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The regulatory trade-off in real & financial markets

Bodo Herzog[1, 2, 3]

[1]Economics Department, Institute of Finance and Economics (IFE), Reutlingen, Germany
[2]ESB Business School, Reutlingen University, Germany
[3]Reutlingen Research Institute (RRI), Reutlingen University, Germany

Email address:
Bodo.Herzog@reutlingen-university.de

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Abstract: It remains undeniable that the regulatory framework in place prior to the financial crisis is built on a flawed system. But does this automatically suggest that more regulation is better? In general, we have to distinguish between the quantity and quality of rules and in particular, the enforcement. The last issue does not necessarily mean we need more regulation – sometimes a better enforcement is enough. Still there remains the question about the degree of regulation. This paper builds a new theory on the optimal degree of the regulatory trade-off. We elucidate the optimal degree of efficacy in financial regulation and compare it with the optimal degree in goods market regulation. We prove that financial regulation does not follow a simple economic trade-off by costs and benefits. In finance, the regulatory trade-off is a boundary solution, i.e. the efficient solution is either no regulation or comprehensive regulation. Either way you prefer, financial markets must be regulated differently in comparison to the real economy.

Keywords: Financial Regulation, Moral Hazard, Externalities and Optimality of Regulation

1. Introduction

Many experts argue that the deficiencies of the regulatory system prior to the financial crisis caused the recent mess. In fact, one problem is the mere focus on microprudential regulation in banking and finance [1,2]. The microprudential approach is just aimed at preventing the failure of individual financial institutions. Thus, it has a partial equilibrium view without taking into account network effects and interdependencies over time. Consequently, to mitigate the systemic risk we have to add a macroprudential approach that recognizes the general equilibrium effects, i.e. feedback loops, interdependencies, and bubbles [3]. Interestingly, despite the on-going debate about the Dodd-Frank Act in the US, there is no regulatory theory which indicates the optimal degree of regulation. We provide a simple theory that identifies the regulatory trade-off in different fields of market environments – real and financial markets. Subsequently, our model closes a current gap in economics and has strong policy implications. But the new insights will also help business leaders to prepare for the challenges ahead.

Putting together the existing insights from the literature on banking regulation and the functioning of financial markets [4], we argue for a different approach to study this problem. We utilize an optimal control approach under specific constraints. Here, we model the specific environments of real and financial markets and identify the differences. This new idea allows us to analyse the regulatory trade-off and is in contrast to the standard approach by [5].

We find novel insights about what distinguishes regulation in real and financial markets. First, the regulatory trade-off in the real economy and financial economy is different. While regulation in the real economy follows more likely a typical cost and benefit analysis, optimal regulation in financial markets is rather different. In financial markets international regulation plays an important role because financial assets are mobile and regulatory arbitrage puts conflicting incentives in place. Second, we show that financial regulation has no singular regulatory trade-off of balancing costs and benefits. It rather has a boundary solution, i.e. either no international regulation or comprehensive regulation for all states. Third, we find that the regulatory trade-off in financial markets depends on the shadow price (effect on utility) for risky assets and the costs of regulation. The higher the benefit from risky assets in comparison to the costs of regulation, the more likely no international regulation is the efficient solution. This sounds astounding and is close to the pure free-market or Hayekian view. However, this finding just demonstrate as long as all regulatory authorities do not agree on a level playing field in finance, regulation is insufficient and unsuccessful. From a domestic point of view, an efficient or optimal regulatory framework requires mutually agreed rules on aglobalscale. Only such a regulatory framework is able to consider the problem of systemic risk and interdependencies.

The literature on banking regulation has a long tradition. There are different aspects considered in this literature. The first and most important issue is the failure of financial institutions. [6]argue for a deposit insurance that could provide a solution to bank runs. But this is only an efficient solution for standalone countries with no international linkages. Another aspect in literature is solvency regulation and the implications of capital buffers [7,8,9]. More in our interest is a small literature on the question of who should be regulated. [10]argue that banks possess better information regarding their own risks and returns and just regulators will never be effective to regulate the dynamics of financial entities. However, we approach the existing challenges of financial regulation from a different angle, and thus get fresh answers to a current debate in politics and economics.

The rest of the paper is organized as follows. In section 2, we present the benchmark and extended model and discuss the results. Section 3, concludes the paper.

2. The Model

Let us now develop a simple model that illustrates the main difference between the regulatory trade-off in the financial and real economy. In general, the basic trade-off in regulation is due to the additional (transaction) costs of new rules which will reduce beneficial but risky investments. On the other hand regulation contains benefits because it ensures (real or financial) market stability and mitigates institutional failures or a crisis. Next, we model this idea in a rigorous analytical framework.

Let *s(t)* denote the stock of risky projects or risky financial investments and *l(t)* the newly defined regulatory safeguards or buffers. Both variables are dependent on time *t*. In financial markets it is possible to imagine that *s(t)* is the stock of risky assets and *l(t)* the liquidity buffers. Furthermore, in country *i* the benevolent regulator maximize the stability of the real and financial economy, given the typical characteristics in each market environment. Suppose market stability is a scarce resource in the economy. The relationship between the change of risky assets over time *ds(t)/dt* and the safeguards *l(t)* gets

$$-\dot{s}(t) = l(t). \tag{1}$$

Intuitively, the risky investments are a declining function of the regulatory requirements over time. This reflects the regulatory trade-off: More regulation or safeguards *l(t)* imply higher costs in terms of lower investments and thus a decline in investments over time $-\dot{s}(t)$. Hence, *l(t)* produce either real or financial stability in markets and creates utility for the regulator. To describe this idea analytically, we define a typical concave production function *F(l(t))* where the first derivative is positive *F'(l(t)) > 0* and second derivative is negative *F"(l(t)) < 0*.

However, the more regulation is in place the lower the investments in the economy. This linkage implies less economic or financial growth and thus welfare costs. We model this by a typical cost function *Z(l(t))*. The derivatives are as in standard economics: *Z'(l(t)) > 0*, and *Z"(l(t)) > 0*. Both functions are elements of the overall utility function *U(F(l),Z(l))* of a benevolent regulator in country *i*. Again, we suppose that the derivative of the utility function is as in standard economics:

$$U(.)_F > 0,\ U(.)_Z < 0, \text{ and}$$

$$U(.)_{FF} < 0, U(.)_{ZZ} < 0,\ U(.)_{FZ} = 0.$$

The first derivatives demonstrate that marginal utility increases with more produced stability *F(l(t))* and decreases with higher costs *Z(l(t))* due to new regulatory rules. The second derivatives indicate that both functions have diminishing returns or costs of regulation.

Note that both functions inside the utility function are only dependent on *l(t)*, i.e. the regulatory safeguards. Thus, the primary control variable for the benevolent regulator in country *i* is to find the optimal amount of regulatory safeguards or buffers *l(t)*. Next, we solve the benchmark model for the real economy. We suppose that this model reflects the regulatory situation of a real economy. On the contrary, financial markets are special because financial assets are highly mobile and international financial regulation is still pretty diverse. Thus, regulatory arbitrage is a specific problem in finance but not in the real economy. International trade is based on mutual free trade agreementswith strict and rigorous product standards. This is the key difference to finance. In financial markets the national safeguards *l(t)* behave differently – sometimes even in contraction to rules in other countries – which gives incentives to regulatory arbitrage. That means you move your financial assets to countries with less regulatory requirements and safeguards to maximize your domestic profits. This simple difference between real and financial markets may sound astonishing but it reflects the current debate in financial regulation. Today several experts argue for more macroprudential regulation in finance, i.e. taking into account the interdependencies, systemic risk, and feedback effects in financial markets. Thus, the major difference between real and financial markets is simply characterized by the issue of interdependencies which require both a level playing field and regulation which accounts for those effects. Now, let us first come back to the modelling of the regulatory problem in the real economy.

Suppose the benevolent regulatory in country *i* maximizes utility by determining the optimal time path of regulatory safeguards or buffers. In this case the regulator solves the following problem

$$\max_{l(t)} \int_0^T U\big[F\big(l(t)\big)\,;\,Z\big(l(t)\big)\big]dt$$

$$s.t. -\dot{s}(t) = l(t) \tag{2}$$

where$s(0) = s_0$ and $s(T) \geq 0$. We compute the solution of this optimal control problem by setting the Hamiltonian function such as

$$H\big(l(t)\big) = U\big[F\big(l(t)\big)\,;\,Z\big(l(t)\big)\big] - \lambda(t)l(t). \tag{3}$$

Next, we maximize *H* with respect to the control variable *l(t)*. The next proposition summarizes the solution.

Proposition 1

The solution of the optimal control problem for the real economy, after optimizing the Hamiltonian function in respect to l(t), results in

$$U_F \frac{dF(l(t))}{dl(t)} + U_Z \frac{dZ(l(t))}{dl(t)} = 0. \tag{4}$$

The proof of proposition 1 is relegated to appendix A. But the intuition of proposition 1 is equally trivial and important. The first term in equation (4) measures the benefits of market stability in the commodity market via more regulatory safeguards *l(t)*. The second term, expresses the disutility or costs of regulation. Consequently, the optimal degree of regulation – i.e. the regulatory trade-off – results by balancing or equating costs and benefits in equation (4). In summary, the optimal amount of regulatory safeguards in the real economy follows an economic trade-off of costs and benefits determined by equation (4).

Admittedly, this intuitive solution is only the case for our benchmark model which describes a pure real economy. However, as pointed out earlier, the optimal regulatory trade-off might be different in financial markets because of the specifics in finance. To analyse the regulatory trade-off in financial markets we need to understand the different mechanisms in financial markets.

In the benchmark model, we have assumed that the regulatory costs, *Z(t),* are a flow variable that dissipate over time. However, the financial crisis has illustrated that costs of regulation does not dissipate over time. In contrary, companies undertake all they can to reduce legal costs especially via regulatory arbitrage. This issue is a particular problem in finance because financial investments are mobile across countries. Hence, we have to consider the international network of rules and regulations – with loopholes and sometimes even contradictions to national laws – that affect the (national) cost function of regulation. Ourmodelling approach takes into account that especially systemic riskin finance can only be reduced by a consistent framework of international regulation. Suppose the following relationship,

$$\dot{Z}(l(t)) = bl(t) - ca(t) - dZ(t) \tag{5}$$

where*b,c > 0* and *0 < d < 1,* and allparameters are constant coefficients. Intuitively, the change of costs $\dot{Z}(l(t))$ due to regulation depends on three terms. First, the national safeguards/rules *l(t)* themselves. The higher the required safeguards, the higher the explicit and implicit costs due to fewer money for investments *s(t)*. Second, the consistency and amount of international regulation *a(t)*. A more consistent and sophisticated international structure of rules establishes a level playing field and thus mitigates the costs of national regulation and regulatory arbitrage. Third, it depends from the level of the cost function *Z(t)* too. Obviously, the potential increase of regulatory costs over time should be less if the existing amount of safeguards and thus costs are already high. To close the model, we take the variable *a(t)* – reflecting the international level of regulation – as a further control variable into consideration such as

$$\dot{s}(t) = -a(t) - l(t). \tag{6}$$

Equation (6) states that higher national safeguards *l(t)* and higher international safeguards *a(t)* reduce the growth of risky assets/investments over time. This is intuitive because the higher the buffers a financial institution has to hold, the lower the amount of money for risky investments. Consequently, the optimal control problem in financial markets for the benevolent regulatory in country *i* results in

$$\max_{l(t),a(t)} \int_0^T U\big[F\big(l(t)\big)\,;\,Z(l(t), a(t), Z(t))\big]dt \tag{7}$$

$$s.t. \dot{s}(t) = -a(t) - l(t)$$

$$\dot{Z}(l(t)) = bl(t) - ca(t) - dZ(t)$$

where $s(0) = s_0$, $s(T) \geq 0$, and $Z(0) = z_0$, $Z(T) \geq 0$, and $0 \leq a(t) \leq A$. The last inequality captures the international range of regulation which has an upper limit of comprehensive regulation for all *A*. But realistically an agreement about international regulation in finance is always limited by a compromise, $\widehat{a(t)} \in [0, A]$. Negotiating international rules is a sophisticated endeavour due to conflicting interests across countries. Thus a compromise $\widehat{a(t)}$ is frequently the best result you can get. This implies that international regulation *a(t)* ranges always in an interval: Either no compromise and no common rules $(a(t) = 0)$, or all countries agreeat the upper limit $(a(t) = A)$. Some level between the two extreme regimes is denoted by $a(t) = \widehat{a(t)}$. The Hamiltonian function for this problem – let me again stress that this is the optimal control problem of the financial sector – yields

$$H(l_t, a_t) = U\big[F(l_t); Z\big(l_t, a_t, Z(t)\big)\big] +$$
$$+\lambda_Z(t)[bl_t - ca_t - dZ(t)] - \lambda_s(t)[l_t + a_t] \tag{8}$$

where the subscript of each costate variable λ_Z indicates the state variable associated with it and the subscript *t* indicates time dependencies. The benevolent regulator in country *i* optimizes the Hamiltonian *H* with respect of *l(t)* and *a(t)*. Note, that in this case we have to consider the

Kuhn-Tucker conditions $\partial H/\partial l_t \leq 0$, together with the complementary-slackness condition $l(t)(\partial H/\partial l_t) = 0$. Both conditions show that we can rule out *l(t) = 0*, i.e. no national safeguards is not a solution for the financial sector (Appendix B).

Theorem

The optimal degree of international regulation in financial markets a(t) will never be in the interior of the interval $a(t) \in (0, A)$. The optimal level of regulation in finance, from the view of an benevolent regulator in country i, gets a boundary solution with either a(t) = 0 or a(t) = A.

The proof is in appendix B. This Theorem provides an absolutely new insight into the dilemma of financial regulation from a national point of view. The national regulator who is maximizing the welfare of its citizens will never have an optimal solution in a financially integrated and interdependent world because every weak compromise, $\widehat{a(t)}$, inside the interval is not efficient. Intuitively, as long as one country x offers regulatory arbitrage every compromise of course is ineffective. Hence, the firms in country i move assets and investments easily to country x even this country is very small for instance an island. Even more surprising is the implication that if all countries agree on a weak compromise, $0 < \widehat{a(t)} < A$, it is not an optimal solution either. The reason is that international regulation in-between increase the costs of regulation *Z(l(t))* but does not produce sufficient (financial) stability *F(l(t))*. Consequently, only no regulation or comprehensive regulation at the upper limit *A* are a necessary and sufficient solution of the optimal control problem of the benevolent regulator in country *i*.

The final step is an in-depth analysis of the two boundary solutions *a(t) = 0* or *a(t) = A* of international regulation in financial markets. What determines both states? We are able to show that the shadow price of risky assets (λ_s) as well as the shadow price of regulation ($b\lambda_Z$) are the two distinguishing factors.

Proposition 2

The boundary solution of international regulation is determined by the shadow price of risky assets in comparison to the shadow price of the regulatory costs, such as

$$a^*(t) = \binom{0}{A} \Leftrightarrow \lambda_s \binom{>}{<} b\lambda_Z. \tag{9}$$

Proof of proposition 2 is in appendix C. Simply, if the shadow price of a risky asset λ_s is lower than the shadow price of the regulatory costs $b\lambda_Z$, we prefer the upper limit *A* of international regulation – and otherwise. Intuitively, a low shadow price for risky assets, *s(t),* means that an additional unit of a risky asset does add less utility than more regulation. Consequently, you prefer a stricter regulation and thus the upper limit *A* is optimal.

But there remains an ordinary question: Does *a(t) = 0* mean no international regulation in finance? Mathematically yes, but economically and politically it is certainly debatable. In general, the debate is similar to the opposing views of F. Hayek and J. Keynes in macroeconomics. While Keynesians always argue in favour of government interventions and regulations, admirers of Hayek oppose this view. They point out the importance of free markets. Both diametrical opinions seem to be efficient solutions as our model show. However, are they realistic options in international governance or business practice of today?

There are two arguments not considered in our model: First, despite the independence of central banks, they frequently intervene in financial markets defined by government principles such as price-stability and low unemployment. Thus, choosing the optimal interest rate according to a Taylor rule and providing liquidity to the market (lender-of-last-resort) limits automatically the idea of free markets proposed by Hayek. However, our stylized model, still very insightful, does not account for these institutional issues. Consequently, the boundary solution of no international regulation is probably neither achievable nor realistic in the real world. But what remains achievable is the global commitment and dialog to achieve a solution of international regulation at the upper limit *A*. Second, there is empirical evidence that people are willing to pay substantial fees or taxes if this mitigates national or global catastrophes [11,12,13,14,15]. This may affect the assumption of the standard cost function of regulation in our model. If people are willing to pay for fewer crises this may result in a cost function which is less convex. The optimization with a modified cost function leads to a singular equilibrium at the level of comprehensive international regulation, *A*. The intuition is simple: the new cost function reduces the weight of costs and increases the weight of benefits of the regulatory framework.

Interestingly, this model does not only reveal policy conclusions for national and international regulators, it also demonstrates business implications. An important business implication is the awareness that the regulatory trade-off is different between the real and financial economy. Thus, in terms of regulation we have to treat both market segments and firms differently. However, the model implications are even more significant to financial regulators and supervisors. Our model reveals that the current financial environment,without any level playing field, is recurrently exposed to regulatory arbitrage. Despite the knowledge of the regulatory dilemma at home, the domestic regulatordoesnot automatically incorporate the need of international regulation. As a matter of fact,thisinfers a systematic domestic and global policy failure. Until today, policy-makers in all countries have failed to achieve a level playing field in international finance. Consequently, the recent financial crises are not only the fault of greedy individuals, banks or businesses. It is mainly the faulty design of international financial regulation by policy-makers.

3. Conclusions

This paper presents a unique contribution to the literature of regulation with strong economic and business implications. We show that financial regulation is different due to the mobility of financial assets, the interdependencies of financial markets and the complexity of the international environment in finance. On the contrary, trade relationships are usually based on mutually negotiated trade agreements with certain standards for both sides. In financial markets this is not the case due to different national rules and a few international rules with loopholes and incentives to regulatory arbitrage. Given this difference we show that the regulatory trade-off of costs and benefits is true in the real economy but false in a financial economy. In addition, financial regulation is more difficult because even a weak international compromise does not lead to an efficient solution. In finance,internationalregulationhasjust two optimal regimes: No regulation or comprehensive regulation.

In summary, the model provides an innovative insight into the current debate about regulating financial markets and the responsibility of the guardians of finance.

Appendix A

Proof of Proposition 1

First calculate the first-order condition of the Hamiltonian function H. It is

$$\frac{\partial H}{\partial l(t)} = U_F \frac{dF(l(t))}{dl(t)} + U_Z \frac{dZ(l(t))}{dl(t)} - \lambda(t) = 0, \qquad \text{(A1)}$$

where $U_F = \frac{dU}{dF}$ and $U_Z = \frac{dU}{dZ}$. To make sure that this problem maximizes the Hamiltonian, we simply check the sign of the second derivative. The Hamiltonian H is maximized if $\frac{\partial^2 H}{\partial l(t)^2} < 0$ which is easily to check and the case in our model. Next, we analyse the time path of $\lambda(t)$. The maximum principle tells us that the equation for λ yields

$$\frac{d\lambda(t)}{dt} = -\frac{\partial H}{\partial s(t)} = 0. \qquad \text{(A2)}$$

This condition imply $\lambda(t) = c$, i.e. is constant. To define the constant c, we use the transversality conditions

$$\lambda(t) \geq 0\,, \quad s(t) \geq 0\,, \quad \lambda(t)s(t) = 0 \qquad \text{(A3)}$$

It is immediately clear that $\lambda(t) = 0$ because of equation (A2). With $\lambda(t) = 0$, equation (A1) reduces to equation (4) in the main text. Q.E.D.

Note: $l(t)^* = l^*$, i.e. the optimal degree or amount of national safeguards is constant over time in our model. The amount of risky assets, as in reality, is given by $s(t) \geq 0$. In the end, equation (4) in the main text balances cost and benefits of regulation and is similar to the well-known condition in microeconomics: Marginal costs (MC) = Marginal Revenue (MR).

Appendix B

Proof of Theorem

We postulate $l(t) > 0$. Then is follows from complementary slackness condition that

$$\frac{\partial H}{\partial l(t)} = U_F \frac{dF(l(t))}{dl(t)} + \lambda_Z b - \lambda_s = 0. \qquad \text{(B1)}$$

Since, the second derivative of H is negative, we have a maximum. In addition, we maximize H with respect to *a(t)*:

$$\frac{\partial H}{\partial a(t)} = -c\lambda_Z - \lambda_s. \qquad \text{(B2)}$$

Besides, *a(t)* is restricted to the closed control set *[0,A]*. Thus, to maximize H, the left-hand-side boundary solution is $a^*(t)=0$, if $\frac{\partial H}{\partial a(t)} < 0$, and the right-hand-side boundary $a^*(t)=A$ if $\frac{\partial H}{\partial a(t)} > 0$. In general,

$$c\lambda_Z + \lambda_s \binom{>}{<} 0 \qquad \Rightarrow \quad a^*(t) = \binom{0}{A}. \qquad \text{(B3)}$$

From complementary slackness together with equation (B1), we see

$$\lambda_s = U_F \frac{dF(l(t))}{dl(t)} + b\lambda_Z\ . \qquad \text{(B4)}$$

Using equation (B4) in equation (B3), gets

$$U_F \frac{dF(l(t))}{dl(t)} \binom{>}{<} - (b+c)\lambda_Z \qquad \Rightarrow \quad a^*(t) = \binom{0}{A}. \qquad \text{(B5)}$$

The optimal choice of $a^*(t)$ thus depends on λ_Z. The optimal policy choice for international regulation *a(t)* is a boundary solution.

Next, we show that $a^*(t)$ is never a interior solution in *(0,A)*. Consider the equations of motion of the following costate variables:

$$\dot{\lambda}_Z = -\frac{\partial H}{\partial Z(l(t))} = -U_Z + \lambda_Z d \qquad \text{(B6)}$$

$$\dot{\lambda}_s = -\frac{\partial H}{\partial s(l(t))} = 0 \Rightarrow \lambda_s = constant \qquad \text{(B7)}$$

If $a^*(t)$ is an interior solution, then

$$c\lambda_Z + \lambda_S = 0. \qquad \text{(B8)}$$

Since λ_S is a constant, equation (B8) shows that λ_Z must also be a constant, which implies that

$$\dot{\lambda}_Z = 0 \quad \Rightarrow d\lambda_Z = U_Z \qquad \text{(B9)}$$

But if λ_Z and d is constant then this requires U_Z to be constant, too. Since *U(.)* is monotonic in *Z(.)*, there can only be one value of *Z(t)* that would make U_Z take this particular and constant value. Thus *Z(t)* must be constant too if *a*(t)* is an interior solution. But given that $Z(T) = z_0 > 0$, , the transversality condition requires

$$Z(T)\lambda_{Z(t)} = 0. \quad \text{(B10)}$$

With a positive *Z(t)*, it is required that $\lambda_{Z(t)} = 0$. Since $\lambda_{Z(t)}$ is constant by equation (B9), we get

$$\lambda_{Z(t)} = 0 \quad forallt\epsilon[0, T]. \quad \text{(B11)}$$

However, $\lambda_{Z(t)} = 0$ would imply for an interior solution, by eq. (B4) with $U_F \frac{dF(l(t))}{dl(t)} = 0$, which contradicts the assumptions that U_F and $\frac{dF(l(t))}{dl(t)}$ are both positive. Consequently, an interior solution of *a*(t)* must be ruled out. Q.E.D.

Appendix C

Proof of Proposition 2

The boundary solution is linked to

$$U_F \frac{dF(l(t))}{dl(t)} = \lambda_s - b\lambda_Z. \quad \text{(C1)}$$

Intuitively, the positive effect of regulation on utility measured by $U_F \frac{dF(l(t))}{dl(t)}$, equals to the shadow prices of risky assets and cost of regulation. Using equation (C1) with condition (B5) gets equation (9) of proposition 2 in the main text. Q.E.D.

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