can be helpful in reducing systemic risk. However, they may also adversely affect the positive effect of countercyclical interest rates on industries with the lowest asset tangibility, which we typically think of as being the main engines for growth in developed economies. This, in turn, opens up the issue of how to optimally design financial regulations together with macroeconomic policy so as to reconcile financial stability and growth.

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7 Appendix

7.1 Socially optimal interest rate policy

We consider in this section the interest policy the central bank must set in order to maximize social welfare. Conditional on state s_{t-1} happening at date $t-1$, and assuming the interest rate the central bank sets is lower in state l, i.e. $r_l < r_h$, social welfare for the generation born at date t writes as

$$W_t = (I-w)\, r_{s_{t-1}} E_\alpha r_s + E_s y_s I - E_s (\lambda y_s - r_s) L_s - (I-w)\, r_{s_{t-1}} E_\alpha r_s$$

The first term represents the welfare of financiers while the second represents the welfare of entrepreneurs. Then denoting p the share of low tangibility entrepreneurs, and given that initial investment is $I = iw$ and high tangiblity entrepreneurs do not need to downsize, social welfare satisfies

$$W_t(r_l, r_h) = \left[E_s y_s i - pq \frac{\lambda y_l - r_l}{r_l - \lambda \underline{\rho_l}} \left[(i-1)\, r_{s\,t-1} E_\alpha r_s - \underline{\rho_l} i\right]\right] w$$

When investment I is such that entrepreneurs face no need to downsize their projects, then social welfare does not depend on the cyclicality of interest rates i.e. $W_t = iwE_s y_s$.

However, when investment I is such that low tangibility entrepreneurs need to downsize in the bad state, then welfare may either increase or decrease with the interest rate r_l. More specifically social welfare W is convex in the interest rate r_l, first decreasing and then increasing, reaching a minimun for

$$r_{s_{t-1}} r_l - \underline{\rho_l} \frac{i}{i-1} = \underline{\rho_l} \frac{\lambda y_l - r_l}{r_l - \lambda \rho_l} \left(\frac{i}{i-1} - r_{s_{t-1}} \lambda\right)$$

Assuming the central bank can set the interest rate r_l between $\underline{r}$ and r with $r > \underline{r}$, choosing the counter-cylical interest policy against the a-cyclical policy, i.e. $r_l = r - \frac{\sigma}{q}$, improves social welfare if and only if the following conditon holds:

$$2\alpha\sigma > \lambda\frac{y_l - \underline{\rho_l}}{r - \underline{\rho_l}\lambda}\left(r - \frac{\underline{\rho_l}}{r_{s\,t-1}}\frac{i}{i-1}\right) - 2\alpha q\left(\lambda y_l - r\right)$$

As is clear, this condition is more likely to be satisfied when:

- the investment level i is larger
- the previous period interest rate $r_{s_{t-1}}$ is lower
- financiers' risk aversion α is higher
- the central bank's ability to cut interest rates in the l state σ is larger.

7.2 Manufacturing industries

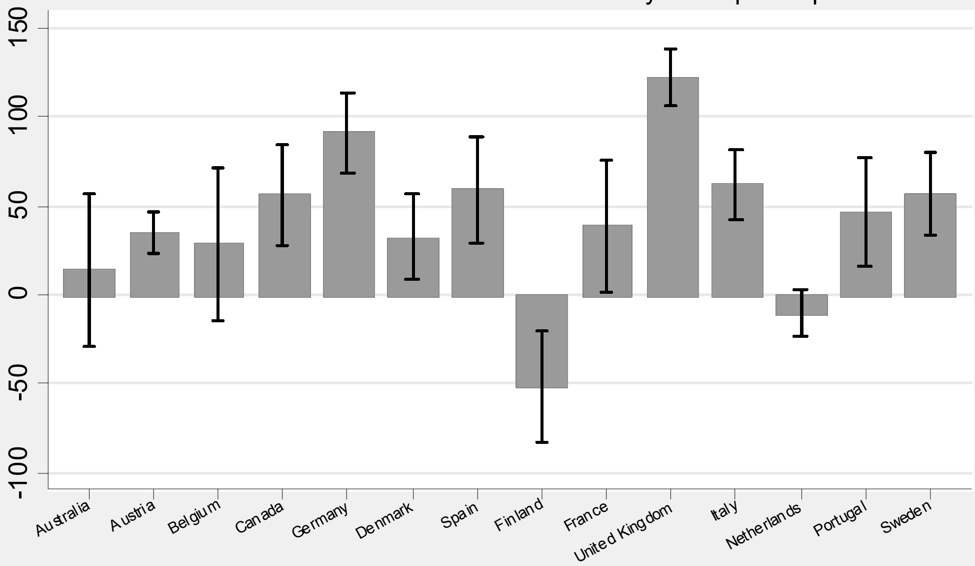
Note: The first column provides the industry code based on the International Standard Industrial Classification (ISIC) revision 3. The second column provides a brief industry description. If an industry description is valid for more than one industry code, the relevant industry codes are reported separated by an "&" character. The industry codes noted "x-y" represent industries with industry code "x" excluding industries with industry code "y".

Industry code	Industry title
15&16	FOOD, BEVERAGES, AND TOBACCO
15	Food and beverages
16	Tobacco
17&18&19	TEXTILES, TEXTILE, LEATHER, AND FOOTWEAR
17&18	Textiles and textile
17	Textiles
18	Wearing apparel, dressing, and dying of fur
19	Leather, leather, and footwear
20	WOOD AND OF WOOD AND CORK
21&22	PULP, PAPER, PAPER, PRINTING, AND PUBLISHING
21	Pulp, paper, and paper
22	Printing, publishing, and reproduction
221	Publishing
22-221	Printing and reproduction
23&24&25	CHEMICAL, RUBBER, PLASTICS, AND FUEL
24	Chemicals and chemical
244	Pharmaceuticals
24-244	Chemicals excluding pharmaceuticals
25	Rubber and plastics
26	OTHER NONMETALLIC MINERAL
27&28	BASIC METALS AND FABRICATED METAL
27	Basic metals
28	Fabricated metal
29	MACHINERY not elsewhere classified,
30&31&32&33	ELECTRICAL AND OPTICAL EQUIPMENT
30	Office, accounting, and computing machinery
31–32	Electrical engineering
31	Electrical machinery and apparatus, not elsewhere classified
313	Insulated wire
31-313	Other electrical machinery and apparatus not elsewhere classified
32	Radio, television, and communication equipment
321	Electronic valves and tubes
322	Telecommunication equipment
323	Radio and television receivers
33	Medical, precision, and optical instruments
331&332&333	Scientific instruments
334&335	Other instruments
34&35	TRANSPORT EQUIPMENT
34	Motor vehicles, trailers, and semi-trailers
35	Other transport equipment
351	Building and repairing of ships and boats
353	Aircraft and spacecraft
35-(351&353)	Railroad equipment and transport equipment not elsewhere classified
36&37	MANUFACTURING NOT ELSEWHERE CLASSIFIED, RECYCLING
36	Manufacturing not elsewhere classified
37	Recycling

7.3 Interest Rate Cyclicality

Figure 1

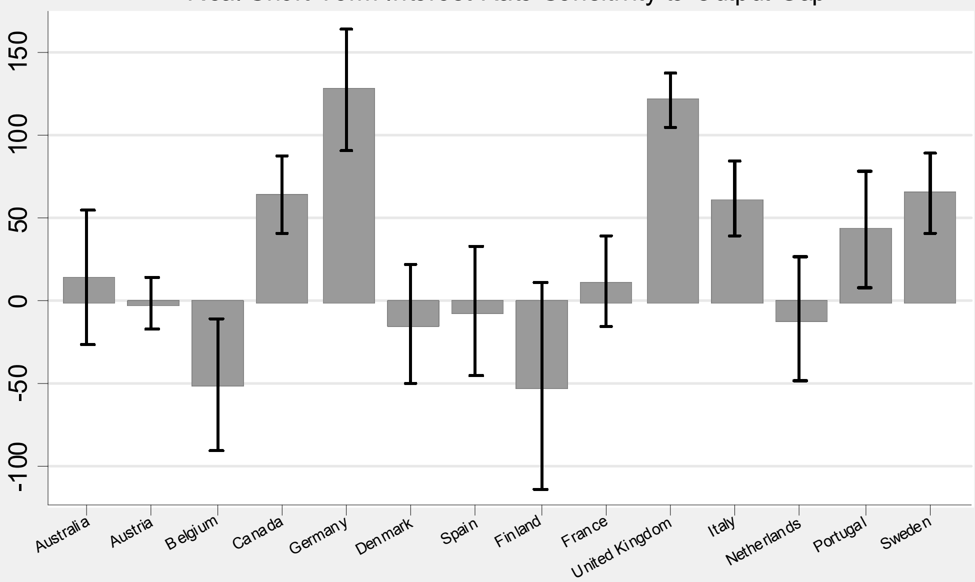
Real Short Term Interest Rate Sensitivity to Output Gap



Note: Each bar represents the output gap sensitivity in percentage points 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

Real Short Term Interest Rate Sensitivity to Output Gap



Note: Each bar represents the output gap sensitivity in percentage points 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 estimates.

7.4 Financial Sector Charactersitics

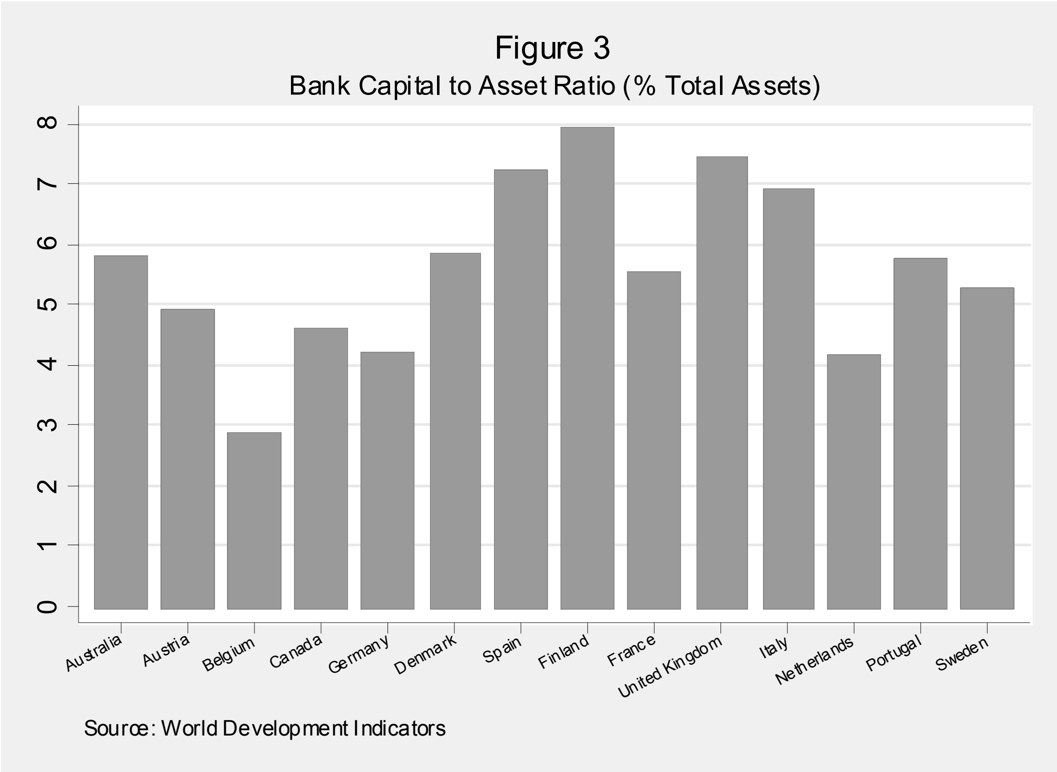
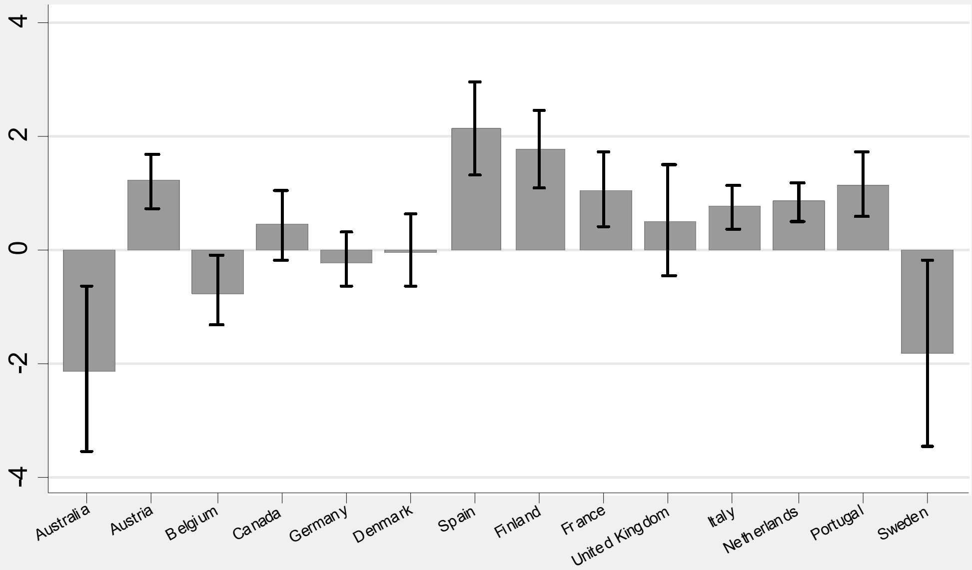


Figure 4

Credit to Non-Financial Corporations Sensitivity to Output Gap



Note: Each bar represents the output gap sensitivity of the credit gap to non-financial corporations for the period 1999-2005 for each country. The black line indicates the confidence interval at the 10% level around the sensitivity estimate for each country.

7.5 Regression Results

Dependent variable: real value added growth				Table 1
	(i)	(ii)	(iii)	(iv)
Log of initial share in manufacturing value added	**–0.0448**	**–0.0745**	**–0.0312**	**–0.0678**
	(0.719)	*(0.719)*	*(0.731)*	*(0.731)*
Interaction (asset tangibility and real short-term interest rate countercyclicality I)	**–18.37***			
	(9.88)			
Interaction (asset tangibility and real short-term interest rate countercyclicality II)		**–15.44****		
		(6.43)		
Interaction (labour costs to sales and real short-term interest rate countercyclicality I)			**20.48****	
			(9.23)	
Interaction (labour costs to sales and real short-term interest rate countercyclicality II)				**15.73****
				(7.25)
Observations	550	550	550	550
R-squared	0.306	0.307	0.305	0.306

The dependent variable is the average annual growth rate in real value added over the period 1999–2005 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 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 1980–89. Labour costs to sales is the median ratio of labour costs to shipments for US firms in the same industry for the period 1980–89. Real short-term interest rate countercyclicality 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 countercyclicality II is the coefficient of the output gap in the regression which minimises the RMSE for each country. The interaction variable is the product of variables in parentheses. Standard errors – clustered by industry – are in parentheses. Estimations include country and industry dummies. Significance at the 1%, 5% and 10% level is indicated by ***, ** and * respectively.

Dependent variable: labour productivity growth				Table 2
	(i)	(ii)	(iii)	(iv)
Log of initial relative labour productivity	**–1.085**	**–1.122**	**–1.226**	**–1.158**
	(1.319)	*(1.294)*	*(1.273)*	*(1.243)*
Interaction (asset tangibility and real short-term interest rate countercyclicality I)	**–17.89***			
	(9.47)			
Interaction (asset tangibility and real short-term interest rate countercyclicality II)		**–15.65****		
		(6.93)		
Interaction (labour costs to sales and real short-term interest rate countercyclicality I)			**22.64****	
			(8.66)	
Interaction (labour costs to sales and real short-term interest rate countercyclicality II)				**16.82****
				(6.83)
Observations	550	550	550	550
R-squared	0.248	0.251	0.249	0.249

The dependent variable is the average annual growth rate in hour labour productivity over the period 1999–2005 for each industry in each country. Initial relative labour productivity is the ratio of industry hour labour productivity to total manufacturing hour labour productivity 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 1980–89. Labour costs to sales is the median ratio of labour costs to shipments for US firms in the same industry for the period 1980–89. Real Short-term interest rate countercyclicality 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 countercyclicality II is the coefficient of the output gap in the regression which minimises the RMSE for each country. The interaction variable is the product of variables in parentheses. Standard errors – clustered by industry – are in parentheses. All estimations include country and industry dummies. Significance at the 1%, 5% and 10% level is indicated by ***, ** and * respectively.

Dependent variable: growth in labour productivity per hour				Table 3
	(i)	(ii)	(iii)	(iv)
Log of initial relative labour productivity	**-1.136**	**-1.193**	**-1.261**	**-1.200**
	(1.379)	*(1.361)*	*(1.273)*	*(1.306)*
Interaction (asset tangibility and real short-term interest rate countercyclicality I)	**-18.04****			
	(7.605)			
Interaction (asset tangibility and real short-term interest rate countercyclicality II)		**-16.22*****		
		(4.111)		
Interaction (asset tangibility and average bank capital to asset ratio)	**1.499**	**2.049**		
	(2.843)	*(2.100)*		
Interaction (labour costs to sales and real short-term interest rate countercyclicality I)			**23.44****	
			(10.61)	
Interaction (labour costs to sales and real short-term interest rate countercyclicality II)				**18.09****
				(5.922)
Interaction (labour costs to sales and average bank capital to asset ratio)			**-2.961**	**-3.469**
			(3.122)	*(2.651)*
Observations	550	550	550	550
R-squared	0.249	0.252	0.251	0.251

The dependent variable is the average annual growth rate in labour productivity per hour for the period 1999–2005 for each industry in each country. Initial relative labour productivity is the ratio of industry labour productivity per hour to total manufacturing labour productivity per hour 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 1980–89. Labour costs to sales is the median ratio of labour costs to shipments for US firms in the same industry for the period 1980–89. Real short-term interest rate countercyclicality I is the output gap sensitivity of the real short-term interest rate, controlling for the one-quarter-lagged real short-term interest rate. Real short-term interest rate countercyclicality II is the output gap sensitivity of the real short-term interest rate in the regression which minimises the RMSE. 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%, 5% and 10% level is indicated by ***, ** and * respectively.

Dependent variable: labour productivity growth					Table 4
	Above median	(i)	(ii)	(iii)	(iv)
Log of initial relative labour productivity		**-1.124** *(1.456)*	**-1.157** *(1.384)*	**-1.400** *(1.298)*	**-1.208** *(1.313)*
Interaction (asset tangibility and real short-term interest rate countercyclicality I)		**-45.97***** *(7.096)*			
Interaction (asset tangibility and real short-term interest rate countercyclicality II)			**-26.07***** *(3.134)*		
Interaction (asset tangibility and real short-term interest rate countercyclicality I)	Average bank capital to asset ratio	**37.19***** *(8.703)*			
Interaction (asset tangibility and real short-term interest rate countercyclicality II)	Average bank capital to asset ratio		**21.15***** *(6.383)*		
Interaction (labour costs to sales and real short-term interest rate countercyclicality I)				**51.20***** *(8.561)*	
Interaction (labour costs to sales and real short-term interest rate countercyclicality II)					**29.26***** *(5.323)*
Interaction (labour costs to sales and real short-term interest rate countercyclicality I)	Average bank capital to asset ratio			**-37.30***** *(8.769)*	
Interaction (labour costs to sales and real short-term interest rate countercyclicality II)	Average bank capital to asset ratio				**-25.25**** *(8.699)*
Observations		550	550	550	550
R-squared		0.261	0.256	0.258	0.255

The dependent variable is the average annual growth rate in labour productivity per hour for the period 1999–2005 for each industry in each country. Initial relative labour productivity is the ratio of industry labour productivity per hour to total manufacturing labour productivity per hour 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 1980–89. Labour costs to sales is the median ratio of labour costs to shipments for US firms in the same industry for the period 1980–89. Real short-term interest rate countercyclicality I is the output gap sensitivity of the real short-term interest, controlling for the one-quarter-lagged real short-term interest rate. Real short-term interest rate countercyclicality II is the output gap sensitivity of the real short-term interest rate in the regression which minimises the RMSE. 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%, 5% and 10% level is indicated by ***, ** and * respectively).

Dependent variable: growth in labour productivity per hour				Table 5
	(i)	(ii)	(iii)	(iv)
Log of initial relative labour productivity	**-1.087**	**-1.140**	**-1.152**	**-1.089**
	(1.382)	*(1.377)*	*(1.221)*	*(1.248)*
Interaction (asset tangibility and real short-term interest rate countercyclicality I)	**-17.94****			
	(7.233)			
Interaction (asset tangibility and real short-term interest rate countercyclicality II)		**-16.09*****		
		(4.850)		
Interaction (asset tangibility and credit to NFC pro-cyclicality)	**-0.124**	**-0.920**		
	(3.317)	*(2.942)*		
Interaction (labour costs to sales and real short-term interest rate countercyclicality I)			**21.02***	
			(11.27)	
Interaction (labour costs to sales and real short-term interest rate countercyclicality II)				**14.65***
				(7.243)
Interaction (labour costs to sales and credit to NFC pro-cyclicality)			**-6.125****	**-5.529****
			(2.244)	*(2.325)*
Observations	550	550	550	550
R-squared	0.249	0.252	0.251	0.251

The dependent variable is the average annual growth rate in labour productivity per hour for the period 1999–2005 for each industry in each country. Initial relative labour productivity is the ratio of industry labour productivity per hour to total manufacturing labour productivity per hour 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 1980–89. Labour costs to sales is the median ratio of labour costs to shipments for US firms in the same industry for the period 1980–89. Real short-term interest rate countercyclicality I is the output gap sensitivity of the real short-term interest rate, controlling for the one-quarter-lagged real short-term interest rate. Real short-term interest rate countercyclicality II is the output gap sensitivity of the real short-term interest rate in the regression which minimises the RMSE. 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%, 5% and 10% level is indicated by ***, ** and * respectively.

Dependent variable: labour productivity growth					Table 6
	Above median	(i)	(ii)	(iii)	(iv)
Log of initial relative labour productivity		**-1.069**	**-1.111**	**-1.224**	**-1.179**
		(1.326)	*(1.284)*	*(1.306)*	*(1.267)*
Interaction (asset tangibility and real short-term interest rate countercyclicality I)		**-20.69****			
		(8.160)			
Interaction (asset tangibility and real short-term interest rate countercyclicality II)			**-18.17****		
			(7.331)		
Interaction (asset tangibility and real short-term interest rate countercyclicality I)	Private credit to NFC cyclicality	**8.230**			
		(11.11)			
Interaction (asset tangibility and real short-term interest rate countercyclicality II)			**13.75**		
			(18.01)		
Interaction (labour costs to sales and real short-term interest rate countercyclicality I)				**22.78****	
				(9.236)	
Interaction (labour costs to sales and real short-term interest rate countercyclicality II)					**15.94****
					(7.464)
Interaction (labour costs to sales and real short-term interest rate countercyclicality I)	Private credit to NFC cyclicality			**-0.432**	
				(13.45)	
Interaction (labour costs to sales and real short-term interest rate countercyclicality II)					**5.156**
					(15.46)
Observations		550	550	550	550
R-squared		0.249	0.252	0.249	0.249

The dependent variable is the average annual growth rate in labour productivity per hour for the period 1999–2005 for each industry in each country. Initial relative labour productivity is the ratio of industry labour productivity per hour to total manufacturing labour productivity per hour 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 1980–89. Labour costs to sales is the median ratio of labour costs to shipments for US firms in the same industry for the period 1980–89. Real short-term interest rate countercyclicality I is the output gap sensitivity of the real short-term interest, controlling for the one-quarter-lagged real short-term interest rate. Real short-term interest rate countercyclicality II is the output gap sensitivity of the real short-term interest rate in the regression which minimises the RMSE. 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%, 5% and 10% level is indicated by ***, ** and * respectively.