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Finance and Growth: A Critical Survey *

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ABSTRACT

We present a survey of the finance-growth nexus that raises a number of qualifications to the mainstream interpretation. Doubts regarding empirical consensus are investigated and we consider the prevalence of cross-section econometrics as dominant in shaping the present theoretical consensus. To facilitate a quantitative understanding of the theoretical literature we develop a model capable of capturing a number of key conclusions from theoretical research. The core implications of many finance and growth theories are shown to be disconnected not only from their modern empirical counterparts, but also from the historical literature.

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1 Introduction

The literature on finance[1] and economic growth has experienced a renaissance in the last fifteen years. The construction of a large World Bank dataset covering the second half of the twentieth century facilitated a large number of cross-country studies. While most of this work supports the hypothesis that finance plays a determining factor in economic growth, there have been one or two voices urging a more cautious interpretation of the data.

At the same time as creating new opportunities for research, it has engendered a, perhaps excessive, focus on cross-sectional results based on financial depth alone. Recognising this, some economic historians (*inter alia* Rousseau and Sylla, 2004) have begun constructing datasets to reveal the time-series experience of countries going through a period of industrial and financial revolution. However, the time-series data remain somewhat sparse and, in general, the implications of the literature in terms of growth and transition *over time* has been largely neglected.

The theory of finance and growth has been developed, almost in parallel to the cross-section empirics, to explain why finance may cause growth. It has been demonstrated that, in a comparative sense, financial institutions can play a role in the level of sustained growth. There is here, however, no clear *quantitative* lesson to be drawn from the existing literature; yet modern macroeconomic theory is judged largely against its ability to be calibrated by and replicate data in a consistent way. Many theoretical considerations of the finance-growth nexus do not rigorously confront theory with data. By adapting the core mechanics of some key theories, we present in this paper a simple and representative model of finance and growth that can aid numerical understanding.

We begin to survey those aspects of the literature on the finance-growth nexus which are not covered in orthodox surveys of the subject, such as Levine (2005). The central thesis of this survey regards the coherence of the various aspects of the finance-growth nexus. We argue that growth theory and growth empirics have become disconnected, especially in relation to the question of finance and growth; in an important sense, they answer different questions. In addition, we demonstrate that both theory and empirics can learn from cliometric evidence and we give a concrete example of just where this reconnection with history may be most fruitful.

[1] Throughout, we use the word 'finance' in the same general sense in which it is interpreted in the literature: Everything from the microeconomic relationships between financial institutions and the agents (both debtors and creditors) demanding their services to macroeconomic aggregates such as ratios of financial debt to national output.

The paper is organised as follows: Section 2 surveys the current state of knowledge in empirical, historical and theoretical terms. This analysis feeds directly into Section 3, which presents a simple model that captures some core mechanics and allows us to survey quantitatively the implications of the theory. Armed with an understanding of the numerics of both applied and theoretical work, Section 4 considers the potential for future research on finance and growth to be more fully integrated across empirical-theoretical-cliometric lines. Section 5 concludes with a summary of our main findings.

2 Existing Literature

2.1 Contemporary Empirics

King and Levine (1993a,b) were among the first to demonstrate the potential for panel datasets such as Beck et al. (1999) and its precursors to make rigorous the finance and growth debate. King and Levine found not only a consistent contemporaneous relationship between aggregate measures of financial depth and growth, but also a strong *predictive* component. They argue that current financial depth can predict economic growth over the consequent ten to thirty years and conclude that "better financial systems stimulate faster productivity growth and growth in per capita output by funneling society's resources to promising productivity-enhancing endeavours." (King and Levine, 1993b, p. 540.)

In addition, Levine et al. (2000) address the obvious endogeneity problems inherent in finance and growth regressions. Demirgüç-Kunt and Levine (2001) cover a great deal of empirical work using a number of different econometric techniques on datasets ranging from micro-level firm data to international comparative studies. These studies, and many others besides, find support for the argument that finance leads growth, in some sense.

There have been some questions raised, by *inter alia* Driffill (2003), about the interpretation of empirical results like those outlined above. These concerns have been omitted from surveys such as Levine (2005), so we pay special attention to them here. Indeed, on further analysis, we suggest that the impact of data limitations may be more acute than is generally believed. It will be argued that these limitations have the tendency to exaggerate the role of finance in determining economic growth.

The World Bank dataset, while currently covering the period 1960-2003 for 192 countries,[2] is not complete for all countries. For example, consider a preferred measure of financial intermediation, the private credit-to-GDP ratio: The mean average number of observations per country is 24.1. As such, a typical cross-sectional estimation necessarily involves an average of financial variables over a long period, often over the whole sample period. Some empirical work has begun to use panel data (*inter alia* Levine et al., 2000), but the longitudinal scope of the panels used is limited (in the case of Levine et al., the panel consists of five seven-year averages over the period 1960-95) and this depth comes at the cost of cross-sectional breadth (Levine et al. include only 71 countries from a total sample of nearly 150 at that time). Not only is it hard to think about finance leading growth when the averaging time periods are so long, but such a trade-off also leaves estimations open to selection bias issues.

A number of specific results, obtained using this dataset, have been called into question. Driffill (2003) and Manning (2002) argue that the results in Levine and Zervos (1998) have implausible implications for the effect of financial development on growth. Specifically, the results suggest a one-percent per annum increase in growth rates could be obtained if developing countries increased the level of financial development to those of more successful countries. He demonstrates that a number of results hinge on the inclusion of outliers, while the inclusion of regional dummies, especially those for the Asian Tigers, also renders coefficients on financial development insignificant. Driffill goes on to consider the robustness of the work on industry-level data of Rajan and Zingales (1998). It is shown again that the positive effect of financial development on growth is contingent upon the specification employed, particularly that including broad regional dummies tends to neutralise the significance of financial variables. Driffill concludes that the positive results on data over this period were likely driven by the growth of the Asian Tigers, growth which is more naturally attributed to other factors (on this see *inter alia* Young, 1995; Rodrik, 1996; Landes, 1998).

With this in mind, it should be noted that the Levine et al. (2000) dataset ends in 1995, before the Asian financial crisis; a period of economic downturn preceded by deepening financial markets. Financial depth, as measured by Levine et al.'s preferred indicator of financial depth (the ratio of private credit-to-GDP), increased significantly in the Asian Tiger countries over the period 1992-

[2]The dataset is available from http://econ.worldbank.org/. We refer to the March 14 2005 revision here.

1998: In China by 30.9%; Hong Kong, 40.3%; Indonesia, 21.9%; the Korean Republic, 53.8%; Malaysia, 45.7%; the Philippines, 142.9%; and Thailand, 89.3%. The year 1998 saw a reduction in GDP in all of these countries except China (the respective percent changes in real GDP per capita were: 5.35; -8.21; -11.6; -9.08; -0.62; -4.06; -10.74).[3] While it is, of course, not possible to draw any hard conclusions from such analysis, if Driffill (2003) is correct in suggesting that most of the significance of financial variables is driven by the growth experience of the Asian Tigers, then this episode calls for a more refined classification of financial depth. A measure which controls for both institutional and regulatory factors that might determine the efficacy of financial deepening in spurring growth may obtain very different results.[4] Additionally, a distinction in growth regressions between foreign and domestic providers of finance may provide more qualified results.

Aghion et al. (2005) use the same 1960-95 dataset as Levine et al. (2000). They also include the same 71 countries despite using the dataset in a purely cross-sectional way (employing an average of the private credit variable over the entire thirty-five-year period) to demonstrate the positive effect of financial development on convergence. It is possible that their results would be very different if we re-estimated on the whole sample, increasing both the number of countries and the endpoint to include properly the Asian financial crisis. While Aghion et al. (2005) do test for some geographical differences, they do not test specifically for the East Asian bloc.

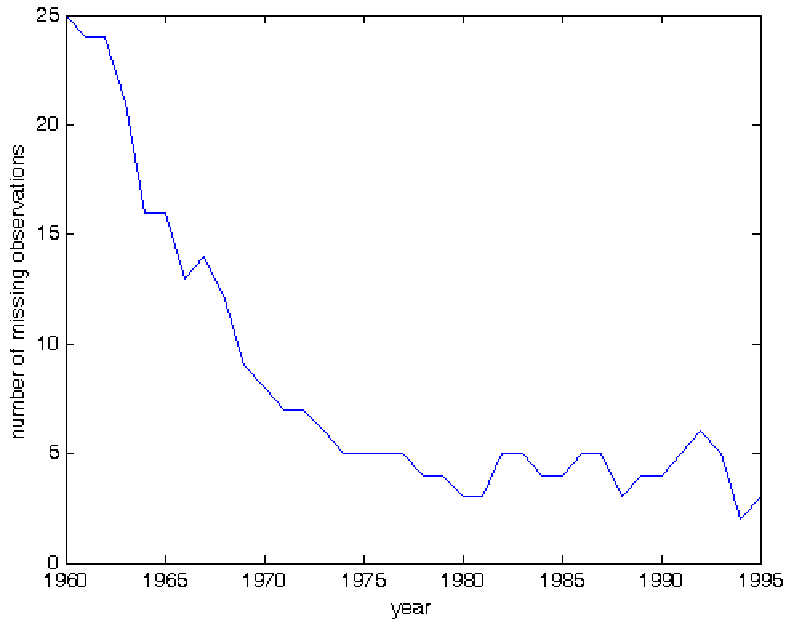
The potential significance of selection bias issues is here even more important since Aghion et al. take an average for their financial proxy over the whole sample period. Countries with available data are more likely to have converged (for example the sample includes only 11 of 54 African countries) and countries with sparse data are generally those that were poor in 1960, such that available data tends to be at the end of the sample, as can be seen in Figure 1.

Added to this, the trend of financial development as measured by the credit-to-GDP ratio is itself rising over time across countries. This can be seen by inspection of the data: The credit-to-GDP ratio trends upwards in around 55 of the 71 countries in the sample. As such, the measure of financial development for countries who were relatively poor in 1960 and so with data for only the

[3]This data is from the Penn World Table, see Heston et al. (2002).

[4]There has recently been a move to consider institutional and legal issues, see particularly Levine (2004) and Beck and Levine (2005).

Figure 1: Distribution of Missing Observations for the Private Credit-to-GDP Ratio in the Levine et al. (2000) Dataset



later years, is biased upwards relative to a rich country with data for every year.[5]

The combination of these factors – the long average, the data sparsity, the sample selection bias and the upward trend in the financial development indicator selected – means that those countries that did converge have, as a result of the methods used, necessarily had a higher measure of financial development over the period. This would explain, at least partly, why the results in Aghion et al. (2005) are so robust to alternate specifications. This critique is, unfortunately, not specific to the Aghion et al. paper; see Beck et al. (2004, p.9): "…we sometimes use data averaged over the period 1960-1999, and sometimes we use data over the period 1980-2000…".

It should be clear that one ought not to be overly reliant on either purely cross-sectional empirics or limited panel datasets. Driffill, *op cit*, suggests a greater emphasis on long-run, historical time-series. He stresses in particular the importance of comparing countries at similar stages of development in order that more robust conclusions might be drawn.

The overall message from contemporary empirical research on finance and growth is indica-

[5]It should be noted that the upward trend is not specific to the credit-to-GDP ratio; two of the three alternative proxies used in Aghion et al. (2005, Table 4), trend upwards. The third, a ratio of commercial bank to central bank assets, is relatively stable for most countries over the period, and this is the one proxy for which the coefficient on financial development is insignificant.

tive but problematic; time-series evidence must be consolidated in order that we can speak of the relation between financial institutions and growth *within* a country over a period of transition with confidence.

2.2 Theories of Finance and Growth

Theoretical models of the finance-growth nexus generally differ along three aspects: The type of endogenous growth; the finance mechanism; and the treatment of asymmetric information. Using this structure, Table 1 outlines the main features of some of the most influential finance and endogenous growth models. It should be clear by inspection that, regardless of the source of endogenous growth, the main feature determining growth in most models is some financial constraint on the acquisition of either knowledge via education or technology via entrepreneurship.

[Table 1 about here.]

Financial intermediation in most models takes the form of a perfectly competitive banking system. Some consider a role for stock markets, but often only as a choice between mutually-exclusive banks and markets (such as Greenwood and Smith, 1997). Blackburn et al. (2005) is an interesting exception, and considers both the joint-determination *and co-existence* of banks and stock markets as determined by state-dependent moral hazard conditions. In these models there is feedback from growth in the economy to the determination of optimal financial structure, be it based on banking alone or on a mixture of banks and markets. As an economy develops so it can afford those financial structures that better facilitate faster growth (Greenwood and Smith, *op cit*).

In a related literature, multiple equilibria can emerge as a result of countries with limited financial sectors caught in a low-growth trap. Saint-Paul (1992) is a further approach to the modelling of stock markets, wherein stock markets that facilitate international risk sharing enable specialisation in technologies and higher growth. There is thus a low- (high-)growth equilibrium associated with low (high) financial development, capturing the idea of different take-off points for industrialising nations. In Bose and Cothren (1996) a bank lends to an entrepreneur of unknown quality and selects by either designing a separating menu contract (where this is possible) or by implementing a costly screening technology, or by a mix of the two. They show that in the early stages of financial development, a fall in the screening cost can actually be growth-*reducing* because of the interaction between dependence on rationing or screening. In concurrence with Schumpeter, the financial sector needs to reach 'critical mass' before advances in financial sophistication will improve growth.

The majority of works outlined in Table 1 treat the financial sector as static (where the nature of the relationship between agents and intermediaries does not change endogenously over time; again, Blackburn et al., 2005, is a notable exception), with the degree of efficiency of identifying/screening/funding/monitoring suitable debtors determining the costs of financial intermediation and so the level of economic growth. Most consider some form of entrepreneur who cannot or will not personally fund a project either because it is too large or too risky. Increasing the ease with which entrepreneurs can obtain funds thus increases the rate of technological progress and so the rate of economic growth. Others consider a role for the accumulation of education or human capital as entering directly into the production function; the efficiency with which this process is facilitated by screening or funding agents thus has an effect on economic growth. Further papers look at the effect of credit constraints on entrepreneurship and, again, the consequence of higher efficiency in financial intermediation for growth are, for all intents and purposes, equivalent.

The major differences between these models largely revolve around the treatment of asymmetric information. In a few (King and Levine, 1993b; Bose and Cothren, 1996; *inter alia*) the information problem is relatively straightforward, wherein asymmetric information plays a role in pre-contracting, i.e., where there is adverse selection, and intermediaries are endowed with the ability to screen heterogeneous agents. Agent behaviour post-contracting in these models is not subject to asymmetric information. In others (such as de la De la Fuente and Marín, 1996; Blackburn and Hung, 1998; Morales, 2003; Aghion et al., 2005; *inter alia*) there is a post-contract incentive for agents to shirk or deceive because of, respectively, an aversion to effort or an ability to hide research outcomes. Such moral hazard issues thus bring the modelling of static intermediation closer to reality, but often simply add another wedge between agents and firms, scaling up intermediation costs and so, *ceteris paribus*, scaling down balanced growth rates.

The implications for policy in these models is, in general, limited to advocating liberalised financial markets and efforts to increase the efficiency of banks and markets while providing the institutional support required to diminish the costs of moral hazard and enforce contracts. The book by Rajan and Zingales (2004) is a prominent example of the sorts of policy prescriptions derived from this literature. In terms of theory, King and Levine (1993b) show that a simple tax on income from financial intermediation will have a monotonic effect on the level of intermediation and so on growth. An interesting result is that of Morales (2003), where effort-averse entrepreneurs with limited liability can be influenced by being subject to bank monitoring. It is shown that, under certain conditions, it is possible that a research subsidy (one direct to the entrepreneur) will accentuate the moral hazard problem and actually reduce growth. It is suggested, therefore, that policy used to stimulate growth should concentrate on financial intermediation and that the optimal tax on research can be non-zero.

In short, the theory reviewed briefly here suggests that greater financial efficiency (be it in providing insurance, pooling resources, screening entrepreneurs or monitoring borrowers) reduces the disincentive to entrepreneurship or the accumulation of human capital, thus increasing the rate of technological progress and consequently also the long-run growth rate of the economy. A key component missing from most of these models is a consideration of their *quantitative* implications. For a comparison between these literatures to take place, we develop in section 3 a stylised model of finance and growth in the spirit of those surveyed here and and draw out the implications for time-series growth in the UK.

However, first we turn to the historical literature and consider the potential for cliometric evidence to enter into the finance-growth debate.

2.3 Historical Evidence

Historical and cliometric research can have a lot to add to our understanding of any subject. If our goal is to answer questions about the necessary preconditions for developing countries to enter a sustained period of higher growth, cross-section analysis of developed countries or theories based on a static intermediation problem can only aid us in a limited way. It is clear that the onus on establishing more rigorous empirical evidence will lead to much fruitful historical research, and a few papers have already begun in this direction. A consideration of the relationship between finance and growth in countries going through a period of transition might tell us more about the dynamics at play. Were there important changes, for example, in the way in which agents raised finance over time? Did legislation inhibit the emergence of the financial sector? Why, and how, do different financial structures emerge? Why did the UK industrialise first, despite not being the first to develop a sophisticated banking system? Are there any cliometric tests which we could impose on theoretical models of finance and growth?

Rousseau and Sylla (2005) combine a long historical US dataset (covering the initial emergence of the financial structure we see today, over the period 1790-1850) with contemporary dynamic econometric techniques. They argue that initial financial developments "placed the United States of the early 19th century on a trajectory of economic growth higher than that of other nations... The US financial system did (and does) what a modern financial system is supposed to do, namely mobilize and efficiently allocate capital, and provide opportunities for risk management" (Rousseau and Sylla, 2005, p. 21). Additional moves to present the empirics of finance and growth in an historical context include Rousseau and Wachtel (1998) and Wright (2004).

Bordo and Rousseau (2006) follow Rousseau and Sylla (2005) and embark upon a long-run analysis of the finance-growth link, and move to consider what they term 'deeper fundamentals'. Considering a number of case-study countries, again on a aggregate basis, they add parameters for legal origin (intended to capture a country's inherent attitude to property and contract rights), the political environment and other factors into regressions on finance and growth. Conclusions from this analysis are not clear since, "...there remains a substantial component of financial development that is correlated with growth and yet not related to these measures of deeper fundamentals." (p.26).

We wish for empirical analysis of both contemporary and historical data to enter into decisions made about the nature of a stylised theory of finance and growth. The historical research, out of necessity, considers *aggregate* financial depth. But the finding that financial depth led periods of sustained growth in a number of countries does not mean that increasing financial efficiency by cutting down on moral hazard and adverse selection will do so also.[6]

So cliometric analyses of the type outlined above cannot, by themselves, support theories based around information and the efficiency of intermediation. To do so would need a detailed consideration of the ways in which banks and markets emerged: An analysis of the role of asymmetric information and entrepreneurship in forming the financial structures observed around the period of industrial revolution, and not just of aggregate measures of financial depth. Large, national

[6]A novel and highly interesting exception, slightly out of place in this analysis, is that of Jayaratne and Strahan (1996), which demonstrates that bank liberalisation in the US increased economic growth for efficiency, rather than depth, reasons.

financial institutions did not appear overnight but were the response to economic incentives that emerged over time, building the financial structures we see today from informal coalitions of agents that saw the initial incentives to act as intermediaries.

Some more normative historical research has approached these considerations in the context of finance and growth. Wright (2002) provides some evidence to support the mechanisms through which financial institutions can facilitate economic growth by compensating for asymmetric information conditions, and so backs-up both the empirical evidence in favour of the finance-led growth hypothesis and the dominant theoretical models. As Wright (p.212) notes, "Problems of information asymmetry, namely adverse selection, moral hazard, and the principal-agent problem, collude to limit effective lending." The author suggests that the early US financial system was in fact much more effective than previously believed, and invokes Adam Smith as being among the first to describe the ways in which banks spur growth by addressing information problems. The central part that asymmetric information plays in determining the efficacy of financial institutions in engendering sustained levels of high economic growth is the central message of this work.

But such analysis does not get to the question of whether such financial structures emerge as a result of economic necessity or whether economic growth, and industrial take-off, can actually be forestalled by an inadequate financial system with the implication that an exogenous improvement in the financial environment will facilitate takeoff. The broader historical consensus on UK growth is that the role of finance in *determining* industrial development was at best limited. Cottrell (1980), Harris (2000), Shea (2005), and others, cite both the ease with which a firm could find initial finance and the ubiquity of profit-ploughback as a means of expansion. It is also shown that a great deal of early financial intermediation was decentralised, where often the regional manufacturing industries opted for local finance and not the use of the London capital markets (on this see *inter alia* Pollins, 1954; Milward and Saul, 1973; Cottrell, 1980; Turnbull, 1987; Harris, 2000). Depicting only the growth of a national financial system thus masks a great deal of complexity and dynamism regarding the relationship between entrepreneurs and financial intermediaries.

3 A Representative Model of Finance and Growth

The purpose of this section is to outline a simple version of an endogenous growth model that can capture the principle mechanics of significant theoretical works. It also reflects in part the historical debate on the nature of asymmetric information, both in terms of adverse selection and an extension to include moral hazard. We calibrate the model to historical data for the UK and so trace out the implied 'transition path' for financial efficiency over the period of the industrial revolution. We feel that by developing a representative model that can generate numerical implications for finance and growth aids the survey in three ways: It provides intuition about the mechanics of typical models; it generates a means to test the quantitative implications of the theory against the data; and, it helps us to consider the theory in an applied historical context.

Since the majority of the literature considers financial intermediation in the form of banking we will consider that alone. We will also take the relationship to be static, i.e., the way in which intermediaries and agents interact does not explicitly change over time. In addition, we assume that there are no arbitrary credit constraints so that the causes of friction are entirely informational. With a suitable model we can thus use numerical methods to compare quantitatively the implications of such models for time-series growth with the historical pattern of industrial finance and growth.

The mechanism by which finance affects long-run growth follows the trend suggested by Table 1, as well as the historical discussion of Wright (2002): Ever since King and Levine (1993b), theories of finance and growth revolve around entrepreneurship and either human capital accumulation or technological progress. We adopt that perspective also.

3.1 Financial Intermediation and Growth

In the model of King and Levine (1993b) intermediaries are effectively venture capitalists that have the technology necessary to screen potential entrepreneurs who are then employed and given funds to run a research project. The fruit of such labour is an addition to the stock of knowledge (specifically, via a quality-ladders setup *à la* Grossman and Helpman, 1991). The screening cost is fixed and the intermediary consequently knows with certainty the ability of the applicant. There is no costly effort (so no moral hazard), and the intermediary market is perfectly competitive. Reductions in the cost of screening or in the tax on intermediary profits thus increase the efficiency of the financial sector, increase the rate of technological progress and so increase the rate of long-run growth. This process remains the core of our survey model; readers uninterested in the details of the theory can safely skip to Section 3.1.7.

3.1.1 Outline

In this model firms demand physical capital and human capital. We have a continuum of agents in each household of total mass one, and a random distribution of type within each. If we assume a large number of households then in the aggregate we can work with the average distribution of type within a given household. So, on average, a proportion φ_1 has no ability to acquire human capital whatsoever, a proportion φ_2 has low ability Λ' and the remainder, proportion $\varphi_3 = 1 - \varphi_1 - \varphi_2$ has high ability $\Lambda > \Lambda'$. It is important that able agents do not know their own level of ability, only that they have some.[7] Agents with no ability take household responsibility for selling physical capital to firms. Only agents with high ability have the potential to develop human capital. All agents with nonzero ability apply to a financial intermediary to be screened. Those that are rejected do not contribute to household income. Those that are accepted are consequently funded by the intermediary to acquire education or conduct research, becoming human capital with fixed probability β. In the case of education this might reflect the likelihood of not dropping-out; in the case of research this might reflect the probability of useful innovation. Those that fail to develop human capital contribute nothing to household income, those that do develop human capital are consequently employed by firms and enter the production function as human capital. In the event that the agent succeeds in acquiring human capital it is the researcher that owns the human capital, paying a proportion t of income from human capital to intermediaries. The intermediary thus sets t to maximise expected profits.

3.1.2 Firms

Firms use human capital, H, and physical capital, K, as inputs to the production process, $Y_t = AK_t^{\alpha}H_t^{1-\alpha}$. Each firm maximises profits, $\pi_t = Y_t - rK_t - hH_t$, where each takes the rates of return on physical capital, r, and human capital, h as given: $r = \alpha(Y_t/K_t)$ and $h = (1 -$

[7] If agents knew their level of ability, given that the screening technology of the intermediary identifies ability with precision, and given also that agents know this, there would be no reason for those with less than high-ability to apply.

$\alpha)(Y_t/H_t)$. We can use equation for h to obtain the firm's demand for human capital, $H_t = [(1-\alpha)Y_t]/h$, which, upon substitution into the production function, obtains a form of the familiar Ak endogenous growth setup,

$$Y_t = \left[A \left(\frac{(1-\alpha)}{h} \right)^{1-\alpha} \right]^{\frac{1}{\alpha}} K_t. \tag{1}$$

3.1.3 Intermediaries

The intermediary incurs the cost $f(H) > 0$ to screen agents for ability and funds successful applicants to acquire human capital at cost $x(H) > 0$. Note that these costs are not invariant to the level of human capital, and we make the assumption that $f' > 0$ and $x' > 0$, i.e., that the costs of intermediation are proportional to the size of the demand for human capital. So both the outlay required to fund the acquisition of human capital, x, and the cost of screening candidate acquirers of human capital, f, is increasing in the level of human capital – a reasonable assumption if we imagine that the higher the level of human capital aspired to, the more costly it is to both fund and identify suitably able agents. This ensures that the costs of intermediation do not become insignificant over time as a proportion of the size of the economy.

There is an analogous requirement for balanced growth in a quality-ladders setup (see Trew, 2004) so it may be a general result that for balanced growth in these simple economies with static financial intermediation we require that the size of the financial sector is constant over time. This explains why, even though (because of data limitations) econometric analyses consider largely financial depth, most theory considers financial efficiency; within an endogenous growth framework it becomes difficult to solve analytically for balanced growth when the size of the financial sector relative to the economy is changing over time. In an economy going through industrial transition, the size of the financial sector does change significantly (see the discussion in section 2.1). It may be that to reconcile these facts, i.e., for both the balanced growth rate and the level of financial depth to change endogenously over a period of industrial takeoff, we require the financial condition to be dynamic, instead of the static relationship depicted below.[8]

We also require that it is not feasible for households to fund the amount $x(H)$ from their own resources. For a given agent, expected intermediary profits will be the probability-weighted

[8]Nolan et al. (Forthcoming) begins work in this direction.

incomes and expenditures. The probability that an agent who applies will be of low ability is $\varphi_2/(1-\varphi_1)$, in which case only the screening cost is expended. The probability of successfully developing human capital from high-ability agents and thus obtaining a rent from him is $\beta(1-\varphi_1-\varphi_2)/(1-\varphi_2)$. If we assume competition then the expected intermediary profit is zero,

$$\begin{aligned} E(\pi) = &\beta\left(\frac{1-\varphi_1-\varphi_2}{1-\varphi_1}\right)[thH - x(H) - f(H)] + \\ &+ (1-\beta)\left(\frac{1-\varphi_1-\varphi_2}{1-\varphi_1}\right)[-x(H) - f(H)] + \\ &+ \left(\frac{\varphi_2}{1-\varphi_1}\right)[-f(H)] = 0. \end{aligned} \tag{2}$$

If we specify $x(H) = \eta_x hH$ and $f(H) = \eta_f hH$,[9] where $\eta_x > 0$ and $\eta_f > 0$ are the cost parameters of intermediation, then we obtain the following expression for the fee charged by the intermediary,

$$t^* = \frac{1}{\beta}\left\{\eta_x + \left[\frac{1-\varphi_1}{1-\varphi_1-\varphi_2}\right]\eta_f\right\}. \tag{3}$$

Equation (3) is increasing in the costs of financial intermediation, η_f and η_x, and in the share of low ability agents, φ_2, and decreasing in both the probability of human capital creation, β and the share of high ability agents, φ_3.

3.1.4 Households

The cost $t^* hH$ is borne by consuming households. The household receives income from physical and human capital, however, at the rates r and h respectively. Using equation (3), the household budget constraint will thus be the familiar $c_t + \dot{k}_t = rk + \tau(1-t^*)hH$. We mirror King and Levine here by incorporating a tax on income from innovation, where $1-\tau$ is the tax rate applied to household income from human capital. Households maximise the discounted present value of

[9] It is possible to generalise this functional form but the consequences for the model are not significant. Specifically, we can specify $y(H) = \eta_y H$, wherein we obtain $t^*(h)$ and a less simple form for the interest rate. We prefer the former since the problem becomes intractable when we consider the full model with moral hazard. As such, the simple model presented here is entirely nested within its extension. It is not such an unreasonable assumption, however; the simplifying feature is merely that both the costs *and revenue* of financial intermediation are proportional to agents' income from human capital, hH.

future consumption,

$$\max_{c_t} U = \int_0^\infty e^{-\rho t} u(c_t) dt, \tag{4}$$

where $u(c_t)$ is the instantaneous utility function. If we assume CES preferences of the form $u(c_t) = (c_t^{1-\theta} - 1)/(1-\theta)$, then we obtain the standard Euler equation governing the growth rate of consumption, $\dot{c}_t / c_t = \theta^{-1}(r - \rho)$.

3.1.5 Equilibrium Growth

In equilibrium we require that the net return on capital is equal to the net return on human capital, i.e., that $r = \tau(1-t^*)h$.[10] From the production function, equation (1) we have the following expression for r,

$$r = \left[A \left(\frac{(1-\alpha)}{h} \right)^{1-\alpha} \right]^{\frac{1}{\alpha}}. \tag{5}$$

By the equilibrium financial intermediation condition, $h = r/[\tau(1-t^*)]$, we may solve for r from,

$$r = A[\tau(1-\alpha)(1-t^*)]^{1-\alpha}. \tag{6}$$

Hence, we have a simple closed-form solution for the equilibrium growth rate,

$$\gamma = \frac{1}{\theta} \left\{ A[\tau(1-\alpha)(1-t^*)]^{1-\alpha} - \rho \right\}. \tag{7}$$

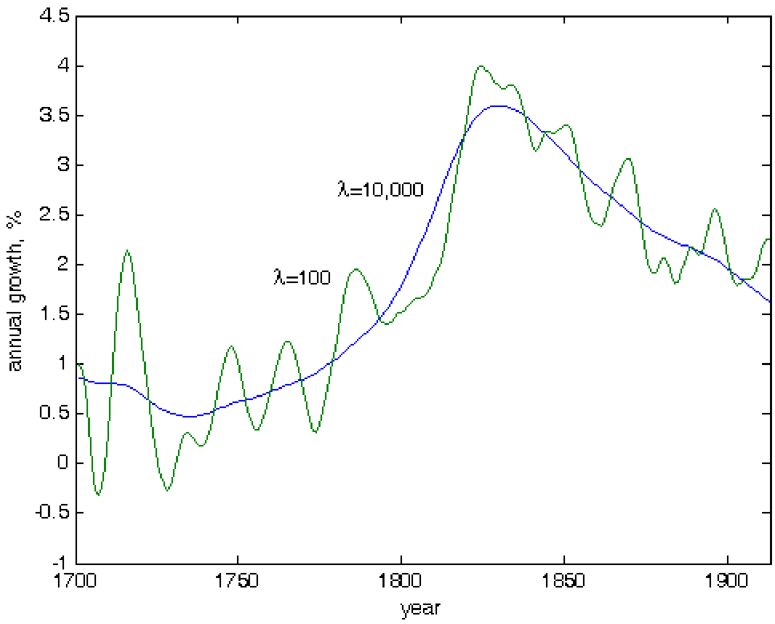
An increase in the efficiency of financial intermediation, by reducing η_f or η_x *ceteris paribus* results in an increase in the equilibrium growth rate by reducing the cost of intermediation, t^*. So there is simply a wedge in between what firms pay for human capital and what agents receive, where the significance of this wedge reflects the efficiency of financial intermediation. This is the main theoretical result of King and Levine (1993b). Inasmuch as we can call exogenous changes in η_f changes in financial efficiency over time within a country we can now calibrate this model and consider its quantitative implications for historical growth.

[10] This is akin to Tsiddon (1992)'s argument: "I assume that each financial intermediary can provide a risk-free return to lenders that is equal to or greater than the risk-free rate of return individuals can earn in the market for physical capital. Competition guarantees that each financial intermediary has zero profit." p. 305

3.1.6 Calibration

Using data from Crafts and Harley (1992) for the level of industrial production in the UK through the industrial revolution we can, with reasonable parameter values, trace back the implied efficiency of financial intermediation in this setup. We use here the 'revised best guess' (Crafts and Harley, 1992, Table A3.I) for the industrial production series. This is a standard reference for such data, and it shows a similar pattern to that in Bairoch (1982). The advantage of the Crafts and Harley dataset is that they provide annual values. We do not extend the data to the current day since the composition of output changed significantly, with a decreasing proportion of industrial production towards the end of the twentieth century. Figure 2 shows the path of the trend growth rate. We report the growth rate of HP-filtered series with both $\lambda = 100$ since this is annual data and with $\lambda = 10,000$ to show the general movement in growth.[11]

Figure 2: Trend UK Growth of Industrial Production



Whichever of the two weights we use in the filter the implications are the same. Trend growth in the UK increased through the early periods of industrial revolution and decreased slightly after around 1825. This is a relatively typical pattern for countries going through industrialisation during the eighteenth and nineteenth century, and the only exception seems to be the US.

[11] All data and results are available from the author.

We can use the growth trend with $\lambda = 10,000$ to find the implied value of η_f, *ceteris paribus*, by using the estimate of trend growth, $\hat{\gamma}$, and equations (3) and (7),

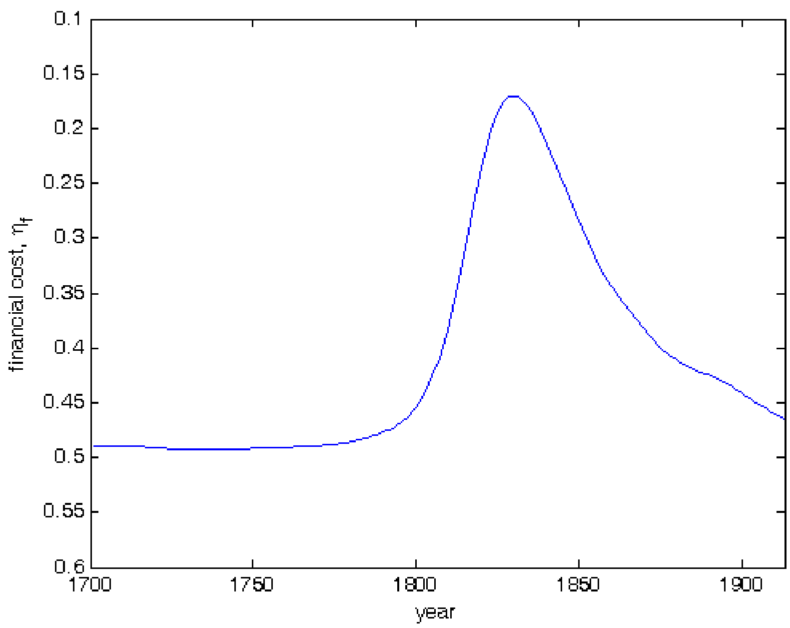
$$\hat{\eta}_f = \left[\frac{1-\varphi_1-\varphi_2}{1-\varphi_1}\right]\left\{\beta\left[1-\left(\frac{\theta\hat{\gamma}+\rho}{A}\right)^{\frac{1}{1-\alpha}}\frac{1}{\tau(1-\alpha)}\right]-\eta_x\right\} \tag{8}$$

We must restrict some parameters for calibration purposes. For $\hat{\eta}_f > 0$ over the range of obvserved trend growth values we require $A[(1-\eta_x/\beta)(1-\alpha)]^{1-\alpha} > \hat{\hat{\gamma}}\theta + \rho$, where $\hat{\hat{\gamma}}$ is the maximum growth rate observed over the sample. Bearing this in mind we use the parameter values given in Table 2 in simulations of this model.[12]

3.1.7 Numerical Implications

So we have inferred the historical *level* of financial efficiency, in the King-Levine mould, as that depicted in Figure 3.

Figure 3: Historical Financial Efficiency in the UK



[12]These results are considerably robust to changes in parameters, so long as we obtain positive values for η_f. Without significantly altering the *shape* of the implied efficiency data over time we can vary α between 0.1 and 0.9, φ_1 and φ_2 can take any value so long as $\varphi_1 + \varphi_2 < 1$, β can take any value in the interval $(0, 1)$, A can be varied widely (while satisfying the inequality for $\eta_f > 0$), θ can be varied (again, so long as we satisfy the inequality), and η_x can take any positive value below unity.

Here we have inverted the y-axis in order to reflect more clearly the movement of implied financial *efficiency* over the period. Plainly there is a great deal of implied movement in the parameter over time. We see an initially low level of financial efficiency at the beginning of the industrial take-off and a peak of financial efficiency at around 1830. The parameter then falls monotonically over the remainder of the sample. The path of financial efficiency mirrors the path of the trend growth rate and so the implied drop in financial efficiency reflects the fall in observed trend growth.

It should be noted also that we are only changing one variable; the implied path of financial efficiency would be affected if we were to account for the technological revolution by exogenously increasing A over the period. Nonetheless, the general shape of the path would remain. The implication of this finance and growth model is thus that the level of financial efficiency was, at the start of the industrial revolution, (relatively) low. Financial efficiency then increased up until around 1830 before dropping again, almost to pre-industrial levels.[13] This observation is an important one, and might be tested using appropriate historical data. In a sense it is surprising to consider a rapid rise and then decline of financial efficiency, and so this suggests that theories of finance and growth, in the main, cannot acceptably account for the dynamics of industrial take-off. Again, this question cannot move beyond speculation without further research.

3.2 Financial Intermediation, Moral Hazard and Growth

The degree to which the model presented in section 3.1 reflects the state of the literature is limited. Most work on financial intermediation and growth considers some further role for asymmetric information, be it imperfect screening, costly state-verification or effort-aversion and costly monitoring. Here we will take the latter approach, along the lines of de la De la Fuente and Marín (1996) and Morales (2003).

In the King and Levine (1993b) model, the entrepreneur knows that there is no difference in his income between success and failure, i.e., he is fully insured, and yet he still supplies effort in the management of a research project, the success rate of which he has no influence over. In the modification presented in section 3.1, the agent is not fully insured (though of course the clan of

[13]The process could equally well be applied to any other country with sufficient data; the growth patterns of many industrialised countries have mirrored this peak shape, see Bairoch (1982).

which he is part is fully diversified) but, still, he has no influence over the probability of acquiring human capital. It is likely, however, that there would be a relationship between the effort the agent puts into acquiring human capital and the likelihood, β, of it occurring. If agents are averse to effort there emerges a role for intermediaries in implementing a costly monitoring technology, where 'monitoring' is hereafter synonymous with 'controlling', to increase their expected income by forcing an increase in β.

Morales (2003) considers an endogenous growth model with financial imperfections but makes the probability of innovation endogenous. Researchers in Morales' model, analogous to the entrepreneurs of King and Levine, dislike effort and have limited liability, i.e., they pay back a certain amount less than their monopoly profits from starting up in the intermediate sector in the case of success, but do not suffer relative to their initial wealth in the case of failure. So there is a level of effort that the entrepreneur will provide given his preferences over effort. The intermediary then has the ability to *monitor* the entrepreneur and force him to increase effort, a mechanism used in a number of papers (*inter alia* De la Fuente and Marín, 1996; Blackburn and Hung, 1998). In the model presented here an agent with high ability is funded and acquires human capital with probability β, paying back an amount to the intermediary in the case of success and nothing otherwise.

A simple approach is to assume that agents are averse to effort and that a monitoring technology is required to increase effort. Effort in this model is reflected in the probability of a good agent becoming human capital, so an increase in effort is the same as an increase in β, though not one-for-one. We could endogenise the quality of intermediary screening but for now we leave the simple case where the agent and intermediary can only influence the probability of becoming human capital.[14] So, post-screening, the agent is faced with the following expected profit condition,

$$\beta(1 - t^*)hH - D(\beta), \tag{9}$$

where effort aversion enters as $D(\beta) = (hH\beta^2)/(2\kappa)$, which is an increasing and convex function of β, and also increasing in the level of human capital. The parameter $\kappa > 0$ reflects the agents' effort aversion, i.e., high κ suggests a low aversion to effort. These assumptions might be justified on two counts: The marginal effect of an increase in effort on the likelihood of success is decreasing

[14] Trew (2004a) considers such an extension in a model that is closer to King and Levine (1993b).

in the probability of success; and the higher the level of human capital to which an agent aspires, the more difficult it is to succeed and so the higher the cost of increasing β. We also abstract from taxation in this version, so $\tau = 1$. The agent thus chooses his level of effort to maximise his private return, given t^* and κ,

$$\beta_0 = \kappa(1 - t^*), \tag{10}$$

which is, importantly, invariant to h.

We thus have a minimum effort level in the absence of monitoring equal to β_0. An intermediary can spend resources on 'monitoring' the agent in order to force his effort level higher. The cost of increasing effort is a function $M(\beta - \beta_0) = [hH(\beta - \beta_0)^2]/2s$ of the difference between the desired β and the minimum, β_0, where $s > 0$ is, again, some scale parameter that influences the cost of monitoring and we again assume that the cost of monitoring is increasing in the level of human capital. So s is some indication of the sophistication of financial intermediaries in mitigating the costs of moral hazard; the higher is s, the less costly is moral hazard. These simplifying assumptions are necessary for both β_0 and β^* to be invariant to H so they could be modified, but the algebra would not permit a simple closed form solution for growth rates. We can define this function to be convex in the difference between desired and minimum effort levels (the convexity here is a consequence of convexity in effort-aversion). As such, the intermediary's expected profit considers this additional cost,

$$\begin{aligned} E(\pi) &= \beta \left(\frac{1 - \varphi_1 - \varphi_2}{1 - \varphi_1} \right) \left\{ thH - x(H) - f(H) - [H(\beta - \beta_0)^2]/2s \right\} + \\ &+ (1 - \beta) \left(\frac{1 - \varphi_1 - \varphi_2}{1 - \varphi_1} \right) [-x(H) - f(H)] + \\ &+ \left(\frac{\varphi_2}{1 - \varphi_1} \right) [-f(H)] = 0. \end{aligned} \tag{11}$$

So the intermediary now maximises expected profits with respect to both β and t. If we again specify $x(H) = \eta_x hH$ and $f(H) = \eta_f hH$, then the optimal β for a given t is the positive solution to,

$$\left\{ 3\beta^2 - 4\beta\kappa(1 - t) + [\kappa(1 - t)]^2 \right\} /2s - t = 0, \tag{12}$$

which is,

$$\beta^* = \frac{2}{3}\kappa(1-t) + \frac{1}{3}\left\{[\kappa(1-t)]^2 + 6st\right\}^{\frac{1}{2}}. \tag{13}$$

It is easy to see from equation (13) that both an increase in the efficiency of monitoring (increasing the scale parameter s) and a lower aversion to effort (higher κ) results in a higher optimal effort.

Substituting the expression for the optimal β into the expected profit function, equation (11), and setting expected profits equal to zero, it follows that the optimal levy on agents acquiring human capital, t^*, is the solution to,

$$\left\{\frac{2}{3}[\kappa(1-t)] + \left[\frac{(\kappa(1-t))^2}{9} + \frac{2}{3}st\right]^{\frac{1}{2}}\right\}\left\{2st - \left[\frac{(\kappa(1-t))^2}{9} + \frac{2}{3}st\right] + \right.$$
$$\left. -\frac{2}{3}\kappa(1-t)\left[\frac{(\kappa(1-t))^2}{9} + \frac{2}{3}st\right]^{\frac{1}{2}} + \frac{1}{9}(\kappa(1-t))^2\right\} = 2s\left[\eta_x + \left(\frac{\varphi_2}{1-\varphi_1}\right)\eta_f\right]. \tag{14}$$

We can now find the growth rate of the economy, as before, as a function of the financial intermediary conditions. It should be clear that parameterisation will not be as simple as in the case without moral hazard since here we require both $t^* \in (0,1)$ and $0 < \beta_0 < \beta^* \in (0,1]$, but there is a range of parameters for which we obtain sensible results.

Again we have $r = (1-t^*)h$[15] so the level of growth in the economy is equation (7). The effect of parameter variations on growth are the opposite of the effect on the optimal t. For a reasonable range of parameters[16] it can be shown that the optimal financial intermediary cost, t^*, is decreasing in the efficiency of monitoring technology, s, and increasing the degree of effort aversion (decreasing in κ). Financial efficiency also has the expected effect, with t^* increasing in both η_f and η_x.

So we have a model of endogenous growth which incorporates both the role of financial efficiency, along the lines of King and Levine (1993b), and a facility to reflect the degree of moral hazard faced, in the spirit of Morales (2003). It is, therefore, possible to consider the results from section 3.1 in the light of changing moral hazard conditions over time.

We can also present an analogous result to that in Figure 3, with combinations of financial

[15]This condition does not change from the model without moral hazard. Decisions over screening and effort are made within the cohort of agents, before employment as human capital, so do not affect the conditions for dynamic optimisation.

[16]In these experiments the benchmark parameterisation is the same as that given in Table 2, and in addition $\kappa = 1$, $\eta_f = 0.1$ and $s = 10$. We vary one parameter holding the others constant in order to infer the partial influences.

efficiency and moral hazard required to obtain the observed UK growth path through the industrial revolution. For each year we have an estimate of trend growth, $\hat{\gamma}$, from which we can infer, from equation (7), the implied estimate for t^*,

$$\hat{t}^* = 1 - \left(\frac{\theta\hat{\gamma} + \rho}{A}\right)^{\frac{1}{1-\alpha}} \frac{1}{1-\alpha}. \tag{15}$$

Again, there are restrictions on parameters in order that $\hat{t}^*$ is in the unit interval. Specifically this requires that $0 < \theta\hat{\gamma} + \rho < A(1-\alpha)^{1-\alpha}$, so we choose parameter values that satisfy this given the range of growth rates over the period 1701-1913.[17] Using parameter values given in Table 3, this inequality is satisfied for the entire sample. The fact that we can use the same parameters for both models demonstrates that the model without moral hazard is nested within the extended model presented here, and also that both are not overly sensitive to parameter variations.

Having identified $\hat{t}^*$ we can find combinations of financial costs, η_f, and s that obtain this growth rate using equation (14), and thus combinations of financial efficiency and moral hazard that replicate the industrial revolution in the UK. Figure 4 depicts this relationship, where we again simply reverse the z-axis to give an impression of financial efficiency *à la* King and Levine (1993b). As anticipated, improving moral hazard conditions (increasing s) means that, *ceteris paribus*, a given level of growth can be obtained with lower financial efficiency.

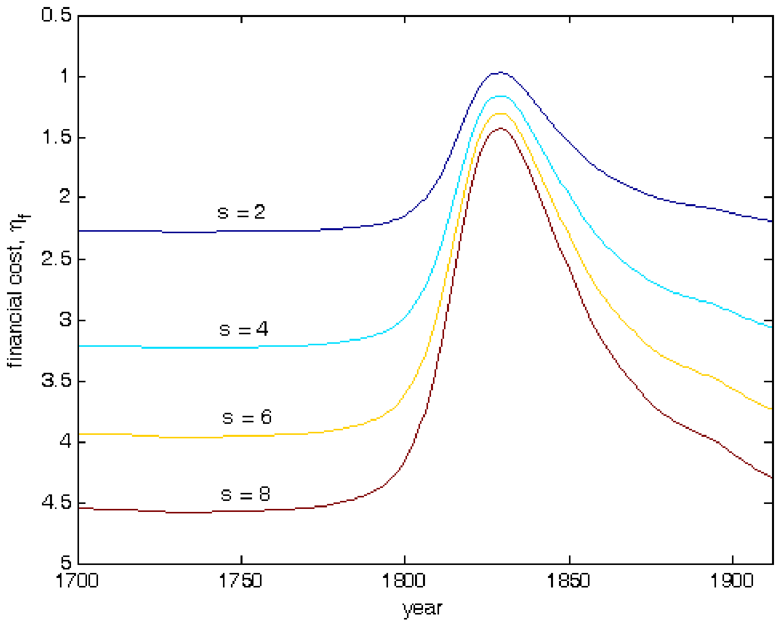
Figure 4 gives combinations of financial efficiency and moral hazard that result in our estimated growth rate. We can see that either high financial efficiency and high moral hazard costs or low financial efficiency and low moral hazard costs obtain the same growth rate, as in Morales (2003). We can imagine a cross-section of the figure as being equivalent to Figure 3.[18] So changes in the conditions of moral hazard affect the level of financial efficiency required to obtain a given growth rate.

The relation between growth and financial efficiency is monotonic but the degree of variation is clearly dependent on the relationship between the rate of growth and moral hazard conditions. Choosing a cross section at $s = 2$ suggests a high level of financial efficiency throughout the period, while at $s = 8$ we see a (relatively) more dramatic variation in the level of financial efficiency. So

[17] The minimum growth rate, using the same procedure as in section 3.1, is 0.47% and the maximum is 3.60%

[18] We cannot think about a single cross-section as representing it perfectly since, in that model, β is fixed whereas here it is endogenous and so changing over the period, but the general pattern is consistent.

Figure 4: Industrial Growth, Moral Hazard and Financial Efficiency



while $\partial\eta_f/\partial s < 0$ holds at all points we have in addition,

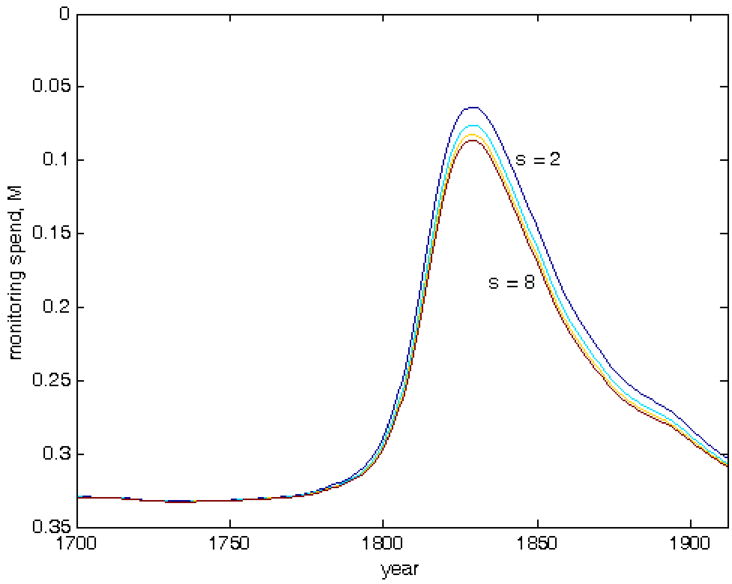
$$\left.\frac{\partial\eta_f}{\partial s}\right|_{\gamma=\overline{\gamma}} > \left.\frac{\partial\eta_f}{\partial s}\right|_{\gamma=\underline{\gamma}} \quad \text{where } \overline{\gamma} > \underline{\gamma} \tag{16}$$

i.e. the partial effect of s on η_f is more negative (closer to zero) when growth is low (high). So the most unusual implication of the figure is that as moral hazard conditions deteriorate, so financial efficiency needs to vary less in order to obtain equal changes in the growth rate. It will help our understanding of the model if we consider the intermediary's total spend on monitoring.

Interestingly, the total spend on monitoring, $M(\beta^* - \beta_0)$, is almost invariant to s, as shown in Figure 5. The minimum effort level, β_0, is invariant to s but the optimal effort level, β^* is of course increasing in s while the overall monitoring cost simultaneously declines. So increases in the efficiency with which intermediaries can monitor agents endogenously decreases the level of moral hazard in intermediation without intermediaries actually spending significantly different amounts on monitoring agents.

The reason why total monitoring spend falls as growth increases is because of the implied increase in financial efficiency, decreasing the optimal intermediation levy, t^*, and so increasing

Figure 5: Industrial Growth and Spend on Monitoring



the minimum effort level, β_0. This causes less emphasis to be placed on the the effect of monitoring on growth. As such, we observe that at high growth rates, when the minimum effort level is high and with roughly constant and, most importantly, low spend on monitoring, the effect of changing moral hazard conditions is less since it enters directly into the monitoring decision. The transmission from moral hazard to growth thus follows: When moral hazard conditions mean that the level of effort in the absence of monitoring is low the total spend on monitoring is high and so, in such cases, the effect of changing moral hazard conditions affects growth more severely.

This sort of result, where moral hazard and economic growth conditions interact, is akin to that in Greenwood and Smith (1997) and Blackburn et al. (2005) and, in the simple form presented here, could be tested empirically with appropriate cliometric evidence.

This section has presented a way of generalising the contemporary approach to finance and growth theory, and has demonstrated that such models can have quantitative, and therefore testable, results. The purpose of the rest of this paper is to consider the scope for such testing, as well as looking at the general implications of the current literature from an historical perspective.

4 Discussion

We have seen that the finance-growth nexus operates along at least four dimensions: The size of the financial sector as a proportion of the economy (financial depth); the effect of institutions and regulations on the efficiency with which financial services are provided (financial efficiency); the nature and extent of asymmetric information (both moral hazard and adverse selection); and the extent of disaggregation. In addition, each of these are evolving over time. Viewed from this perspective, the literatures surveyed in this paper typically address the finance-growth nexus in an incomplete way.

It has been shown that applied econometric work considers financial depth while holding efficiency to be exogenous. By contrast, most theories consider financial efficiency holding depth to be constant. This clear disconnection has significant implications for the reconciliation of applied and theoretical work: Applied (theoretical) research of this sort cannot without qualification be held to support theoretical (applied) conclusions.

Quite apart from the mapping between the theory and empirics of finance and growth, there has been little in the way of historical motivation or cliometric testing in the standard approach to most theoretical modelling. Section 3 has demonstrated that most theories consider asymmetric information and financial efficiency but pay little heed to questions of disaggregation; there is no scope for sub-national coalitions of financial intermediaries to provide services more efficiently.

The time-series historical analysis based on financial depth have demonstrated clear and consistent results that supplement what was learned from the cross-sectional research. This literature tells us that the level of financial depth *does* change over time, and that theories of static intermediation thus miss an important element of the story which robust econometric analyses suggest is so important. But in terms of understanding *why* financial depth leads economic growth we need to understand the reasons why financial structures emerge. Economic theory justifies the existence of banks, or more generally coalitions of agents who provide finance, by appealing to asymmetric information. It is necessary, if we are to endogenise the financial development of an economy going through industrial transition, to consider historical experience in this light.

Instead of appealing to such historical beacons, decisions about modelling are typically driven by cross-section evidence in a way that limits the time-series implications of the theory, i.e., there are few meaningful transitional dynamics.[19] A major drawback with present theory is that, even if we can back out some indicative path for financial efficiency, this transition would be exogenous and, as suggested by Section 3, perhaps even counterfactual. We must look properly at the historical record in order to understand the mechanics behind the degree of asymmetric information, and in this way develop a theory of endogenous growth and *endogenous financial development*.[20]

The historical evidence presented in Section 2 suggests that the relationship between agents and financial intermediaries is dynamic and disaggregated, and where the level of financial depth is not constant. The mechanics of theories such as King and Levine (1993b) appear, prima facie, to be difficult to square with with the historical evidence presented here. The numerical implications of these models raise further questions since are also difficult to reconcile with the historical literature. In general, the static approach to modelling finance and growth in which financial depth is not endogenously changing and where aggregative factors are not considered, is thus inappropriate and the implications of the models described in Section 3 must be considered with caution.

The problem is in establishing the quantitative significance of each of these aspects. If we can work towards uncovering the richness of the dynamic interplay between asymmetric information, financial structure, financial depth and economic growth, during the transition to an industrial economy, then we would have a new, more historically congruent, micro-founded, theory of finance and growth. Townsend and Ueda (2006) is an interesting start to work in this direction, matching rich, disaggregated data on Thailand to a theory of inequality, financial deepening and growth. But a step further than this would be to consider a long time series of a country incorporating the pre-industrial, take-off, and post-industrial phases of development with an understanding of the morphing financial depth, financial efficiency, asymmetric information and aggregation issues all coming into play.

5 Conclusions

Applied and theoretical research on any question in economics cannot be considered in isolation from each other. We have argued that the theoretical, contemporary econometric and historical

[19] A clear exception is the work of Townsend and Ueda (2006).
[20] Nolan et al. (Forthcoming) begins work in this direction.

literatures on the finance-growth nexus are if not contradictory then at best simply disconnected. An attempt at reconciliation will need to move beyond the concentration on contemporary econometrics, beyond the assumption of static information asymmetry, and beyond the conception of aggregate variables alone.

These criticisms apply equally to empirical, theoretical and historical research. Future work will thus need to identify the key features of the interaction between finance and growth over continuous periods, such as the industrial revolution. The historical literature surveyed briefly here strongly suggests that current theories of finance and growth do not depict adequately the experiences of countries going through industrial revolution. A potentially more fruitful avenue for research will be to establish the historical experience of industrialisation, asymmetric information and intermediation, and then construct a growth theory founded in microeconomics that more faithfully reflects it. Understanding the relationship between increasing financial depth and evolving conditions of asymmetric information through a period of industrial revolution is required as a first step.

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Table 1: Core Features of Some Finance and Growth Models

	source of endogenous growth	**finance mechanism**	**information problem**
BS91	production externalities	insurance market and entrepreneurship	exogenous liquidity shock
S92	production externalities	capital market	exogenous productivity shock
KL93b	vertical innovation	entrepreneurial funding, heterogeneous agents	adverse selection (screening)
BC96	production externalities	contract or screen heterogeneous entrepreneurs	adverse selection (ration or screen)
FM96	horizontal innovation	funding and monitoring entrepreneurship	moral hazard (effort aversion)
BH98	horizontal innovation	entrepreneurship, project appraisal, risk diversification	moral hazard (deceit)
GK98	human capital accumulation	credit markets vs. intergenerational altruism	none
M03	vertical inn., capital accumulation	entrepreneurship, screening	moral hazard (effort aversion)
AHM05	vertical innovation	entrepreneurship, credit constraints	moral hazard (deceit)
BBC05	production externalities	entrepreneurship, markets and banks	adv. selection and moral hazard

N.B. BS91 is Bencivenga and Smith (1991); S92 is Saint-Paul (1992); KL93b is King and Levine (1993b); BC96 is Bose and Cothren (1996); FM96 is de la De la Fuente and Marín (1996); BH98 is Blackburn and Hung (1998); GK98 is de De Gregorio and Kim (1998); M03 is Morales (2003); AHM03 is Aghion et al. (2005); BBC05 is Blackburn et al. (2005).

Table 2: Parameter Values for the Representative Model

capital share	α	0.67
subjective discount rate	ρ	0.02
elasticity of substitution	θ	5
human capital probability	β	0.75
proportion of zero ability	φ_1	0.4
proportion of low ability	φ_2	0.2
coefficient of technological progress	A	30
scale parameter on financial investment	η_x	0.01
tax parameter	τ	1

Table 3: Benchmark Calibration for the Model with Moral Hazard

capital share	α	0.67
subjective discount rate	ρ	0.02
elasticity of substitution	θ	5
proportion of zero ability	φ_1	0.4
proportion of low ability	φ_2	0.2
coefficient of technological progress	A	30
scale parameter on financial investment	η_x	0.01
scale parameter on screening	η_f	0.1
effort aversion parameter	κ	1
monitoring cost parameter	s	10

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