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A Gold Rush Theory of Economic Development

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Abstract
This paper presents a model of social learning about the suitability of local conditions for new business ventures and explores its implications for the microeconomic patterns of economic development. I show that: i) firms tend to 'rush' into business ventures with which other firms have had surprising success thus causing development to be 'lumpy'; ii) sufficient business confidence is crucial for fostering economic growth; iii) development may involve wave-like patterns of growth where successive business ventures are first pursued and then given up; iv) there is, nevertheless, no guarantee that firms pursue the best venture even in the long-run.

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1 Introduction

Technology transfers are a prerequisite for many new business ventures in developing countries. This tends to make the prospects of such ventures hard to predict, as it is often unclear how suitable local conditions are for the transferred technology.[1] The experiences of pioneering firms play an important role in reducing this uncertainty. Their success with particular ventures is indicative of the suitability of local conditions and the thus gained information can be used by other firms to guide their investment decisions.[2] So, learning about the suitability of local conditions for new business ventures then also has a social dimension, as firms not only learn from their own experience but also from the experiences of other firms.

This paper develops a model of such social learning and explores its implications for the microeconomic patterns of growth. In this model, firms update their prior beliefs about the suitability of local conditions for particular business ventures in a Bayesian fashion by observing their own experience and the experiences of other firms with these ventures. Four main results emerge from the analysis. First, I show that firms tend to 'rush' into business ventures with which other firms have had surprising success thus causing development to be 'lumpy'. One implication of this 'lumpiness' is that improvements in the economic environment (policies, institutions, infrastructure, etc.) which trigger entry into

[1] Rosenberg (1982, p. 249), for example, writes that "the successful transfer of technology is not a matter of transporting a piece of hardware from one geographic location to another (but) depends greatly upon the specific domestic circumstances in the recipient country". Evenson and Westphal (1995, pp. 2262–2263) emphasize that "the body of case study research and anecdotal evidence includes numerous cases of failure to achieve the minimum mastery needed to attain the levels of productivity expected when the physical investment was undertaken. It also includes numerous cases of unforeseen success in achieving sufficient mastery to exceed the expected levels of productivity".

[2] Evenson and Westphal (1995), for example, cite several cases of such a technology diffusion from pioneering firms to imitators.

unexplored business ventures can potentially kick-start economic development. Second, I demonstrate that sufficient business confidence is crucial for fostering economic growth and development. If firms have overly pessimistic initial beliefs, viable business ventures remain unattempted, whereas overly optimistic beliefs never make firms pursue non-viable ventures permanently. However, even if initial beliefs are sufficiently optimistic, viable ventures may be abandoned if firms misinterpret the evidence available to them. Third, I establish that development may involve a wave-like pattern of growth where successive business ventures are first pursued and then given up until a venture is found for which local conditions are sufficiently suitable. Finally, I show that, despite this potential 'stuttering' towards a viable venture, there is no guarantee that firms pursue the best venture even in the long-run.

Case study evidence suggests that this 'lumpiness' and the associated 'stuttering' towards a viable business venture seem to be important characteristics of the microeconomic pattern of growth and that the above mentioned social learning plays an important role in bringing about such 'lumpiness' and 'stuttering'. Regarding 'lumpiness', Rhee (1990), for example, reports that Bangladesh's garment industry experienced a sudden and rapid takeoff in the late 1980s due to the wide imitation of a surprisingly successful initial business venture of the Daewoo Corporation of Korea.[3] In a related paper, Rhee and Belot (1990) point out that the astonishing success of the Colombian cut flower industry originated in a single surprisingly successful investment of an American entrepreneur which was then imitated by local entrepreneurs. Burgess and Venables (2004) present further evidence that development is often 'lumpy' and conclude that 'lumpiness' is an important characteristic of the microeconomic pattern of growth. As for the 'stuttering' towards a viable business venture, an interesting example is provided by Urquiola et al. (1999) who report that the recent growth of the agricultural

[3]Interestingly, Rhee (1990) points out that Daewoo did not have much confidence in the project reflecting the uncertain success of technology transfers. It mainly viewed the venture as a vehicle to get involved in some of Bangladesh's other industries.

sector in lowland Bolivia was driven by successive booms of rice, cotton, sugar cane, and finally soybeans.[4] As is pointed out by Arrieta et al. (1990, pp. 221-258), the unfavorable local conditions (in particular climate and soil) were among the main reasons why the booms of rice, cotton, and sugar cane all came to an end eventually.

To the best of my knowledge, this paper is the first attempt to explore the implications of social learning about the suitability of local conditions for new business ventures on the microeconomic patterns of economic development. Hoff (1997) and Hausmann and Rodrik (2003) also study social learning about the suitability of local conditions for new business ventures, but focus on the inefficiency which comes along with the learning externality, rather than studying its implications for the microeconomic patterns of growth. Entrepreneurship is shown to be underprovided in these papers due to the divergence between the private and the social value of gaining experience. Burgess and Venables (2004) sketch a framework which suggests that increasing returns to scale which are external to individual firms (e.g. thick market externalities) could be underlying 'lumpy' development. Social learning about the suitability of local conditions for new business ventures does not play a role in their analysis. This social learning, however, seems crucial for understanding the above examples of 'lumpy' development as well as the observed 'stuttering' towards a viable business venture.[5]

The remainder of this paper is organized as follows: The next section lays out the basic model and discusses its implications for the microeconomic patterns of growth. It is demonstrated how the model generates 'lumpy' development and how

[4] In particular, it is reported that the share of rice, cotton, sugarcane, and soybeans in the total area under cultivation exceeded 20 percent in successive time periods. The shares of rice, cotton, and sugarcane declined quickly after their respective booms. Soybean cultivation, on the contrary, remained successful and is now dominating the local agriculture.

[5] Caplin and Leahy (1993) also explore the welfare implications of such social learning in the context of structural change and again demonstrate that entrepreneurship is underprovided. In a related paper, Caplin and Leahy (1998) show that social learning can potentially explain the rapid revitalization of New York's Lower Sixth Avenue. Hausmann, Hwang, and Rodrik (2005) argue that a country's pattern of specialization is in part determined through social learning and provide some evidence that the pattern of specialization is a determinant of economic growth.

improvements in the economic environment may kick-start microeconomic growth. Also, the importance of sufficient business confidence in fostering economic growth and development is highlighted. A third section then generalizes this basic model to allow for multiple sectors or regions. It is shown that development may take a wave-like pattern where successive business ventures are first pursued and then given up until a venture is found for which local conditions are sufficiently suitable. Moreover, it is shown that, despite this potential 'stuttering' towards a viable venture, there is no guarantee that firms pursue the best venture even in the long-run. A fourth section concludes.

2 The basic model

2.1 The setup

Consider an economy with two sectors - traditional and modern - which is inhabited by L workers and is endowed with T units of land. The traditional sector uses both land and labor while the modern sector requires labor only. Initially, all workers are employed in the traditional sector so that the modern sector is not operating. It is uncertain how suitable local conditions are for modern sector production and modern sector firms rely on their exogenous initial beliefs when deciding on whether or not to invest in the modern sector. If their priors are optimistic enough so that there is entry into the modern sector, some information about the unknown parameter is revealed. In particular, the outputs of the active modern sector firms are indicative of the suitability of local conditions for modern sector production, and this information is then used by firms to update their prior beliefs in a Bayesian fashion. Importantly, all firms are assumed to observe these outputs (not only the active modern sector firms). Moreover, their priors are assumed to be identical so that the best guess about the unknown parameter is always the same among all firms. Also, potential costs of entering or leaving the

modern sector are ignored. Therefore, there is no intertemporal trade-off to be solved by the firms when making their entry decision. Free entry ensures that, in all time periods, the number of modern sector firms is such that expected profits are driven down to zero. The equilibrating mechanism is labor market competition. Workers have to be attracted from the traditional sector which increases the wage rate. Output prices do not play a role here. The economy is supposed to be small relative to other economies and trades both modern and traditional sector goods at fixed prices.[6] For simplicity, a demand side is not explicitly modelled. In a small open economy, production decisions are independent of consumption decisions, and a particular demand structure only has to be imposed if one wants to solve for domestic consumption or the pattern of international trade.

2.2 The modern sector

2.2.1 Technology

It is assumed that each modern sector firm has a fixed labor requirement l. Modern sector firm output is determined by multiplying this fixed labor requirement with the productivity parameter ϕ, a random variable which can take two values, $\overline{\phi}$ (high productivity) and $\underline{\phi}$ (low productivity), $\overline{\phi} > \underline{\phi} > 0$. The suitability of local conditions for modern sector production is captured by p, the probability that productivity is high. This parameter is fixed but unknown to the firms. Denoting modern sector firm output by y, modern sector technology is thus given by

$$y_{it} = \phi_{it} l \tag{1}$$

where $\phi_{it} = \overline{\phi}$ with probability p, $\phi_{it} = \underline{\phi}$ with probability $1 - p$ and i indexes firms and t indexes time. In short, firms can either be successful or not and the

[6] Another option would be to use product market competition as the equilibrating mechanism. This modification would be relatively straightforward and the results of the basic model would remain unchanged.

suitability of local conditions determines average firm success.[7]

All the risk is assumed to be borne by the modern sector firms in this model. At the beginning of the period modern sector firms enter (exit) the modern sector and hire (lay off) workers which determines the wage rate. Then the productivities are drawn, determining whether a firm makes profits or losses.[8]

2.2.2 Learning

Firms have exogenously given prior beliefs about p which they update through a process of Bayesian learning. It is assumed that all firms can observe the outputs of all modern sector firms so that the history of modern sector firm output is common knowledge. Since a modern sector firm's output is either high or low according to whether the productivity draw of the given firm in the given time period was good or bad, the number of good productivity draws in all draws is also common knowledge. Since all modern sector firms have access to the same information and use the same updating method, beliefs are the same among firms in all time periods.

Priors In particular, suppose that the firms' beliefs about p are characterized by a beta distribution, $p \sim Be(\alpha, \beta)$, so that[9]

$$f(p) \propto p^{\alpha-1}(1-p)^{\beta-1} \tag{2}$$

The beta distribution is a relatively general distribution on the support $[0, 1]$. Basically, all reasonably smooth unimodal distributions on this support can be approximated by a beta distribution by choosing suitable values for the parameters α and β. This includes the case of uniform priors ($\alpha = \beta = 1$) which is probably

[7] Notice that this specification of technology guarantees that y can only take positive values.

[8] Of course, one has to assume that modern sector firms own some assets which they can use to finance the losses in the bad state. This will be done henceforth.

[9] Recall that the beta distribution has density $f(p) = \frac{1}{B(\alpha,\beta)} p^{\alpha-1}(1-p)^{\beta-1}$, where $0 \leqq p \leqq 1$, $B(\alpha, \beta) = \frac{(\alpha-1)(\beta-1)}{\alpha+\beta-1}$.

the most intuitive starting point in the case of complete ignorance.[10] For future reference, recall that if $p \sim Be(\alpha, \beta)$, then $E(p) = \frac{\alpha}{\alpha+\beta}$.

Updating Consider now the updating of these beliefs. Denote the number of good draws until period $t-1$ by z_{t-1} and the total number of draws by n_{t-1}. If m_t is the number of modern sector firms operating in period t and s_t is the number of high productivity draws in period t, then $z_{t-1} = s_1 + ... + s_{t-1}$ and $n_{t-1} = m_1 + ... + m_{t-1}$. As discussed above, these two variables can be inferred from the output history and constitute the information set available to firms at the beginning of period t. By Bayes' Rule, the posterior beliefs are given by

$$f(p \mid z_{t-1}, n_{t-1}) = \frac{g(z_{t-1} \mid p, n_{t-1}) f(p)}{g(z_{t-1})} \tag{3}$$

where $g(.)$ is a density function which is further defined below. Notice that therefore $f(p \mid z_{t-1}, n_{t-1}) \propto g(z_{t-1} \mid p, n_{t-1}) f(p)$. Since z_{t-1} is just the number of 'successes' in a series of n_{t-1} draws, z_{t-1} follows a binomial distribution of index n_{t-1} and parameter p, $z_{t-1} \sim B(n_{t-1}, p)$ so that

$$g(z_{t-1} \mid p, n_{t-1}) = \binom{n_{t-1}}{z_{t-1}} p^{z_{t-1}} (1-p)^{n_{t-1}-z_{t-1}} \tag{4}$$

Hence, $g(z_{t-1} \mid p, n_{t-1}) \propto p^{z_{t-1}} (1-p)^{n_{t-1}-z_{t-1}}$. Recalling that $f(p) \propto p^{\alpha-1}(1-p)^{\beta-1}$ it then follows that

$$f(p \mid z_{t-1}, n_{t-1}) \propto p^{\alpha+z_{t-1}-1} (1-p)^{\beta+n_{t-1}-z_{t-1}-1} \tag{5}$$

and hence

$$p \mid z_{t-1}, n_{t-1} \sim Be(\alpha + z_{t-1}, \beta + n_{t-1} - z_{t-1}) \tag{6}$$

[10] The proposition that uniform priors should be used in the case of complete ignorance is sometimes referred to as Bayes' postulate.

These are the updated beliefs at the beginning of period t. Nicely, they are again beta distributed so that the incoming information only changes the parameters of the underlying distribution of beliefs but not the distribution itself.[11] This implies in particular that

$$E(p \mid z_{t-1}, n_{t-1}) = \frac{\alpha + z_{t-1}}{\alpha + \beta + n_{t-1}} \tag{7}$$

Discussion Modern sector firms are assumed to be risk-neutral so that the expected probability of a high modern sector firm productivity will be a key variable in the analysis. Before proceeding with the remainder of the model, it is therefore useful to clarify some of the properties of the updating of this expectation. For this purpose, the following decomposition is particularly insightful. It is easy to show that the posterior expectation is just a weighted average of the prior expectation and the 'success rate', the ratio of high productivity draws to total draws,

$$E(p \mid z_{t-1}, n_{t-1}) = \lambda_{t-1} E(p) + (1 - \lambda_{t-1}) \frac{z_{t-1}}{n_{t-1}} \tag{8}$$

where $\lambda_{t-1} = \frac{\alpha+\beta}{\alpha+\beta+n_{t-1}}$. Notice that λ is decreasing in the total number of draws which is very intuitive. The 'success rate' $\frac{z_{t-1}}{n_{t-1}}$ is a natural estimator of p and it becomes more influential relative to the prior belief, the more experience has been gained in the modern sector. Several things become obvious from this decomposition. First, it becomes clear that only surprises change the firms' beliefs since $E(p \mid z_{t-1}, n_{t-1}) \lesseqgtr E(p) \iff \frac{z_{t-1}}{n_{t-1}} \lesseqgtr E(p) \iff \frac{z_{t-1}}{n_{t-1}} \lesseqgtr E(\frac{z_{t-1}}{n_{t-1}})$.[12] Second, it is revealed that beliefs converge to the truth as

[11] In other words, the beta distribution is thus conjugate to a binomial likelihood which makes it a suitable prior distribution for the purposes of this model. See Lee (1998) for more details on this derivation.

[12] It is also easy to show that $E(p \mid z_{t-1}, n_{t-1}) = \widetilde{\lambda}_{t-1} E(p \mid z_{t-2}, n_{t-2}) + \left(1 - \widetilde{\lambda}_{t-1}\right) \frac{s_{t-1}}{m_{t-1}}$, where $\widetilde{\lambda}_{t-1} = \frac{\alpha+\beta+n_{t-2}}{\alpha+\beta+n_{t-1}}$, which emphasizes this point. Relative to the *previous* rather than the *initial* period, $\frac{s_{t-1}}{m_{t-1}} \lesseqgtr E(p \mid z_{t-2}, n_{t-2})$ is a surprise.

the number of observations increases since $\lim_{n_{t-1}\longrightarrow\infty}\lambda_{t-1}=0$ and $\frac{z_{t-1}}{n_{t-1}}$ converges to p as $n_{t-1}\longrightarrow\infty$. Third, it follows that the current beliefs can always be calculated by updating the initial beliefs using formula (8). The result is the same as if the current beliefs are calculated recursively by applying the updating rule period by period. To see this define $p_t\equiv E(p\mid z_{t-1},n_{t-1})$ and consider the sequence $p_1,...,p_t,...,p_T$. From the above formulae it follows that $p_T=\frac{\alpha}{\alpha+\beta+(m_1+...+m_{T-1})}p_1+\frac{(m_1+...+m_{T-1})}{\alpha+\beta+(m_1+...+m_{T-1})}\frac{(s_1+...+s_{T-1})}{(m_1+...+m_{T-1})}$ if the initial belief is used and $p_T=\frac{\alpha'}{\alpha'+\beta'+(m_t+...+m_{T-1})}p_t+\frac{(m_t+...+m_{T-1})}{\alpha+\beta+(m_t+...+m_{T-1})}\frac{(s_t+...+s_{T-1})}{(m_t+...+m_{T-1})}$ if the period t belief is used, where $\alpha'=\alpha+(s_1+...+s_{t-1})$ and $\beta'=\beta+(m_1+...+m_{t-1})-(s_1+...+s_{t-1})$. Some manipulation reveals that both expressions are indeed the same.[13]

2.3 Traditional sector

The traditional sector is assumed to be perfectly competitive with constant returns to scale technology. Apart from labor, it also requires land for production (e.g. the agricultural sector). In particular, technology is of the Cobb-Douglas type:

$$x_t=\left(T_t^T\right)^{\gamma}\left(L_t^T\right)^{1-\gamma} \tag{9}$$

where x is traditional sector output, T^T is the land employed in the traditional sector, L^T is the labor employed in the traditional sector, and $0<\gamma<1$. Equation (9) gives the aggregate traditional sector output. Firm subscripts have been omitted as individual firm size is anyway indeterminate with constant returns to scale technology. Choose units such that the price of the traditional sector good is 1 so that the value marginal product of labor in the traditional sector is given by $(1-\gamma)\left(\frac{T_t}{L_t^T}\right)^{\gamma}$. As usual, workers are paid their value marginal product so that the (inverse) labor supply curve faced by modern sector firms trying to attract

[13] All these are general properties of Bayesian learning. See, for example, Chamley (2004) for more on this issue.

workers from the traditional sector is given by

$$w_t = (1-\gamma)\left(\frac{T}{L - L_t^M}\right)^{\gamma} \tag{10}$$

In this equation, w is the wage rate and the factor market clearing conditions $L = L_t^T + L_t^M$ and $T_t^T = T$ have been imposed. Recalling that modern sector firms have a fixed labor requirement l so that the number of modern sector firms at time t is given by $m_t = \frac{L_t^M}{l}$, the wage rate is given by

$$w_t = (1-\gamma)\left(\frac{T}{L - lm_t}\right)^{\gamma} \tag{11}$$

The wage rate hence increases in all time periods in which firms are entering the modern sector. This is, of course, due to fact that the Cobb-Douglas technology exhibits diminishing returns to labor.

2.4 Equilibrium

If units are again chosen such that the price of the modern sector good is 1,[14] modern sector firm profits in period t are given by

$$\pi_{it} = \phi_{it} l - w_t l \tag{12}$$

From above, recall the notation $p_t \equiv E(p \mid z_{t-1}, n_{t-1})$. At the beginning of period t, period t profits are thus expected to be

$$E(\pi_{it} \mid z_{t-1}, n_{t-1}) = \left[p_t \overline{\phi} + (1-p_t)\underline{\phi} - w_t\right] l \tag{13}$$

As discussed previously, free entry drives $E(\pi_{it} \mid z_{t-1}, n_{t-1})$ down to zero. Firms are not willing to invest in period t unless they expect to make profits in period t.

[14] Recall that the economy is assumed to be small relative to other economies and trades both modern and traditional sector goods at fixed prices. Therefore, it is possible to choose units in both sectors which set goods prices equal to 1.

They never invest just to learn something about the suitability of local conditions since the private value of this information is zero. If there is a good surprise and local conditions turn out to be very favorable for modern sector production, this becomes common knowledge and triggers entry in the following period. Using the wage rate from equation (11), the equilibrium number of modern sector firms at time t can thus be computed from setting (13) equal to zero,

$$m_t = \kappa - \frac{\rho}{\left[p_t\overline{\phi} + (1-p_t)\underline{\phi}\right]^{\frac{1}{\gamma}}} \tag{14}$$

where the parameters $\kappa \equiv \frac{L}{l}$ and $\rho \equiv \frac{T}{l}(1-\gamma)^{\frac{1}{\gamma}}$ have been introduced to simplify the notation.[15] Since $\overline{\phi} > \underline{\phi}$, the equilibrium number of firms is thus increasing in p_t. The better local conditions are believed to be, the more modern sector firms are operating. Together with equation (7), this equation yields

$$\begin{aligned} m_t &= \kappa - \frac{\rho}{\left[\frac{\alpha+z_{t-1}}{\alpha+\beta+n_{t-1}}\left(\overline{\phi}-\underline{\phi}\right)+\underline{\phi}\right]^{\frac{1}{\gamma}}} \\ &= \kappa - \frac{\rho}{\left[\frac{\alpha+(s_1+\ldots+s_{t-1})}{\alpha+\beta+(m_1+\ldots+m_{t-1})}\left(\overline{\phi}-\underline{\phi}\right)+\underline{\phi}\right]^{\frac{1}{\gamma}}} \end{aligned} \tag{15}$$

Hence, the number of firms in period t depends on the number of firms in previous periods and the history of high productivity draws. The industrialization path is random, since changes in beliefs are driven by the random productivity draws. Notice also that, for a given history, the number of firms is increasing in α and decreasing in β. This is because an increase in α (β) makes beliefs more skewed to the left (to the right) so that local conditions are believed to be more (less) suitable for modern sector production.

To make the model interesting, assume that

[15] Of course, the equilibrium number of modern sector firms cannot be negative. So if $\kappa \leqq \frac{\rho}{\left[p_t\overline{\phi}+(1-p_t)\underline{\phi}\right]^{\frac{1}{\gamma}}}$, $m_t = 0$.

$$\underline{\phi} < \left(\frac{\rho}{\kappa}\right)^{\gamma} < \overline{\phi} \tag{16}$$

This assumption ensures that the modern sector firms' entry decisions are not independent of their beliefs. If $\left(\frac{\rho}{\kappa}\right)^{\gamma} < \underline{\phi}$, the initial wage rate would be so low that it would be profitable to enter the modern sector even if the bad state occurred with certainty. Similarly, if $\overline{\phi} < \left(\frac{\rho}{\kappa}\right)^{\gamma}$, the initial wage rate would be so high that it would not be profitable to enter the modern sector even if the good state occurred with certainty. With this condition, there hence exists an expected success probability $\overline{p}$ such that the modern sector is operating if and only if beliefs are more optimistic than $\overline{p}$. From equation (14) it follows that this threshold belief is given by[16]

$$\bar{p} = \frac{\left(\frac{\rho}{\kappa}\right)^{\gamma} - \underline{\phi}}{\overline{\phi} - \underline{\phi}} \tag{17}$$

It is easy to show that $\overline{p}$ is decreasing in both productivities given that the above parameter restriction is satisfied. This is not surprising since higher productivities make modern sector production more attractive regardless of the suitability of local conditions.

This completes the derivation of the basic model. The next section now turns to analyzing its implications for industrial growth and development.

2.5 Analysis

This analysis of the basic model establishes the first two results of the paper. In a first part, it is shown that sufficient business confidence is crucial for fostering economic growth. The discussion in that part also serves to characterize more generally the development patterns which are consistent with the model. In a second part, it is then demonstrated how social learning about the suitability of local conditions for new business ventures can lead to 'lumpy' economic development.

[16] Notice that $\underline{\phi} < \left(\frac{\rho}{\kappa}\right)^{\gamma} < \overline{\phi} \iff 0 < \overline{p} < 1$.

2.5.1 Business confidence and the patterns of modern sector development

In this model, business confidence is captured by the firms' initial beliefs about the suitability of local conditions for modern sector production. Three main points need to be made to characterize how these beliefs shape the microeconomic patterns of growth:

1. If initial beliefs are sufficiently pessimistic, there will never be any modern sector production regardless of how suitable local conditions are in reality. If $p_1 < \overline{p}$, no firm finds it profitable to invest in the modern sector in the first time period. But without modern sector activity, there is no learning and hence no investment in future time periods. No firm has an incentive to incur an expected loss in one period in order to learn something about the suitability of local conditions for modern sector production, since this information has no private value in the given context of social learning.

2. If local conditions are not suitable for modern sector production, $p < \overline{p}$, modern sector production will always be given up at some point in time. If local conditions are suitable for modern sector production, $p > \overline{p}$, and modern sector production is not given up, the number of firms will converge to the full information equilibrium

$$m^{FI} = \kappa - \frac{\rho}{\left[p\overline{\phi} + (1-p)\underline{\phi}\right]^{\frac{1}{\gamma}}} \tag{18}$$

This is due to the convergence property of Bayesian learning which was discussed in section (2.2.2). If the modern sector does not stop operating, $n_{t-1} \longrightarrow \infty$ as $t \longrightarrow \infty$ so that $p_t \longrightarrow p$. Beliefs converge to the truth as experience is gained in the modern sector. If $p < \overline{p}$ and $p_1 > \overline{p}$ so that there is some modern sector activity initially although local conditions are not suitable for modern sector production, beliefs will therefore hit $\overline{p}$ at some

point in time with probability 1. From then on, the modern sector will stop operating and beliefs will remain unchanged since no new information becomes available. Similarly, if $p > \overline{p}$ and $p_1 > \overline{p}$ so that there is some modern sector activity initially and local conditions are suitable for modern sector production, beliefs will converge to the truth provided that modern sector production is not given up. As $p_t \longrightarrow p$, $m_t \longrightarrow m^{FI}$ from equation (14).

3. Even if there is some modern sector activity initially and local conditions are suitable for modern sector production, $p > \overline{p}$ and $p_1 > \overline{p}$, modern sector production will be given up with a positive probability. This is because p is only the expected value of the success rate $\frac{s_t}{m_t}$ which is distributed over $[0, 1]$. Sufficient bad luck will lead to a series of bad surprises $\frac{s_t}{m_t} < p_t$ which will drag down beliefs to the threshold level $\overline{p}$. The more suitable local conditions are for modern sector production (the higher p) and the more optimistic initial beliefs are (the higher p_1), the less likely it is that a viable modern sector is given up. The higher p, the less likely it is to get a sufficient number of success rates $\frac{s_t}{m_t} < \overline{p}$ which are necessary to make beliefs reach $\overline{p}$ if $p_1 > \overline{p}$ as is obvious from the updating formula. Also, the higher p_1, the more success rates $\frac{s_t}{m_t} < \overline{p}$ are required to make beliefs reach $\overline{p}$ if $p_1 > \overline{p}$ as the incoming information is always weighted with p_1.

As an illustration, the case of a viable modern sector and too pessimistic initial beliefs is drawn in figure 1. The two dotted lines illustrate that if the priors are such that there will be some initial activity in the modern sector, beliefs either converge to the truth or to the threshold level. This corresponds to the number of firms converging to the full information equilibrium or to modern sector production being given up. The dashed line illustrates that if priors are such that there is no initial investment, then beliefs will stay unchanged since no experience is gained.

In summary, if firms have overly pessimistic initial beliefs, viable business ventures remain unattempted, whereas overly optimistic beliefs never make firms pursue non-viable ventures permanently. However, even if initial beliefs are sufficiently optimistic, viable ventures may be abandoned if firms misinterpret the evidence available to them.

2.5.2 'Lumpiness' of modern sector development

In their analysis of 'lumpy' economic development, Burgess and Venables (2004) suggest to divide the determinants of microeconomic growth into '1st advantages' and '2nd advantages'. In their framework, '1st advantages' capture the prerequisites of growth such as good policies, institutions, and infrastructure, while '2nd advantages' cover the self-reinforcing aspects of growth which boost modern sector development once it has started. As indicated earlier, increasing returns to scale which are external to the firm (e.g. thick market externalities) are thought to be underlying these '2nd advantages' in their analysis.

Although thick markets do not play a role here, it is nevertheless insightful to apply this conceptual framework to the present analysis. Here, '1st advantages' are captured by the two productivity parameters which get larger as the economic environment improves. Once the environment is favorable enough to induce some modern sector investment, the evolution of beliefs becomes important for the pattern of development. Due to the learning dynamics, this development pattern can - though need not - be self-reinforcing so that social learning can be seen as a potential source of '2nd advantage'. To see this, consider an initial situation where beliefs are such that no firm has an incentive to invest in the modern sector. As '1st advantages' improve, $\overline{\phi}$ and $\underline{\phi}$ increase so that $\overline{p}$ decreases. If the productivities increase sufficiently, $\overline{p}$ will at some point become lower as p_1 so that some firms enter the modern sector. Now the process of learning begins. Since beliefs only become more optimistic as a consequence of good surprises, the mod-

ern sector will only continue to grow if the productivity draws are surprisingly good, $\frac{s_t}{m_t} > p_t$. This can happen either by chance or because local conditions are truly surprisingly suitable for modern sector production, $p > p_1$. If it happens by chance and local conditions are in reality not very well suited for modern sector production, modern sector development will take an inverted u-shape since eventually beliefs must converge to the truth. If, however, local conditions are indeed surprisingly favorable, learning can lead to longer lasting, rapid growth until the full information equilibrium is attained. It is this adjustment of expectations following overly pessimistic initial beliefs that can bring about 'lumpy' modern sector development in this model.

This is illustrated in figure 2. Suppose that at time t^* '1st advantages' are such that some investment in the modern sector occurs. If local conditions are in reality not suitable for modern sector production so that the full information equilibrium number of firms is zero, then good surprises can only occur by chance which can give rise to a u-shaped development pattern as depicted by the dashed line. If, however, the full information equilibrium number of firms is positive, good surprises do not come by accident and can give rise to rapid modern sector development as shown by the dotted line. Then learning about the suitability of local conditions has a '2nd advantage' character since growth is then self-reinforcing.

Notice that this discussion also implies that improvements in the economic environment may map discontinuously into microeconomic growth. As long as increases in the productivity parameters are not sufficient to trigger entry into the modern sector, the improvement in the economic environment does not have any effects. But if the economic environment becomes sufficiently good so that some firms invest in the modern sector, the modern sector may take-off suddenly so that small changes in the institutional environment may trigger rapid economic development.

3 Multiple modern sectors or multiple regions

Consider now a simple extension of the basic model allowing for multiple sectors. This extension delivers the two main additional results. First, it is established that development may involve a wave-like pattern of growth where successive business ventures are first pursued and then given up until a venture is found for which local conditions are suitable. Second, it is shown that, despite this potential 'stuttering' towards a viable venture, there is no guarantee that firms pursue the best venture even in the long-run.

Suppose thus that there are r modern sectors indexed by j and k and assume that local conditions suit different modern sectors differently so that $p^j \neq p^k$, $j \neq k$, for all j, $k = 1, 2, ..., r$. Only a few changes to the basic model are required to allow for this generalization. Modern sector technologies are now given by

$$y_{it}^j = \phi_{it}^j l \tag{19}$$

where $\phi_{it}^j = \overline{\phi}$ with probability p^j, $\phi_{it}^j = \underline{\phi}$ with probability $1 - p^j$, and $\overline{\phi} > \underline{\phi}$. Crucially, the parameter p now has an index j to denote that local conditions suit different modern sectors differently. At the beginning of period t, period t modern sector firm profits in sector j are thus expected to be[17]

$$E(\pi_{it}^j \mid z_{t-1}^j, n_{t-1}^j) = \left[p_t^j \overline{\phi} + (1 - p_t^j)\underline{\phi} - w_t^j\right] l \tag{20}$$

Therefore, the maximum wage a firm of modern sector j can pay in period t and expect non-negative profits is given by

$$\overline{w_t^j} = p_t^j \overline{\phi} + (1 - p_t^j)\underline{\phi} \tag{21}$$

The discussion of this extended model is again summarized in three remarks. Remark 1 clarifies an important property of the extended model while remarks 2

[17] The output prices are again normalized to 1 for simplicity.

and 3 establish the main additional results:

1. At any given point in time, only one modern sector will operate. From equation (21) it is obvious that $\overline{w_t^j}$ is increasing in p_t^j. Since break even wages must be paid in equilibrium due to the free entry assumption, firms in the modern sector which is believed to perform best under the given local conditions are thus paying the highest wages. Firms of any other modern sector will not be able to afford these high wages and will not be operating. Notice that such extreme specialization even evolves if beliefs are uniform initially since one good surprise from one modern sector suffices to make firms 'rush' into that sector.

2. Although only one modern sector will operate at any given point in time, it must not always be the same one. As a given modern sector is active, information about the suitability of local conditions for this particular modern sector is revealed which changes the firms' beliefs about that sector. At the same time, beliefs about all other sectors are unaffected. A series of bad surprises, $\frac{s_t^k}{m_t^k} < p_t^k$ can drag down p_t^k to the level of the modern sector which was initially believed to be second best. Then this modern sector starts operating and information about it becomes available. If there are good surprises, it will continue to be active. If there are bad surprises, production in the initial modern sector will be resumed. Notice that a given sector k might always be operating if and only if $p^k > p_t^j$ for all $j \neq k$ since beliefs converge to the truth eventually. The *true* suitability of local conditions for a given modern sector must hence be better than the *expected* suitability of local conditions for all other modern sectors.

   The potential 'stuttering' towards a viable business venture follows as a corollary from this result. To see this most clearly, consider the extreme case where firms wrongly believe all sectors to be viable initially, $p_1^j > \overline{p}$ for all j, although local conditions are only suitable for modern sector k,

$p^j < \overline{p}$ for all $j \neq k$ and $p^k > \overline{p}$. Then, of course, firms will eventually give up all sectors they attempt until they reach sector k, indeed giving rise to a wave-like pattern of economic development.[18]

3. Production will not necessarily move to the best modern sector as time passes by and knowledge accumulates. From remark 1 we know that the modern sector which is believed to be best will be operating, in general, not the modern sector which is best in reality. From remark 2 we know that a modern sector can only be active over a long period of time if the true suitability of local conditions for that sector is better than the expected suitability of local conditions for all other modern sectors. This implies that the suitability of local conditions for the best sector must hence be underestimated to allow for a less productive modern sector to be operating in the long run.

Of course, the remarks from the basic model also apply with suitable modifications: 1) If initial beliefs are sufficiently pessimistic, no modern sector will develop; 2) If production is not viable in any of the modern sectors, it will be given up with probability 1. If one modern sector keeps operating for a long time, the equilibrium number of firms in that sector will converge to the respective full information value; 3) Even if local conditions are suitable for some sectors and one of these modern sectors is active, modern sector production will be given up with a positive probability.

Notice that the same extension could also be interpreted as being the case of multiple regions which offer different suitabilities for modern sector production and share a common labor market. The predictions would, of course, be analogous: 1) Only one region is operating a modern sector at any given point in time; 2) Nevertheless, different regions can operate a modern sector at different points in

[18] As was clarified by remark 3 of the previous section, the firms may, of course, also give up the viable sector k by mistake.

time; 3) The modern sector will not necessarily move to the best region as time passes by.

4 Conclusion

This paper presented a model of social learning about the suitability of local conditions for new business ventures and explored its implications for the micro-economic patterns of growth. The analysis delivered four main results. First, firms tend to invest in business ventures with which other firms have had surprising success, thus causing development to be 'lumpy'. One consequence of this 'lumpiness' is that improvements in the economic environment (policies, institutions, infrastructure, etc.) may map discontinuously into microeconomic growth. Second, sufficient business confidence is crucial for fostering economic growth and development. If firms have overly pessimistic initial beliefs, viable business ventures remain unattempted, whereas overly optimistic beliefs never make firms pursue non-viable ventures permanently. However, even if initial beliefs are sufficiently optimistic, viable ventures may be abandoned if firms misinterpret the evidence available to them. Third, development may involve a wave-like pattern of growth where successive business ventures are first pursued and then given up until a venture is found for which local conditions are sufficiently suitable. Finally, despite this potential 'stuttering' towards a viable venture, there is no guarantee that firms pursue the best venture even in the long-run.

Although the role of technology transfers was stressed in the motivation of this paper, the mechanisms which were highlighted here are probably at work in many other settings. Firms can learn from the experiences of other firms whenever there is non-idiosyncratic uncertainty, i.e. uncertainty concerning factors which affect all firms alike. Such social learning can then lead to 'lumpy' and 'stuttering' economic growth unless those uncertain business ventures are patentable.

Regarding future research, more formal econometric work on the importance

of such learning externalities now seems to be most urgently needed. I believe that this paper could be a useful starting point for such research since it delivers some observable (and potentially testable) predictions for the microeconomic patterns of growth.[19] The main challenge, of course, is to disentangle social learning from other determinants of the microeconomic patterns of growth.

[19] Hausman and Rodrik (2003, pp. 613-614), for example, argue that it is hard to test the predictions of their model since "much of our story has to do with outcomes that are not observed: the failure to develop non-traditional activities because of inadequate incentives to invest in learning what one is good at producing".

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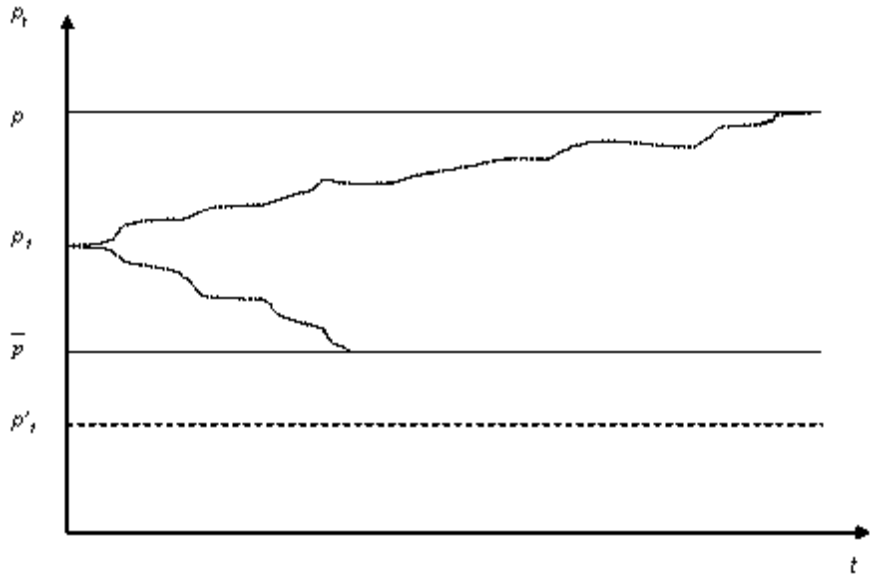

Figure 1: Business confidence and the microeconomic patterns of growth

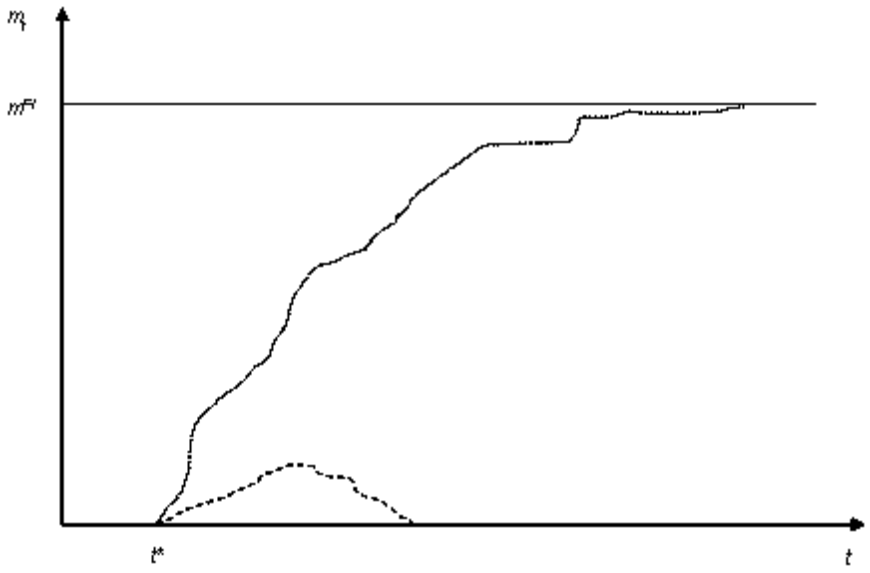

Figure 2: Sudden and rapid modern sector development

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