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FINANCIERS VS. ENGINEERS:
SHOULD THE FINANCIAL SECTOR BE TAXED OR SUBSIDIZED?

Thomas Philippon

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ABSTRACT

I study the allocation of human capital in an economy with production externalities, financial constraints and career choices. Agents choose to become entrepreneurs, workers or financiers. Entrepreneurship has positive externalities, but innovators face borrowing constraints and require the services of financiers in order to invest efficiently. When investment and education subsidies are chosen optimally, I find that the financial sector should be taxed in exactly the same way as the non-financial sector. When direct subsidies to investment and scientific education are not feasible, giving a preferred tax treatment to the financial sector can improve welfare by increasing aggregate investment in research and development.

Thomas Philippon
NYU Stern School of Business
Department of Finance
44 West 4th Street, Suite 9-190
New York, NY 10012-1126
and NBER
tphilipp@stern.nyu.edu

This paper studies optimal financial development by analyzing the interactions between the financial and non-financial sectors. On the one hand, entrepreneurs need financial services to overcome problems of moral hazard and adverse selection. An efficient financial sector is therefore critical for economic growth. On the other hand, the financial and non-financial sectors compete for the same scarce supply of human capital. Without externalities, the competitive allocation is optimal. In many innovative activities, however, social returns exceed private returns. Does this lead to an inefficient allocation of human capital? If so, are there too many or too few financiers? What kind of corrective taxes should be implemented?

I study these questions by combining insights from the endogenous growth and financial development literatures. External effects play an important role in the analysis of Romer (1986) and Lucas (1988). Moreover, in most models of endogenous growth, the decentralization of the Pareto optimum requires subsidizing investment, production or R&D, as discussed in Aghion and Howitt (1998) and Barro and Sala-i-Martin (2004). The number of entrepreneurs can be inefficiently low in the competitive equilibrium because social returns to innovation exceed private returns. Indeed, Baumol (1990) and Murphy, Shleifer, and Vishny (1991) argue that the flow of talented individuals into law and financial services might not be entirely desirable, because social returns might be higher in other occupations, even though private returns are not.

On the other hand, however, a large body of research has shown the importance of efficient financial markets for economic growth. Levine (2005), in his comprehensive survey, argues that "better functioning financial systems ease the external financing constraints that impede firm and industrial expansion, suggesting that this is one mechanism through which financial development matters for growth."

These issues have become increasingly relevant over time, for several reasons. Immediately after World War II, the financial sector accounted for less than 2.5% of all labor income in the United States. In 2007, this share is close to 8%. Moreover, since the early 1980s, the growth of the financial sector has been strongly biased towards highly skilled individuals (Philippon and Resheff (2007)). Some individuals, who would have become engineers in the 1960s, now become financiers.[1] The decline in engineering has prompted a debate

[1] "Thirty to forty percent of Duke Masters of Engineering Management students were accepting jobs

about the role of science and technology in U.S. economic performance. It is commonly argued that policy interventions that promote science and technology are desirable because of externalities in knowledge and the diffusion of new technologies (National Academy of Sciences (2007)).[2]

This line of reasoning also appears in the debate about the tax treatment of hedge funds and private equity funds. Hedge funds and private equity funds have their fees taxed at the 15 percent capital gains rate rather than the 35 percent ordinary income rate. The properties of an optimal tax system are not *a priori* obvious. On the one hand, one could argue that finance diverts resources from entrepreneurship and scientific progress. For instance, critics of the finance industry argue that lower taxes for private equity firms and fund managers distort the incentives of college students when they decide what career to pursue.[3] On the other hand, executives of investment funds argue that they promote economic growth by relaxing entrepreneurs' constraints, which justifies their preferred tax treatment.

I propose a simple model where one can evaluate the relative merits of these seemingly contradictory arguments. In the model, agents choose to become workers, entrepreneurs or financiers. Like in the endogenous growth literature, entrepreneurs have the ability to innovate, and these innovations have positive externalities. Like in the financial development literature, innovators face binding borrowing constraints and may require the use of financial services in order to invest efficiently. I characterize the social planner's allocation and the competitive equilibrium, and I study the efficiency of various tax systems.

I obtain the following results. First of all, the model makes it clear that one should not discuss optimal taxation without taking into account direct subsidies to investment, R&D or scientific education. More precisely, I show that the constrained efficient allocation can always be decentralized with the same tax rate on income in the financial and non-financial sectors. The constrained efficient allocation requires just an investment subsidy when the external effects depend only on aggregate investment, as in Romer (1986). When

outside of the engineering profession. They chose to become investment bankers or management consultants rather than engineers." Vivek Wadhwa, *Testimony to the U.S. House of Representatives, May 16, 2006.*

[2] "Our goal should be to double the number of science, technology, and mathematics graduates in the United States by 2015. This will require both funding and innovative ideas." Bill Gates, *Testimony to the U.S. Senate, March 7, 2007*

[3] "Industry Groups Warn of Adverse Effects of Private Equity Tax Hike", Alan Zibel, Associated Press Business Writer, Tuesday July 31 2007. See in particualr the quotes of Joseph Bankman, law professor at Stanford University, and Bruce Rosenblum, managing director of the Carlyle Group.

the external effects also depend directly on the number of entrepreneurs, the second best requires positive subsidies to scientific education (or, equivalently, equal and positive tax rates on workers and financiers).

In any case, the presence of binding credit constraints does not invalidate the prescription that, whenever possible, externalities should be corrected at the source. The second-best subsidies increase the incentives of agents to become entrepreneurs and to invest in research and development. In equilibrium, the demand for labor and financial services adjust and there is no reason to tax financiers more or less than workers. The fact that financial services help relax borrowing constraints does not change this result.

Interestingly, the specificity of financing constraints and their impact on the optimal taxation of the financial sector appear when one moves away from the second best. In practice, and for a variety of reasons, governments are unlikely to be able to set the optimal education and investment subsidies. Starting from a competitive equilibrium without corrective taxation, a subsidy given to the financial sector could then enhance welfare. I show that subsidizing the financial sector is generally useful if one seeks to increase aggregate investment. If one is more interested in increasing the number of entrepreneurs, on the other hand, it might be optimal to tax the financial sector.

The rest of the paper is organized as follows. Section 1 lays down the model and discusses how it relates to the literature. Section 2 characterizes the social planner's allocation. Section 3 derives the competitive equilibrium outcome and compares it to the social planner's outcome. Section 4 shows how the second best allocation can be decentralized, and then discusses optimal taxation in a third-best economy with limited tax instruments. Section 5 concludes.

1 The model

1.1 Technology and preferences

Consider an economy with overlapping generations. Each generation is made of a continuum of ex-ante identical individuals, indexed by $i \in [0, 1]$. Let c_{jt}^i be the consumption at time t of individual i from generation $t + 1 - j$. The lifetime utility of the agent is:

$$U_t^i = u\left(c_{1t}^i\right) + \beta u\left(c_{2t+1}^i\right). \tag{1}$$

The function $u(.)$ is strictly increasing, strictly concave. The horizon of the model, T, can be finite or infinite. When T is finite, the last generation has utility $u(c_{1T})$.

Production of goods

The production of goods uses labor n_t and capital k_t. Labor productivity is a_t and the production function is:

$$y_t = f(a_t n_t, k_t). \tag{2}$$

The function f is increasing, concave, and has constant returns to scale. I will abuse notations and denote $\partial f_t / \partial n_t$ the partial derivative with respect to the first argument, instead of $\partial f_t / \partial (a_t n_t)$.

Career choice and education

Agents choose a career at the beginning of their first period. Let e_t be the number of agents who chose to become entrepreneurs, n_t the number of workers in the industrial sector, and b_t the number of financiers. Population size is normalized to one, so that one can think of e_t, b_t and n_t as shares of the labor force. I will abuse notation and use e_t to denote both the measure of entrepreneurs and the set of individuals who choose to become entrepreneurs. Becoming an entrepreneurs requires scientific education, which costs $a_t s^e$ units of output.[4]

Saving and investment

The investment technology requires the human capital of entrepreneurs as well as physical capital. Let x_t^i be the amount of resources allocated to entrepreneur i at time t. At time $t+1$, this entrepreneur produces $g\left(a_t, x_t^i\right)$ new units of capital. The function $g(.,.)$ is concave and has constant returns to scale. For simplicity, I assume full depreciation of the existing capital at the end of each period, so that:

$$k_{t+1} = \int_{i \in e_t} g\left(a_t, x_t^i\right) di. \tag{3}$$

Enforcement constraint and monitoring technology

The enforcement of financial contracts is limited. More precisely, I assume that an entrepreneur can always steal and consume at time 2 some of the resources that she controls. Without monitoring, if individual i becomes an entrepreneur and commands the resources

[4] For simplicity, I assume that the level of schooling is the same for workers and financiers, and I normalize it to zero.

x_t^i, her consumption in the second period, c_{2t+1}^i, cannot be less than zx_t^i. Financiers have access to a monitoring technology that makes it more difficult for entrepreneurs to divert resources. If m_t^i units of monitoring are allocated to a particular entrepreneur i, the enforcement constraint is relaxed and becomes:

$$c_{2,t+1}^i \geq zx_t^i - a_t q\left(m_t^i\right). \tag{4}$$

The function $q(.)$ is increasing and concave. In an equilibrium with b_t bankers, the total amount of monitoring available in the economy is b_t. The resource constraint in the monitoring market is:

$$\int_{i \in e_t} m_t^i \leq b_t. \tag{5}$$

External effects

Following Romer (1986) and Lucas (1988), I assume that external effects determine the evolution of productivity. Productivity evolves according to:

$$a_{t+1} = a_t + h\left(a_t e_t, X_t\right), \tag{6}$$

where X_t is the aggregate level of investment in the economy:

$$X_t \equiv \int_{i \in e_t} x_t^i.$$

The function $h(.,.)$ has constant returns to scale.

1.2 Discussion and relation to the literature

The two critical components of the model are the external effects from investment and entrepreneurship, captured by the function $h(e, X)$ in equation (6), and the monitoring services provided by the financial sector, described in equations (4) and (5).

The production technology in equation (6) allows for external effects, in the spirit of the endogenous growth literature. In Romer (1986), who builds on early contributions by Arrow (1962) and Sheshinski (1967), the output of a particular firm depends not only on its own capital, but also on the aggregate capital stock. Griliches (1979) distinguishes between firm specific and economy-wide knowledge. Lucas (1988), on the other hand, emphasizes human capital because "*human capital accumulation is a social activity, involving groups* *of people in a way that has no counterpart in the accumulation of physical capital.*" Several types of external effects have therefore been studied in the literature. Some might plausibly be linked to the number of entrepreneurs, e, while others might depend more directly on aggregate investment, X. The function $h(e, X)$ captures these various possibilities. One should also keep in mind that I have normalized the population to one, so one can think of X as investment per capita, and e as the fraction of entrepreneurs. Barro and Sala-i-Martin (2004) discuss how these scale effects matter in the comparison of small and large economies, across countries and over time.

There are two approaches to modelling financial intermediation. The first is to assume exogenous transaction costs and study the organization of the industry. In this approach, financial institutions (FIs) are to financial products what retailers are to goods and services. However, as Freixas and Rochet (1997) argue, "*the progress experienced recently in telecommunications and computers implies that FIs would be bound to disappear if another, more fundamental, form of transaction costs were not present*". A second approach, which I follow here, focuses on moral hazard and information asymmetries, instead of mechanical transaction costs. I build on the financial intermediation literature, but I am more concerned with the macroeconomic outcomes than with the microeconomic ones. I therefore abstract from the issues of delegated monitoring emphasized in Diamond (1984), from the supply of bank capital studied by Holmström and Tirole (1997), and from the formation of optimal coalitions analyzed by Boyd and Prescott (1986). In the model, the cost of financial intermediation is an opportunity cost, because an agent cannot be a banker, an engineer or a worker at the same time. I assume that there is no asymmetric information between FIs and their creditors. As a result, even though there exists a well defined financial sector, the boundaries of FIs within the industry are inconsequential.

The paper is also related to the work of Bencivenga and Smith (1991), Greenwood and Jovanovic (1990), Levine (1991), King and Levine (1993), Khan (2001) and Greenwood, Sanchez, and Wang (2007) who study the links between financial intermediation and growth.[5] Compared to these papers, my contribution is to study the decentralization of the second-best allocation of talent in the presence of credit constraints and external effects.

[5] It is impossible to cite all the relevant contributions here. See Levine (2005) for an excellent survey and extensive references.

Finally, I would like to discuss an important assumption that I maintain throughout the paper. I assume that all the externalities from innovation are in the industrial sector, and I neglect financial innovations. Yet innovations also happen in the finance industry (Allen and Gale (1994), Duffie and Rahi (1995), Tufano (2004)). I make this modelling choice for two reasons. First, because it is interesting to understand when and why the financial sector should be subsidized even though it does not create direct externalities. Second, in the current debate on the taxation of hedge funds and private equity funds, even the advocates of these funds do not argue that externalities from financial innovations justify the preferred tax treatment that they receive. Rather, they argue along the lines of this paper, that the funds provide important services by promoting growth in the industrial sector. This view is also consistent with the fact that, in most advanced countries, direct subsidies to scientific education are much more common that direct subsidies to business education.

2 Social planner's solution (SP)

For each individual $i \in [0,1]$, the social planner chooses a job (entrepreneur, worker or financier), two levels of consumption $\left\{c_{1t}^i, c_{2t+1}^i\right\}$, and, if the individual is an entrepreneur, an amount of investment x_t^i and a level of monitoring m_t^i. The planner faces the constraints (4) and (5), as well as the usual resource constraints. To be able to compare the social planner's allocation to the decentralized equilibrium where all agents are free to choose their jobs, I look for Pareto-optima where all the agents of the same generation have the same ex-ante utility.[6]

Lemma 1 *In any solution to the planner's problem with free career choices, all entrepreneurs of the same generation receive the same allocation* $\left\{x_t, m_t, c_{1t}^e, c_{2t+1}^e\right\}$.

Proof. See appendix. ■

[6] It might appear objectionable to assume that workers, entrepreneurs and investment bankers all receive the same expected utility. However, one can simply restate the model in terms of efficiency units of human capital, and assume that different agents are endowed with different efficiency units. The analysis would be essentially the same, except that the comparison of expected utilities among ex-ante heterogenous agents would be more cumbersome.

The first thing to notice is that the planner can always adjust the relative consumptions in the first period without affecting any of the technological or incentive constraints. Therefore, starting from any Pareto-efficient allocation, it is possible to construct another Pareto-efficient allocation where agents are indifferent between jobs. The planner could however choose different allocations of capital and monitoring for different entrepreneurs, since this could potentially relax some enforcement constraints. It is not optimal to do so because the production function, the utility function and the monitoring technology are concave. Since financiers and workers do not face enforcement constraints, it is never optimal to give them different allocations. When the enforcement constraint binds, however, the planner chooses to distort the consumption pattern of entrepreneurs relative to workers and financiers.

Lemma 1 allows me to state the planner's problem in a simple form:

$$(\text{SP}) : \max u\left(c_{11}\right) + \beta u\left(c_{22}\right),$$

given k_1 and a_1, and subject to a set of constraints. The resource constraint is:

$$c_{1t} + e_t\left(c_{1t}^e - c_{1t} + x_t + a_t s^e\right) + c_{2t} + e_{t-1}\left(c_{2t}^e - c_{2t}\right) \leq f\left(a_t n_t, e_{t-1} g\left(a_{t-1}, x_{t-1}\right)\right). \quad (7)$$

The law of motion for technology is:

$$a_{t+1} = a_t + h\left(a_t e_t, e_t x_t\right). \quad (8)$$

The enforcement constraint can be written as:

$$z x_t - a_t q\left(\frac{1 - n_t}{e_t} - 1\right) \leq c_{2t+1}^e. \quad (9)$$

The indifference constraint within a generation is:

$$u\left(c_{1t}^e\right) + \beta u\left(c_{2t+1}^e\right) = u\left(c_{1t}\right) + \beta u\left(c_{2t+1}\right) \text{ for all } t. \quad (10)$$

The population constraint is:

$$e_t + n_t \leq 1. \quad (11)$$

And the welfare of future generations is guaranteed by:

$$\bar{U}_t \leq u\left(c_{1t}\right) + \beta u\left(c_{2t+1}\right) \text{ for all } t \geq 2. \quad (12)$$

The control variables are $\{e_t, n_t\}$ chosen in $[0,1]$, x_t in $[0,\infty)$ and $\{c_{1t}, c_{2t}, c^e_{1t}, c^e_{2t}\}$ in $(0,\infty)$. The initial stock of capital k_1, the initial level of knowledge a_1 and the series of utilities $\{\bar{U}_t\}_{t=2..T}$ are given. The solution for consumption, investment, labor and entrepreneurship is typically interior.[7] I only need to study three cases: the first best with a slack enforcement constraint (9), the second best with no bankers and a tight constraint (11), and the interesting case of an active monitoring market and a slack constraint (11).

2.1 First best

The first best is obtained when $z = 0$. Financiers are not needed and all agents are either workers or entrepreneurs. The marginal utilities are equalized between all agents, and, given the indifference constraint (10), the levels of consumption are also equalized. Let R_t be the marginal rate of substitution between t and $t+1$:

$$R_t \equiv \frac{u'(c_{1t})}{\beta u'(c_{2t+1})} \tag{13}$$

Let π_t be the multiplier on the law of motion (8), scaled by marginal utility: it captures the value of a unit increase in labor productivity at time t. The dynamics of π_t satisfy:

$$\pi_t = n_t \frac{\partial f_t}{\partial n_t} - e_t s^e + \frac{\pi_{t+1}}{R_t}\left(1 + e_t \frac{\partial h_t}{\partial e_t}\right) + \frac{e_t}{R_t}\frac{\partial g_t}{\partial a_t}\frac{\partial f_{t+1}}{\partial k_{t+1}}. \tag{14}$$

The first order condition for optimal investment per-entrepreneur, x_t, is simply:

$$R_t = \frac{\partial g_t}{\partial x_t}\frac{\partial f_{t+1}}{\partial k_{t+1}} + \pi_{t+1}\frac{\partial h_t}{\partial X_t} \tag{15}$$

The first term on the right hand side measures the contribution to the future stock of capital, while the second term measures the contribution to future labor productivity. The allocation of workers and entrepreneurs is optimal when:

$$\frac{x_t}{a_t} + s^e + \frac{\partial f_t}{\partial n_t} = \frac{g_t}{a_t R_t}\frac{\partial f_{t+1}}{\partial k_{t+1}} + \frac{\pi_{t+1}}{R_t}\left(\frac{\partial h_t}{\partial e_t} + \frac{x_t}{a_t}\frac{\partial h_t}{\partial X_t}\right). \tag{16}$$

The left hand side of this equation is the cost of adding one entrepreneur and removing one worker. The right hand side is the return to entrepreneurship, properly discounted. Because the functions f, g and h have constant returns to scale, equations (14), (15) and

[7] It is always interior when $\lim_{c\to 0} u'(c) = \infty$ and $f(.,0) = f(0,.) = 0$. Otherwise, there might be corner solutions with no investment, no labor or zero consumption.

(16) can be used to compute a balanced growth path with constant and equal growth rates for productivity and aggregate quantities, constant values for R and π, and constant fractions e and n. When the horizon is finite, it is optimal to set $n_T = 1$ and $x_T = 0$. When it is infinite, there is a transversality condition.

2.2 Second best

We now turn to the case where the enforcement constraint binds. Let $\{\mu_t\}_{t=1..T}$ be the Lagrange multipliers on (9), and let $\{\lambda_t\}_{t=1..T}$ be the multipliers on (7). The marginal rates of substitutions are not equalized when $\mu_t > 0$. The intratemporal condition for the allocation of consumption between workers and entrepreneurs is also affected. Suppose that the social planner decides to provide one extra unit of utility to all agents at time t. For an agent with consumption c, this costs $1/u'(c)$ units of output. For the population of agents, it becomes a weighted average of inverse marginal utilities. At the optimum, this costs must be equal to the relative price of consumption, i.e. $1/\lambda_t$:

$$\frac{1}{\lambda_t} = \frac{e_t}{u'\left(c^e_{1t}\right)} + \frac{1-e_t}{u'\left(c_{1t}\right)} \ . \tag{17}$$

This does not reduce to the usual condition $u'(c_{1t}) = \lambda_{1t}$ because $u'(c^e_{1t}) > u'(c_{1t})$ due to the enforcement constraint. Define:

$$\phi_t \equiv \frac{\mu_t}{\lambda_{t+1}}.$$

The consumption smoothing condition of workers and financiers is (13). For entrepreneurs, it is:

$$\frac{u'\left(c^e_{1t}\right)}{\beta u'\left(c^e_{2t+1}\right)} = \frac{R_t}{1-\phi_t}. \tag{18}$$

The dynamics of π_t become:

$$\pi_t = n_t \frac{\partial f_t}{\partial n_t} - e_t s^e + \frac{\pi_{t+1}}{R_t}\left(1 + e_t \frac{\partial h_t}{\partial e_t}\right) + \frac{e_t}{R_t}\frac{\partial g_t}{\partial a_t}\frac{\partial f_{t+1}}{\partial k_{t+1}} + \frac{\phi_t e_t q_t}{R_t} \tag{19}$$

The optimality condition for investment equates the marginal cost to the marginal return. The marginal cost includes both physical and monitoring costs:

$$R_t + \phi_t z = \frac{\partial g_t}{\partial x_t}\frac{\partial f_{t+1}}{\partial k_{t+1}} + \pi_{t+1}\frac{\partial h_t}{\partial X_t}. \tag{20}$$

Two conditions ensure that the allocation of human capital is optimal. First, the net return to adding an entrepreneur equals the net return to adding a worker. Workers produce output while entrepreneurs deliver capital, but require investment, education and monitoring. Taking into account that their consumptions are also different, we obtain:

$$\frac{c^e_{1t} + x_t - c_{1t} + a_t s^e}{a_t} + \frac{\partial f_t}{\partial n_t} + \frac{c^e_{2t+1} - c_{2t+1}}{a_t R_t} = \frac{g_t}{a_t R_t}\frac{\partial f_{t+1}}{\partial k_{t+1}} - \frac{\phi_t m_t q'_t}{R_t} + \frac{\pi_{t+1}}{R_t}\left(\frac{\partial h_t}{\partial e_t} + \frac{x_t}{a_t}\frac{\partial h_t}{\partial X_t}\right). \tag{21}$$

The second condition for the optimal allocation of agents depends on whether the population constraint (11) binds or not. If it binds, there are no financial intermediaries in equilibrium and:

$$n_t = 1 - e_t. \tag{22}$$

If (11) does not bind, we have an optimality condition for the allocation of financiers and workers. Since these agents have the same consumptions, the planner simply chooses to equalize their marginal productivities:

$$R_t \frac{\partial f_t}{\partial n_t} = \phi_t q'_t. \tag{23}$$

For the remaining of the paper, I focus on the (relevant) case where active financial intermediaries exist in equilibrium. Once again, one can construct a balanced growth path with constant allocations of agents e and n and constant values for R and ϕ.

3 Decentralized equilibrium (DE)

In this section, I study the decentralized competitive equilibrium (DE), and I compare it to the social planner outcome (SP).

3.1 Workers and financiers

In (DE), workers earn the competitive wage and save at rate R_t. The program of a worker is to maximize $u(c_{1t}) + \beta u(c_{2t})$, subject to the budget constraint:

$$c_{1t} + \frac{c_{2t}}{R_t} \leq a_t \frac{\partial f_t}{\partial n_t}.$$

The bankers receive a fee φ_t for each unit of monitoring that they provide. Their budget constraint is:

$$c_{1t} + \frac{c_{2t}}{R_t} \leq \varphi_t.$$

Whenever there are both workers and financiers, the following indifference condition for career choice must hold:

$$a_t \frac{\partial f_t}{\partial n_t} = \varphi_t. \tag{24}$$

With these notations, we obtain the Euler equation (13).

3.2 Entrepreneurs

Each entrepreneur faces an enforcement constraint because she cannot commit to repay her debts. She can purchase m units of monitoring from the banking sector to mitigate this constraint, at a price of φ_t. Her program is therefore

$$\begin{aligned} V^e &= \max_{\{c_t^e\},x,m} u\left(c_{1t}^e\right) + \beta u\left(c_{2t}^e\right), \\ \text{subject to } zx_t - a_t q\left(m_t\right) &\leq c_{2t+1}^e, \\ \text{and } c_{1t}^e + \frac{c_{2t+1}^e}{R_t} + x_t + a_t s^e &\leq \frac{g\left(a_t, x_t\right)}{R_t} \frac{\partial f_{t+1}}{\partial k_{t+1}} - \varphi_t m_t. \end{aligned}$$

Define ϕ_t such that the first order condition for the intertemporal choice of consumption by the entrepreneur is like in equation (18). The optimal choice of monitoring leads to

$$a_t \phi_t q'\left(m_t\right) = R_t \varphi_t \tag{25}$$

The optimal choice of investment leads to:

$$\phi_t z + R_t = \frac{\partial g_t}{\partial x_t} \frac{\partial f_{t+1}}{\partial k_{t+1}}. \tag{26}$$

The entrepreneur equates the private marginal return and marginal cost of investment, but does not take into account the external effects of her activities on future labor productivity. Comparing equations (13) and (18), we see that the entrepreneur chooses a steeper consumption profile than workers or financiers. The entrepreneur takes into account that it is optimal to delay consumption in order to relax the credit constraints.

3.3 Comparison with the social planner's allocation

The last equilibrium condition of the decentralized equilibrium is that investment equals savings:

$$a_t n_t \frac{\partial f_t}{\partial n_t} = e_t \left(c_{1t}^e + x_t + a_t s^e\right) + \left(1 - e_t\right) c_{1t}$$

Of course, (SP) faces no such constraint because (SP) can always redistribute across generations. For simplicity, I restrict my attention to taxes that redistribute income only within a generation. Other allocations can be decentralized by adding transfers across generations.

The indifference condition (10) and the market clearing conditions are the same in (SP) and in (DE). Using (25), we see that the Euler equations and the worker/banker career choice (23, 24) are also equivalent. The first discrepancy appears between the investment equations (20) and (26) when $h_X \neq 0$. The second discrepancy appears in the career choice between entrepreneurs and workers/bankers. Using the budget constraints of workers and entrepreneurs, we see that in (DE):

$$\frac{x_t + a_t s^e + c_{1t}^e - c_{1t}}{a_t} + \frac{\partial f_t}{\partial n_t} + \frac{c_{2t+1}^e - c_{2t+1}}{a_t R_t} = \frac{g_t}{a_t R_t} \frac{\partial f_{t+1}}{\partial k_{t+1}} - \frac{\phi_t q'(m_t)\, m_t}{R_t} \tag{27}$$

The corresponding condition in SP is (21). Once again, a discrepancy appears when $h_X \neq 0$ or $h_e \neq 0$. The decentralized outcome is constrained efficient when there are no externalities in production. Credit constraint by themselves do not create scope for policy intervention in this model. When external effects are present, however, the perceived returns to investment and the value of becoming an entrepreneur are both too low.

4 Optimal taxation

I consider first the implementation of the second best. The general principle is that externalities should be corrected at the source, and that, once this is done, no other taxes are needed. In the model presented above, however, there are credit constraints in addition to externalities, and one might wonder whether these constraints create the need for specific taxes. It turns out that the answer is no: the second best is obtained by subsidizing entrepreneurs and investment. Labor income taxes are generally positive, but the tax rates are the same for the financial and non financial sector.

I then consider the third best, assuming that the government cannot subsidize young entrepreneurs directly. The analysis of the third best requires a quantitative calibration to properly assess the various economic forces. I use the calibrated model to discuss the efficiency of subsidies to the financial sector.

4.1 Implementation of the second best

In this section, I study how the constrained efficient equilibrium can be decentralized with subsidies and income taxes. Let τ_t^x and τ_t^e denote the subsidies to investment and scientific education. Let τ_t^w and τ_t^ϕ denote the tax rates of labor income in the industrial and financial sectors. Capital income is not taxed, and all entrepreneurial income is treated as capital income.[8] Lump sum transfers can be used to balance the budget of the government.

Proposition 1 *The second best outcome can be decentralized with an investment subsidy and the same income tax rate in the financial and non-financial sectors. The optimal tax rates, expressed as functions of the second best allocations, are:*

$$\tau_t^x = \frac{\pi_{t+1}}{R_t} \frac{\partial h_t}{\partial X_t},$$

and

$$\tau_t^\phi = \tau_t^w = \frac{\pi_{t+1}}{R_t} \frac{\partial h_t}{\partial e_t} / \frac{\partial f_t}{\partial n_t}.$$

Equivalently, the second best can be decentralized by subsidizing investment at the rate τ_t^x defined above, and scientific education at the rate:

$$\tau_t^e = \frac{\pi_{t+1}}{s^e R_t} \frac{\partial h_t}{\partial e_t}.$$

Proof. See appendix. ■

External effects determine the characteristics of the optimal tax system. Consider first the case where external effects depend only on aggregate investment, and $h_e = 0$, as in Romer (1986). The optimal tax rates τ_t^w and τ_t^ϕ are then both equal to zero. This is surprising, because the partial derivative h_X appears in two different equations: the investment equation, and the career choice equation. How is it possible, then, to implement the second

[8] In practice, there is much confusion in the Law as to what distinguishes capital gains from ordinary income, and why they should be treated differently. Weisbach (2007) argues that "At best, we can try to observe where the tax law draws the lines [..] There appears to be two key factors. First, the more entrepreneurial the activity, the more likely the treatment will be capital. Second, the more that labor and capital are combined into a single return, the more likely it will be treated as capital [...] Entrepreneurs such as founders of companies get capital gains when they sell their shares even if the gains are attributable to labor income. For example, most or possibly all of Bill Gates's fortune comes from his performance of services for Microsoft, but the overwhelming majority of his earnings from Microsoft will be taxed as capital gain."

best with only one instrument? To understand this result, notice first that investment subsidies increase the value of becoming an entrepreneur. When $h(.)$ is only a function of X, the external effects in equation (21) are measured by $x_t \pi_{t+1} h_{Xt}/R_t$. The effective subsidies received by an entrepreneur are $x_t \tau_t^x$. Since $\tau_t^x = \pi_{t+1} h_{Xt}/R_t$, the investment subsidies also solve the career choice problem.

The polar opposite happens when external effects do not depend on aggregate investment for a given number of entrepreneurs. A simple example is when investment has a fixed scale $\bar{x}$ and the only effective choice variable is e.[9] In this case, the investment subsidy is zero, and the optimal system is to tax the labor income of workers and financiers, and redistribute lump-sum transfers to all agents. Alternatively, one could interpret such a scheme as a subsidy τ^e to education in those fields that are complement with innovation and entrepreneurship, financed by lump-sum taxes.

Finally, it is remarkable that in all cases, the second best is obtained with the same tax rates in the financial and non-financial sectors.[10] The reason is the following. Suppose that one has found a tax system that implements the second best, without taxing capital income. This tax system does not affect the Euler equations. Therefore, R_t and ϕ_t must be the same as in the social planner's allocation. Consider now the programs of the workers and bankers. The indifference condition for career choice with taxes is $(1-\tau_t^w) R_t f_{n,t} = \left(1-\tau_t^\phi\right) \phi_t q'(m_t)$. Since R and ϕ are the same as in the planner's allocation, we must set $\tau_t^w = \tau_t^\phi$. In other words, because the externalities do not enter directly the career choice between workers and bankers, a tax system that manages to deal with these externalities should treat workers and financiers in the same way.

It is important to realize, of course, that this is only true in a tax system that actually implements the second best outcome. I now turn to the case where the second best outcome cannot be implemented.

4.2 Taxation in a third best economy

What happens if we restrict the menu of tax instruments available to the government? More precisely, suppose that investment subsidies are not available. This case is of practical

[9] This can be achieved by making the function $g(x)$ extremely concave, until it looks like a step function.

[10] Allowing the entrepreneurs to produce some output when they are young, as though they were partly workers, does not change this result.

relevance because it is difficult to subsidize young firms and small firms efficiently. Tax credits for investment and R&D work well only when profits are positive, which is not the case for most young firms. It is also well-known that the rate of noncompliance is much higher for taxes on self-employed and other businesses' profits than for taxes on wages and salaries (Plumley (2004)). In practice, there are large economies of scale in tax collection, and tax authorities seek to minimize the number of agents with whom they must deal. Banks and financial institutions are stable and have long term relationships with tax authorities and regulators, in emerging countries and in developed countries, while even in the U.S., the survival rate of private businesses over their first 10 years is only about 34% (Moskowitz and Vissing-Jorgensen (2002)).

It is therefore much less costly to subsidize the financial sector than to subsidize small firms in the industrial sector. But does it improve welfare? The answer, it turns out, depends on the type of externality one considers. In the case where $h_e = 0$, welfare is enhanced if the new tax system increases aggregate investment. In the case where $h_X = 0$, welfare is enhanced if the new tax system increases the number of entrepreneurs. In practice, of course, it is difficult to achieve both goals, and we need a quantitative model to analyze the issue.

Calibration

I calibrate the model by computing the balanced growth path without taxes. I assume that the utility function $u(c)$ has a constant coefficient of relative risk aversion of 2 (since the model is non-stochastic, it is really the elasticity of intertemporal substitution that matters). I set the annual discount factor to 0.97 and the length of one period to 25 years, so $\beta = 0.97^{25}$. The production function is Cobb-Douglas:

$$y_t = k_t^{1-\alpha} (a_t n_t)^{\alpha}$$

with $\alpha = 0.6$. The investment function is:

$$g(a_t, x_t) = \gamma a_t^{1-\theta} x_t^{\theta}$$

with $\gamma > 0$ and $\theta \in (0, 1)$. The monitoring function is also assumed to be linear:

$$q(m_t) = q m_t,$$

with $q > 0$. I choose the parameters of the model to match a size of 6% for the financial sector, an equilibrium interest rate of 3.5% per year, and a growth rate of productivity of 1% per year, which implies that $h = 1.01^{25} - 1$. In the calibration, I set the education parameter s^e to zero, but the results are not sensitive to this choice.[11] Investment in the model should include physical capital as well as R&D, so I target a value for the ratio to GDP of 12.5%, 10% for physical investment and 2.5% for R&D.

I must also include some information about the degree of moral hazard. The severity of the moral hazard problem can be understood by comparing $z_t x_t$ to $g(a_t, x_t)\, \partial f_{t+1}/\partial k_{t+1}$. The first term is the amount of consumption the manager could obtain by misbehaving (without monitoring). The second term is the realized value of its project. Philippon (2007), using information from the distribution of investment and income across firms, calibrates a value of 0.82. Philippon and Sannikov (2007), in a dynamic agency model, calibrate a value of 0.77 and show that this is consistent with micro estimates from actual Venture Capital contracts. I use a value of 0.8.

The quantitative targets are therefore:

R	b	ex/y	$zx/(g(a,x)\, f_k)$
1.035^{25}	0.06	0.125	0.8

Solving the model, this leads to:

γ	θ	q	z
0.59	0.79	0.95	3.28

The tightness of credit constraints is measured by ϕ, which is zero when the constraints do not bind, and has an upper bound of one. With the calibrated parameters, the model predicts a value of $\phi = 0.268$. This means that, while the annual market return is 3.5%, the return on internal funds would be 4.8%. The predicted fractions of entrepreneurs and workers are $e = 7.18\%$ and $n = 86.82\%$.

So far I did not need to specify the function h, since the calibration relies only on its steady state value. To analyze the different tax systems, I assume that the external effects are linear in e and X:

$$h(e, X) = 1 + h_e \cdot e + h_X \cdot X,$$

[11] I have experimented with values up to one half of first period entrepreneurial consumption. In practice, because the calibration targets a given investment to GDP ratio and a given size for the financial sector, the values of q and γ adjust in such a way that the choice of s^e does not matter much.

where h_e and h_X are constant. The calibration does not pin down the elasticities h_e and h_X independently, but the consequences of introducing a particular tax depend on the relative values of these elasticities. I therefore consider two cases, one where h_e is zero and the externalities come from aggregate investment, as in Romer (1986), and another case where half of the externalities come from the number of entrepreneurs: $h_e = 0.5\,(h-1)\,/e$.

I study two types of tax systems. Both include lump-sum taxes and transfers to balance the budget of the fiscal authority, but they exclude all investment subsidies. The first system imposes a tax on labor income in the industrial sector, at a rate τ^w. This tax system alters the career choice of agents by making it relatively more attractive to become either a financier or an entrepreneur. The tax revenues are rebated as lump-sum payments to all agents. The second tax system imposes a subsidy or a tax on income in the financial sector, at rate τ^ϕ. The after-tax revenue of financiers becomes $\left(1-\tau^\phi\right) q\phi/R$, and the budget is balanced with with lump-sum transfers.

Taxes and Growth

Figure 1 depicts the consequences of these tax systems for the growth rate of the economy. An increase in the growth rate is a necessary condition for a Pareto improvement, but it is not sufficient because agents discount the future. For small tax rates, however, I find that increases in growth always allow the Planner to improve the welfare of all generations. I report growth rates because they are easier to interpret.

The top panel of Figure 1 deals with taxes on labor income in the non-financial sector. Two fundamental forces explain the results. It is clear that an increase in τ^w leads to a drop in the number of workers, and to an increase in the number of entrepreneurs. The drop in the number of workers decreases output and increases the interest rate. With fewer resources an more entrepreneurs, investment per entrepreneur falls. When the external effects come from aggregate investment, the two forces tend to cancel out. This explains why the solid line is relatively flat. When a significant fraction of the external effects come from the number of entrepreneurs, on the other hand, significant gains can be obtained by taxing labor income.

The bottom panel of Figure 1 studies the consequences of subsidizing or taxing the financial sector.[12] When τ^{ϕ} decreases, more agents become financiers. This decreases the number of workers and entrepreneurs, and increases the interest rate. While the number of entrepreneurs falls, investment per entrepreneur increases because the financial constraints are relaxed. The effect on aggregate investment is theoretically ambiguous, but in practice aggregate investment increases. As a consequence, when $h_e = 0$, subsidizing the financial sector increases the growth rate of the economy. When $h_e = 0.5\,(h-1)\,/e$, the fall in e and the increase in X mostly cancel out. Of course, if we were to consider the extreme case where $h_X = 0$, it would be optimal to tax the financial sector. However, in this case, the top panel suggests that it would be even more efficient to tax labor income in the industrial sector.

The influence of the nature of the external effects on the optimal tax system sheds light on the current debate regarding the taxation of private equity funds. During his Senate Finance Committee hearing, Bruce Rosenblum, managing director of the Carlyle Group, a Washington-based private equity fund, argued that, if the tax rate is increased, some deals will not be done, "*there will be entrepreneurs that won't get funded and turnarounds that won't get undertaken.*"[13] On the other hand, Robert H. Frank argues that "*No one denies that the talented people who guide capital to its most highly valued uses perform a vital service for society. But at any given moment, there are only so many deals to be struck. Sending ever larger numbers of our most talented graduates out to prospect for them has a high opportunity cost, yet adds little economic value. By making the after-tax rewards in the investment industry a little less spectacular, the proposed legislation would raise the attractiveness of other career paths, ones in which extra talent would yield substantial gains.*"[14] In essence, one argues that aggregate investment is elastic and is the variable we should care about, while the other argues that it is not very elastic and that the number of entrepreneurs is the variable of interest. The model makes is clear why they reach opposite conclusions regarding the optimal taxation of the financial sector.

[12] The magnitudes in panels 1a and 1b are not comparable because the financial sector is much smaller than the industrial sector, so that a tax rate τ^{w} of 1% involves transfers equivalent to a tax rate τ^{ϕ} of more than 10%.

[13] "Industry Groups Warn of Adverse Effects of Private Equity Tax Hike", by Alan Zibel, Associated Press Business Writer, Tuesday July 31 2007.

[14] A Career in Hedge Funds and the Price of Overcrowding, The New York Times, July 5, 2007.

5 Conclusion

I have studied an economy with career choices, financial constraints and externalities from innovation and entrepreneurship. The implementation of the second best requires investment subsidies to the extent that there are externalities linked to aggregate investment, and subsidies to entrepreneurship or to scientific education to the extent that there are externalities linked to the number of entrepreneurs and scientists. Once these subsidies are in place, it is optimal to set exactly the same tax rate on labor income in the financial and non-financial sectors, even in the presence of binding credit constraints.

When the second best subsidies are not feasible, the model sheds light on the two economic forces that determine the efficiency of subsidizing the financial sector. On the one hand, subsidizing the financial sector increases the investments that entrepreneurs can undertake. On the other hand, it decreases the number of entrepreneurs by attracting more individuals to the financial sector. In the quantitative analysis, I find that, starting from a competitive economy without taxes, the introduction of a subsidy to the financial sector increases the growth rate of the economy in the benchmark case where the external effects depend on aggregate investment and R&D.

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A Proof of Lemma 1

Fix the number of entrepreneurs e_t and aggregate investment X_t. From the law of motion (6), this implies that a_{t+1} is given. Let $i = 0$ denote a particular entrepreneur. Consider the following program, denoted SP^0:

$$\max u\left(c_{1t}^0\right) + \beta u\left(c_{2t+1}^0\right)$$

subject to the set of constraints

$$\begin{aligned}
\int_{i\in e} c_{1t}^i &\leq C_t : \{\lambda_t\} \\
\int_{i\in e} c_{2t+1}^i - f\left(a_{t+1}n_{t+1}, \int_{i\in e_t} g\left(a_t, x_t^i\right) di\right) &\leq -C_{t+1} : \{\lambda_{t+1}\} \\
\int_{i\in e_t} m_t^i &\leq M_t : \{\theta_t\} \\
\int_{i\in e_t} x_t^i di &\leq X_t : \{\chi_t\} \\
z x_t^i - a_t q\left(m_t^i\right) - c_{2,t+1}^i &\leq 0 : \left\{\mu_t^i\right\} \\
\bar{U}_t - u\left(c_{1,t}^i\right) + \beta u\left(c_{2,t+1}^i\right) &\leq 0 : \left\{\gamma_t^i\right\}
\end{aligned}$$

And, to be consistent with the constraint that all agents must receive the same utility in the original problem, $\bar{U}_t$ is chosen such that

$$\bar{U}_t = u\left(c_{1t}^0\right) + \beta u\left(c_{2t+1}^0\right)$$

For given values of e_t, b_t and X_t, the first two constraints keep the allocation of consumption to the other agents feasible. The other constraint are satisfied by the original program of the social planner. For the solution of the planner to be optimal, the allocation among entrepreneur must therefore solve (SP^0). The optimality conditions are:

$$\begin{aligned}
\frac{u'\left(c_{1,t}^i\right)}{\beta u'\left(c_{2,t+1}^i\right)} &= \frac{\lambda_t}{\lambda_{t+1} - \mu_t^i} \\
\lambda_{t+1}\frac{\partial g\left(a_t, x_t^i\right)}{\partial x_t^i}\frac{\partial f_{t+1}}{\partial k_{t+1}} &= \mu_t^i z + \chi_t \\
\theta_t &= \mu_t^i a_t q'\left(m_t^i\right)
\end{aligned}$$

Let us show that μ_t^i must be the same for all $i \in e_t$. Consider two entrepreneurs i and j and suppose that the enforcement constraint binds more for i and than for j: $\mu_t^i > \mu_t^j$. Therefore $u'\left(c_{1t}^i\right)/u'\left(c_{1t}^j\right) > u'\left(c_{2t+1}^i\right)/u'\left(c_{2t+1}^j\right)$. Since both i and j receive the same ex-ante utility, we must have $c_{1t}^i < c_{1t}^j$ and $c_{2t+1}^i > c_{2t+1}^j$. Since $\mu_t^i > \mu_t^j$ and $q(.)$ is concave, it must be the case that $m_t^i \geq m_t^j$. Therefore $z x_t^i = a_t q\left(m_t^i\right) + c_{2,t+1}^i > a_t q\left(m_t^j\right) + c_{2,t+1}^j \geq z x_t^j$ and $x_t^i > x_t^j$. The optimality condition for investment implies that $\partial g\left(a_t, x_t^i\right)/\partial x_t^i > \partial g\left(a_t, x_t^j\right)/\partial x_t^j$. Since g is concave, this implies that $x_t^i < x_t^j$, which contradicts the previous inequality. Therefore, μ_t^i must be the same for all $i \in e_t$. QED.

B Proof of Proposition 1

For bankers and workers, the consumption/saving decision is unchanged and the career choice condition becomes:

$$\left(1-\tau_t^w\right) R_t a_t \frac{\partial f_t}{\partial n_t} = \left(1-\tau_t^\phi\right) \varphi_{t+1}.$$

The program of the entrepreneur changes because her budget constraint becomes:

$$c_{1t}^e + \frac{c_{2t+1}^e}{R_t} + \left(1-\tau_t^x\right) x_t + \left(1-\tau_t^e\right) a_t s^e \leq \frac{g\left(a_t, x_t\right)}{R_t} \frac{\partial f_{t+1}}{\partial k_{t+1}} - \frac{\varphi_{t+1} m_t}{R_t}.$$

The Euler equation of the entrepreneur does not change, but the first order condition for investment becomes:

$$\phi_t z + \left(1-\tau_t^x\right) R_t = \frac{\partial g_t}{\partial x_t} \frac{\partial f_{t+1}}{\partial k_{t+1}}. \tag{28}$$

The optimal choice of monitoring is still:

$$a_t \phi_t q'\left(m_t\right) = \varphi_{t+1}.$$

We are looking for tax rates $\left(\tau^\phi, \tau^w, \tau^x\right)$ that decentralize the SP outcome. Because the Euler equations of workers and bankers have not changed, we must have the same R. Similarly, from the Euler equation of the entrepreneurs, we must have the same ϕ. From the career choice of workers and financiers, it follows that:

$$\tau_t^\phi = \tau_t^w.$$

The tax rate on labor income is the same inside or outside the financial services industry. From (20), we see that $R_t + \phi_t z = \frac{\partial g_t}{\partial x_t} \frac{\partial f_{t+1}}{\partial k_{t+1}} + \pi_{t+1} \frac{\partial h_t}{\partial X_t}$. From (28), we see that $R_t + \phi_t z = \frac{\partial g_t}{\partial x_t} \frac{\partial f_{t+1}}{\partial k_{t+1}} + \tau_t^x R_t$. Therefore, we must have:

$$\tau_t^x = \frac{\pi_{t+1}}{R_t} \frac{\partial h_t}{\partial X_t}.$$

Finally, to get the correct number of entrepreneurs, we must ensure that the career choice coincides with the choice of the social planner. With taxes, the career choice is:

$$x_t + a_t s^e + c_{1t}^e - c_{1t} + a_t \frac{\partial f_t}{\partial n_t} + \frac{c_{2t+1}^e - c_{2t+1}}{R_t} = \frac{g_t}{R_t} \frac{\partial f_{t+1}}{\partial k_{t+1}} - \frac{a_t \phi_t b_t}{e_t R_t} q_t' + a_t \left(\tau_t^x \frac{x_t}{a_t} + \tau_t^e s^e + \tau^w \frac{\partial f_t}{\partial n_t} \right).$$

Comparing with (21), we see that the two equations are equivalent if and only if:

$$\tau_t^x \frac{x_t}{a_t} + \tau_t^e s^e + \tau^w \frac{\partial f_t}{\partial n_t} = \frac{\pi_{t+1}}{R_t} \left(\frac{\partial h_t}{\partial e_t} + \frac{x_t}{a_t} \frac{\partial h_t}{\partial X_t} \right).$$

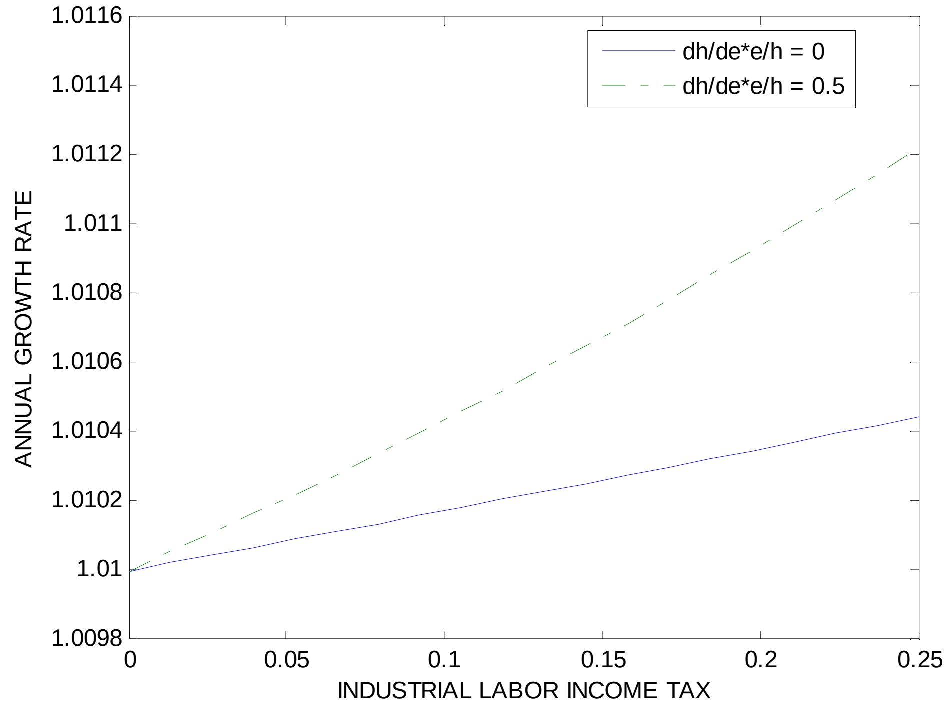
Using the optimal value of τ_t^x, this leads to:

$$\tau_t^e s^e + \tau_t^w \frac{\partial f_t}{\partial n_t} = \frac{\pi_{t+1}}{R_t} \frac{\partial h_t}{\partial e_t}.$$

I have shown the necessary conditions for implementation. It is easy to check that they are sufficient as well, since all the other equilibrium conditions are also satisfied. QED.

Figure 1: Growth and Taxes in a Third Best Economy

1a: Tax on Labor Income in Industrial Sector



1b: Tax on Income from Financial Sector