Nobody's Business but My Own:

Self Employment and Small Enterprise in Economic Development

Douglas Gollin*

Williams College

May 9, 2000

JEL Classifications: O1 (Economic Development); L11 (Production and Market Structure; Size Distribution of Firms); J23 (Self Employment)

---

*Comments are welcome. Author's address: Department of Economics, Fernald House, Williams College, Williamstown, MA 01267. E-mail address: *dgollin@williams.edu*.

This research was supported in part by National Science Foundation Grant NSF/SBR 9515256 and by the MacArthur Interdisciplinary Program for Peace and International Cooperation at the University of Minnesota. I am especially indebted to Tim Kehoe and Ed Prescott, and to Boyan Jovanovic, Jeffrey Campbell, and Vincenzo Quadrini for their comments and suggestions. I am also grateful to Cheryl Doss, Tom Holmes, Richard Rogerson, and members of the Applied Theory working group at the University of Minnesota. Finally, this paper has benefited from the comments received at the Econometric Society 1997 Summer Meetings, the Society for Economic Dynamics 1997 Meetings, the NBER Universities Consortium Workshop on "Innovation and Accumulation in Firms, Industries, and Nations," the Macro/International workshop at the University of Virginia, and the Yale University Macro Lunch.

Nobody's Business but My Own:

Self Employment and Small Enterprise in Economic Development

ABSTRACT

In most poor countries, small firms and self employment are the dominant forms of business enterprise. This phenomenon is true not only in agriculture and the service sector: even in manufacturing, large fractions of the workforce are self-employed. In Ghana, as an illustration, more than 75 percent of the manufacturing workforce were self-employed in 1984. For rich countries, in contrast, self-employed people account for very small shares of manufacturing employment and almost negligible fractions of output. Some observers explain the prevalence of self-employment in poor countries as a phenomenon of distorted policies or credit market imperfections. This paper, in contrast, uses a variant of the Lucas (1978) span-of-control model to ask whether changes in establishment size and employment structure can be explained as a consequence of growing productivity. A model, calibrated to Japanese time series data, is shown to mimic key features of cross-country and time series data. An implication is that changes in relative factor prices, driven by changing productivity, account for a large portion of the cross-country differences in establishment size and self-employment rates. Although policy distortions and market imperfections may also be important in explaining the prevalence of self employment in developing countries, productivity changes alone could account for as much as two-thirds of the variation observed in the cross-section data.

Introduction

Small businesses dominate the economic life of most developing countries. Despite the attention given to multinational corporations, it is family firms and the self employed who fill the market stalls of Accra and Agra, Dhaka and Dakar. As was the case in the United States or Great Britain two hundred years ago, small businesses account for the majority of employment in all sectors of today's developing countries. Some of the most visible small businesses are those engaged in service activities: restaurants, automotive repair shops, and food stands. Agriculture is less visible, but as in rich countries, farming is almost exclusively the realm of family enterprises.

Perhaps more surprising, however, is the importance of the self employed in the manufacturing sector in many developing countries. From cramped workshops and backyard foundries emerges an astonishing array of manufactured goods: clothing, footwear, pottery, metal products, processed foods, cement blocks, to name a few. In most developing countries, vast amounts of manufactures are produced on a scale unimaginably small by the present-day standards of the United States or Europe. In Ghana, as an illustration, more than 75 percent of the manufacturing workforce reports being self-employed. Fewer than 15 percent of manufacturing workers are employed in establishments with more than 10 workers (Republic of Ghana 1987, 1991).

In most rich countries, by contrast, small enterprises play a relatively minor role. Despite the boosterism of local Rotarians — and despite the claims of researchers such as Birch (1987) — the smallest businesses account for a tiny fraction of output in the United States and other rich countries. For example, in the United States manufacturing sector, establishments with fewer than 5 employees accounted for less than 1 percent of the value added in 1987, while firms with more than 500 employees accounted for almost half the value added (U.S.

Department of Commerce 1987). Establishments with fewer than 20 employees accounted for less than 5 percent of the total manufacturing workforce, whereas firms with more than 500 employees employed about two-thirds of manufacturing workers. If all manufacturing workers in the United States are ranked by the number of co-workers that they have (i.e., by the size of the establishment in which they work), the median worker in this distribution has between 2,500 and 5,000 co-workers (U.S. Department of Commerce 1987).

The data from the United States and Ghana are consistent with a broad range of cross-section and time series evidence suggesting that as countries grow richer, small businesses and own-account work play a diminishing economic role (Gollin 1997). What accounts for the differences in establishment characteristics between poor and rich countries? Can a standard model adequately capture the relationship between economic development and the structure of production and employment? Are faulty policies chiefly responsible for suppressing the emergence of large firms in poor countries?

This paper attempts to shed light on such questions by analyzing a model that incorporates establishment size explicitly. The model, based on the Lucas span-of-control framework (1978), is explored quantitatively, using parameters drawn from Japanese time series data. The calibrated model performs remarkably well in reproducing key features of the Japanese data – and also succeeds in replicating a variety of cross section and time series observations from other countries.

Analysis of the model suggests that the large differences observed across countries in establishment size and employment structure can be explained to a surprising extent by differences in productivity and factor prices. Although distortionary policies – such as taxes that repress the growth of larger firms – undoubtedly play a role in exacerbating these effects, there would be substantial differences across countries even in the absence of distortions. Moreover, the model suggests that it is efficient in poor countries for many lower-skilled people to remain self-employed.

The first section of this paper briefly summarizes key facts concerning establishment size and economic growth and poses some research questions that emerge from the data. The second section outlines a span-of-control model that is used to address the research questions. The third section describes the procedure by which the parameters of the model were chosen and the ways in which the model was used to address research questions. The fourth section reports data on the behavior of the model economy. A fifth section explores the sensitivity of the model to alternative specifications and parameterizations. Finally, the sixth section offers some interpretation and draws conclusions from the behavior of the model economy.

1. Patterns and trends in establishment size and employment structure

As early as the classical economists, observers have noted that economic growth is accompanied by a concentration of production in ever-larger units and by a corresponding decline in self employment and family enterprises. In more recent times, empirical work by Kuznets (1966), among others, documented this tendency in cross-country data. Kuznets suggested that one of the principal "characteristics of modern economic growth" was a series of shifts in the structure of production: from small to large firms; from self employment to wage work; and from unincorporated enterprises to large corporations. A number of types of data reinforce this view today.

1.1 Cross-section and time series data

Perhaps the most direct data on self employment come from labor force surveys. These typically categorize people in the work force according to the 1958 United Nations Statistical Commission Classification (International Labour Office 1993). According to this convention, the labor force consists of *employers and own-account workers, employees, unpaid family workers, members of producer cooperatives*, and *persons not classifiable by status*.[1] The International Labour Organization (ILO) collects national-level data on employment status from a large number of participating countries. These data are highly comparable across countries: the categories are well-defined and easily understood. The data are usually collected as part of population censuses, and there are few incentives for people to lie about their employment status. (In contrast, surveys of firms may systematically understate establishment size, since in many countries larger establishments face added taxes and regulations.) The ILO reports national-level data on the employment status of manufacturing workers for more than 50 countries for the years 1988-93.[2] Table 1 shows the ratio of employers and own-account workers to all workers for the manufacturing sector and for the entire economy in all countries for which current data are available.[3] (For convenience, I will refer to this as the entrepreneur-workforce ratio, where the workforce is presumed to consist of entrepreneurs and workers.[4])

The manufacturing sector data indicate clearly that in poor countries, relatively large proportions of the workforce are employers or own-account workers. Relatively few people in

---

[1] The definitions of these categories are given as Appendix 1.

[2] The data are apparently based on figures obtained from national statistical authorities. There seem to be some systematic gaps in the responding countries: in particular, there are relatively few poor countries reporting data (especially from Sub-Saharan Africa) and relatively many rich countries. (The data are essentially complete for the OECD nations.) Thus, the data cannot be considered to represent a random sample of all countries, but they do provide a large fraction of the potential sampling population.

[3] I use manufacturing data here for simplicity. Data are available on other sectors as well; manufacturing sector data are used here to limit confusion that might arise from differences in the sectoral composition of output across countries. For example, the agriculture share of total product is higher in poor countries than in rich countries. Since agricultural production almost everywhere is dominated by self-employment and family business, and since agriculture tends to be a large sector in poor countries, we might expect that poor countries will appear at the aggregate level to have relatively high levels of self-employment and family business. For this reason, it makes sense to focus only on the manufacturing sector.

[4] For rhetorical purposes, I will occasionally use the term "employers and own-account workers" in place of the briefer term "entrepreneurs." No meaningful distinction is intended here; the underlying definitions are identical.

poor countries work for wages in the manufacturing sector.[5] The data make clear the relationship between the entrepreneur-workforce ratio and per capita GDP. It is evident that in poor countries, far larger shares of the workforce are entrepreneurs than in rich countries.

The differences across countries are striking. In the United States, less than 2 percent of the manufacturing workforce consisted of employers or own-account workers. In Bangladesh and Nigeria, by contrast, almost 80 percent of manufacturing workers were employers or own-account workers. Although some rich countries, such as Italy, are known for having vital small business sectors, these are relatively modest outliers: there is a surprisingly close relationship between per capita product and the entrepreneur-workforce ratio. The cross-section data thus support the idea that fundamental differences exist at the establishment level between today's poor and rich countries.

A reasonable question is whether the time series data reveal similar differences in the entrepreneur-workforce ratio as economies grow. Although it is difficult to obtain time series data that reflect the same range of income per capita as the cross section, the experiences of a few rapidly growing countries suggest that the time series data are broadly consistent with the cross section. Table 2 shows time series data for Japan. Time series data for Japan and other rapid-growth countries appear to be consistent with the cross-country observations.

This story is reinforced by the full ILO data, which include observations over time for 308 observations on 84 countries dating to 1946.[6] Appendix 2 presents these data in full. Both

[5] Note that the approach used here implicitly treats unpaid family laborers and those not classifiable by status as employees, rather than employers. This may actually *understate* the proportion of entrepreneurs in the workforce in developing countries.

[6] The observations included were most countries and years for which data were available at the level of the manufacturing sector and for which manufacturing sector employment exceeded 10,000 workers. Excluded were countries of the former Soviet bloc, where the concept of entrepreneurship was unclear during much of the period in question. Also excluded was a small number of island nations and other low-population countries. In some cases, for larger countries, certain years were omitted because data were not available at the sectoral level.

across countries and within countries, the data reveal a pronounced negative relationship between real per capita GDP and the entrepreneur-workforce ratio.[7]

In addition to data on employment, Gollin (1997) reviews a variety of additional data supporting the idea that self employment and small enterprise are more prevalent in poor countries than in rich and that establishment size tends on average to increase with per capita income. One additional measure is the share of GDP that is earned by the proprietors of unincorporated enterprises — which are generally small and often are operated as family businesses or as forms of self employment. Table 3 presents cross-section data on the "operating surplus of unincorporated enterprises," taken from United Nations data on national income and product accounts. It appears from Table 3 that income from unincorporated enterprises is generally less important in rich countries than in poor.

In conclusion, cross-country and time series data indicate that there are large differences across countries and over time in establishment size and rates of self employment. These differences appear to be linked to levels of economic development.

1.2 Theories of the firm and firm size

Standard models of neoclassical growth do not account for the changes we observe in firm size and self employment. Most growth models assume constant returns to scale at the level of the firm and hence abstract from establishment-level behavior. As a result, these models do not grapple with questions of establishment size. Moreover, the standard models abstract from individuals' employment decisions and typically omit the self-employment sector. Within the literature on industrial organization, however, there is a substantial body of theory on the

---

[7] For this section, all data on real GDP per capita are taken from the Penn World Tables v. 5.6. This data set provides estimates in terms of constant 1985 US dollars to 1950 for most countries. For some countries, the data do not extend back to 1950. In six instances, the ILO data include observations on the entrepreneur-workforce ratio for years prior to 1950. In these cases, linear extrapolation was used to estimate real per capita GDP.

nature of the firm and on firm size. One set of theories attributes the formation and size of firms to transaction costs, property rights, information constraints, and strategic behavior within firms. (See, for example, Coase 1937, Stigler 1968, Alchian and Demsetz 1972, Williamson 1985 and 1989, Holmström and Tirole 1987, and Hart and Moore 1990.) A different theoretical approach is posed by Kremer (1993), who suggests that the size distribution of production units is related to the complexity of production processes and the distribution of skills among workers.

An alternative approach abstracts from questions of intra-firm incentives and information and instead attempts to model an industry with a size distribution of firms. This is the strategy followed by Lucas (1978), who uses heterogeneity in a fixed factor of production to generate an equilibrium with firms of different sizes. Evans and Jovanovic (1989) analyze a model in which liquidity constraints determine the growth patterns of individual firms and generate a distribution over firm size. Hopenhayn (1992) uses exogenous productivity shocks, which affect firm size, in a model of firm entry and exit that seeks to simulate the processes of job creation and destruction. Jovanovic (1994) generalizes the Lucas model to an environment in which people are heterogeneous in labor quality as well as in managerial ability.

Within the development literature, there is a longstanding recognition that small firms play an important role in poor countries. Hirschman (1958), Rostow (1960), Kuznets (1966), Lewis (1965), and many of their contemporaries recognized that structural changes in employment and firm size were a central feature of economic growth. However, as Fafchamps (1994) points out, these authors implicitly viewed heterogeneity of firm size in developing countries as a disequilibrium phenomenon in which small firms were destined to vanish as economies adjusted to new technologies that required a larger scale of production.

Within the more recent literature on development, a number of authors have focused on the empirical determinants of self employment and the constraints to firm growth. Liedholm and

Mead (1999) offer a valuable summary of the empirical literature on micro and small enterprises, based on detailed field surveys. Liedholm and Mead characterize patterns of firm birth, death, and growth and explore some of the interactions between small enterprises and the macro economy. In a similar vein, Biggs and Srivastava (1996) draw on a number of recent surveys to characterize manufacturing enterprises in Africa.

A frequent argument is that perverse government policies restrict the formation and growth of large firms, thereby forcing people into self employment or the "informal sector" (e.g., de Soto 1989). Alternatively, imperfections in labor or capital markets are seen as restricting the growth of firms. (See for example, Aryeetey and Steel 1992, Aryeetey *et al.* 1994, Biggs and Srivastava 1996, Liedholm 1993, Teal 1994, and Teal 1995, for a few examples.)

2. A model of establishment size and employment status in the context of economic growth

This paper offers a Lucas-type model of establishment size and employment status and asks whether such a model is a useful for answering questions about economic growth and development. Several questions motivate this research. First, would our theories of growth be improved if we incorporated explicit treatment of establishment size and employment status? Second, to what extent can we account for differences across economies in establishment size and employment status as consequences of technological change (and corresponding adjustments in relative factor prices)? Third, how important are policies in affecting the size distribution of firms? Are small enterprises so widespread in poor countries primarily because policies discriminate against larger enterprises, as de Soto (1989) and others have argued? Are imperfections in labor and capital markets critical in explaining the prevalence of self-employment?

To analyze questions about the evolution of establishment size and self-employment, this paper uses a dynamic general equilibrium model in which the fraction of self-employed workers is endogenously determined and can change with economic growth. The model is based on Lucas (1978), but it extends the Lucas framework to an infinite time horizon and explicitly includes consumers and self-employed people.

For a given economy, there is a single sector producing a composite good which can be consumed or used as capital. People in the model economy differ *ex ante* only in their entrepreneurial ability. In each period, people can choose among three alternative forms of employment: wage work, self employment, and full-time entrepreneurship. Workers receive the market wage, w, while full-time entrepreneurs receive the rents from operating a firm. The self-employed divide their time between physical production and other entrepreneurial activities needed for operation of an establishment. The self-employed receive some entrepreneurial rents as well as a return to time spent in production. Individuals make their employment decisions in such a way as to maximize earnings (since they are indifferent, in terms of utility, between the three uses of their time).

In equilibrium, people sort themselves by occupation according to their levels of entrepreneurial ability. Those with levels of entrepreneurial ability below an endogenously determined level, z_1, have a comparative advantage in wage work. Those with levels of entrepreneurial ability above the endogenously determined level z_2 will choose to be full-time entrepreneurs, where $z_2 \geq z_1$. If z_2 is strictly greater than z_1, then there will be a group of people with intermediate levels of entrepreneurial ability who choose self-employment. (If $z_2 = z_1$ then there will be no self-employment.)

The analysis presented in this paper considers the steady-state performance of a number of different model economies. These economies are identical except for differences in aggregate productivity. Countries with high levels of aggregate productivity are rich; i.e., they achieve relatively high levels of steady-state output. Countries with low levels of aggregate productivity are, in relative terms, poor. By comparing rich model economies with poor ones, it is possible to understand the relationship between per capita output and the structures of production and employment.

The analytic framework employed here has a number of attractive features. In addition to imitating some of the observed patterns in the size distribution of firms, it lends itself well to empirical work. Macroeconomic data on the model economy can be compared to data from actual economies. The next sections describe the model in more detail.

2.1 *Environment*

Formally, the environment is characterized by the following features. In a particular model economy, denoted *i*, there is a measure one of infinitely-lived people, who are indexed on the interval [0,1] by entrepreneurial ability, x. There is a distribution $\Delta(x)$ over skill types.

2.1.1 PREFERENCES AND ENDOWMENTS

People in the model economy have identical, preferences defined over their lifetime consumption streams $\{c_t(x)\}_{t=0}^{\infty}$ by:

$$U = \sum_{t=0}^{\infty} b^t u\left(c_t(x)\right) \tag{1}$$

In addition to skills, individuals are endowed with one unit of labor in each time period, which is supplied inelastically; and with k_0 units of initial capital, also supplied inelastically.

2.1.2 TECHNOLOGY:

At each date, a single good is produced; this can be consumed or saved as capital to be used in the next time period. The production process involves three factors: labor, capital, and entrepreneurial ability. The latter is not traded, and it is distributed heterogeneously within the population.

Production can take place in two types of establishments: those operated by full-time entrepreneurs and those operated by the self-employed. In either type of establishment, an individual's entrepreneurial ability, x, determines the amount of output attained from given levels of capital and labor. Thus, the entrepreneur's choices of n and k depend on her level of entrepreneurial ability, x. Optimal establishment size is thus determinate, and it varies across individual entrepreneurs.

The two types of establishments face an identical production technology but differ in two respects. First, the self-employed face a size restriction on their firms: they may use no more than a units of labor input, where $0 \leq a \leq 1$. This reflects the time constraint faced by the self-employed. A second difference between the two types of establishments is that self-employed entrepreneurs have an advantage in managerial efficiency, relative to full-time entrepreneurs. This reflects the substantial incentive advantage that the self-employed face with respect to labor supervision. Specifically, this advantage is represented by a scalar term A_{SE} that enters multiplicatively into the managerial technology.[8]

In equilibrium, entrepreneurs with relatively high ability will choose to face the lower managerial productivity associated with operating large establishments, but some people of more modest ability will be better off operating at a small scale using only their own labor.

---

[8] This is consistent with a number of observations suggesting that the productivity of small and micro firms is higher than that of larger firms (e.g., Liedholm 1993) or at least comparable with that of larger firms (e.g.,

Full-Time Entrepreneurs

Specifically, an individual of type x who is a full-time manager of a firm with n workers and k units of capital in country i produces output:

$$y = xA_i\left[f\left(n,k\right)\right]^q , \qquad \textbf{(2)}$$

where f is constant returns to scale, increasing, and concave in each argument, and where $0 < q < 1$. Note that countries differ only in the value of the scalar A_i. The parameter q reflects the fact that production displays decreasing returns to scale in capital and labor, due to the fixed factor (entrepreneurial ability).

Self-Employed People

An individual of type x who is self-employed produces output according to the production function:

$$y = xA_{SE}A_i\left[f\left(n,k\right)\right]^q \qquad \textbf{(3)}$$

where f and q are the same as above and $0 \leq n_t\left(x\right) \leq a \leq 1$. As noted above, the parameter A_{SE} is an indicator of productivity in establishments operated by the self-employed, relative to productivity in establishments operated by full-time entrepreneurs. Note that A_{SE} is invariant across countries.[9]

Tybout 1998), although one-person firms tend to have lower measured productivity than firms with 2-10 workers.

[9] Although it appears that A_{SE} and a are not separately identified, the two parameters have slightly different effects in the model. This issue is discussed in greater detail below.

2.2 *Individual's problem*

An individual in this economy must choose the type of employment that will maximize his or her income. The returns from working for a wage are simply w, which the individual takes as given. Note that all individuals are homogeneous as wage workers; differences in entrepreneurial ability do not alter labor productivity.[10] The individual compares this wage with the income derived from self-employment and from full-time management, and chooses the occupation that gives the highest income.

2.2.1 INCOME FROM SELF-EMPLOYMENT

The returns from self-employment consist of entrepreneurial rents as well as the market value of the time available for labor.[11] Thus, a self-employed individual earns $p_t^{SE}(x)$, where this income includes returns to labor as well as rents:

$$p_t^{SE}(x) = \max_{\{n,k\}} xA_{SE}\, A_i \left[f(n_t\,,\, k_t)\right]^q - r_t k_t + w_t(a - n_t) \qquad \textbf{(4)}$$
$$s.t. \quad k_t \geq 0$$
$$0 \leq n_t \leq a < 1$$

Note that the derived demand for n and k depend on the individual's level of entrepreneurial ability, x. In equilibrium, individuals with sufficiently low levels of x will prefer wage work to self employment, and individuals with sufficiently high levels of x will prefer full-time management.

---

[10] See Jovanovic (1994) for a model in which individuals differ in labor productivity as well as entrepreneurial ability.

[11] Implicitly, I assume that the self employed are able to divide their labor time between their own businesses and the wage market; in other words, the fraction $(1 - \alpha)$ of their time is devoted to managing a business and perhaps to some transaction costs associated with dividing their labor among uses. The fraction α is then used for productive labor. The alternative assumption, that they cannot use their labor in the wage market, would obviously make self employment far less attractive but would not qualitatively change the results of the paper.

2.2.2 INCOME FROM FULL-TIME MANAGEMENT

An individual who operates a firm as a full-time manager will receive only the entrepreneurial rents. These individuals receive no returns to labor time. Rents increase with the individual's level of entrepreneurial ability, x, so that those with low values of x will not in general choose to be full-time managers.

Given x, the would-be manager chooses levels of labor and capital inputs to maximize rents. This is a straightforward problem. Thus, the full-time manager's income is given by:

$$p_t^{FT}(x) = \max_{\{n,k\}} xA_i \left[f\left(n_t, k_t\right)\right]^q - w_t n_t - r_t k_t \qquad \textbf{(5)}$$

$$s.t. \quad n_t,\ k_t \geq 0$$

2.2.3 CONSUMER'S PROBLEM

Having chosen an employment option to maximize income, the individual faces a straightforward problem in allocating this income to current-period consumption and to savings.

Denote the individual's maximum income from employment in a given period as:

$$p_t(x) = \max\left\{w_t, p_t^{SE}(x), p_t^{FT}(x)\right\} \qquad \textbf{(6)}$$

The individual's decision rules can be represented by marker functions. Let $m_t(x) = 1$ if the individual earns maximum income from full-time management, and let $m_t(x) = 0$ otherwise. Similarly, let $s_t(x) = 1$ if the individual earns maximum income from self-employment, and let $s_t(x) = 0$ otherwise.

The problem of a consumer with entrepreneurial ability x can be written as:

$$\max_{\{c_t, n_t, m_t, s_t\}} \sum_{t=0}^{\infty} b^t u(c_t(x))$$
$$s.t. \quad c_t(x) + k_{t+1}^s(x) \leq (1 + r_t - d) k_t^s(x) + p_t(x) \qquad \textbf{(7)}$$
$$c_t(x),\ k_t^s(x) \geq 0 \quad \forall\ t$$

where k_t^s denotes the capital supplied by the consumer, in contrast with k_t^d, which denotes capital demanded by a particular entrepreneur.

2.3 Equilibrium

An equilibrium for this economy consists of sequences:

$$\{c_t(x), n_t(x), k_t^s(x), k_t^d(x), w_t, r_t, y_t(x), m_t(x), s_t(x)\}_{t=0}^{\infty}\ \forall x \in [0,1]$$

such that:

(*i*) The consumer's problem is solved for all individuals $x \in [0,1]$.

(*ii*) All establishments are maximizing profits, taking prices as given.

(*iii*) The usual feasibility and market clearing conditions are satisfied, for all t.

The market-clearing condition for the goods market is given in Equation (8), which holds that consumption plus investment must not exceed the sum of production from the self-employed and from establishments operated by full-time entrepreneurs. On the right-hand side of Equation (8), the first term gives the output of all firms operated by full-time entrepreneurs, while the second term gives the output of the self-employed.

$$\int_0^1 c_t(x)\, d\Delta(x) + \int_0^1 k_{t+1}^s(x)\, d\Delta(x) \le \int_0^1 m_t(x)\, x A_i \left[f\left(n_t(x),k_t(x)\right)\right]^q\, d\Delta(x)$$

$$+ \int_0^1 s_t(x)\, x\, A_{SE}\, A_i \left[f\left(n_t(x),k_t(x)\right)\right]^q\, d\Delta(x) + (1-d)\int_0^1 k_{t+1}^s(x)\, d\Delta(x) \qquad \textbf{(8)}$$

Market-clearing in the wage labor market is given in Equation (9). This condition requires that the demand for wage workers by full-time entrepreneurs must not exceed the supply of wage labor. In particular, the left-hand side of Equation (9) is the total amount of labor used by establishments operated by full-time entrepreneurs. The first term on the right-hand side is the measure of people who choose neither self-employment nor full-time entrepreneurship, and the second term gives the supply of wage labor from the self-employed.

$$\int_0^1 m_t(x)\, n_t(x)\, d\,\Delta(x) \le \int_0^1 \left(1-m_t(x)\right)\left(1-s_t(x)\right) d\Delta(x) + \int_0^1 s_t(x)\left(a - n_t(x)\right) d\Delta(x) \qquad \textbf{(9)}$$

Finally, the market for capital services clears when:

$$\int_0^1 k_t^d(x)d\Delta(x) \leq \int_0^1 k_t^s(x)d\Delta(x) \qquad \textbf{(10)}$$

The structure of the model immediately implies that people's work choices, $m_t(x)$ and $s_t(x)$, will be (weakly) monotonic in x. In other words, at each date, there will be two cutoff levels of entrepreneurial ability z_{1t} and $z_{2t} \in [0,1]$ such that everyone with a skill level below z_{1t} will work, and everyone with a skill level above z_{2t} will be a full-time manager, while individuals with intermediate levels of entrepreneurial ability (i.e., $x \in [z_{1t}, z_{2t}]$) will be self-employed. This can be expressed more formally as:

PROPOSITION 1:

At each date t, if there are both self-employed people and full-time managers in equilibrium, then $\exists\, z_{1t}, z_{2t} \in [0,1]$ *such that:*

$$\begin{cases} m_t(x) = 1, & x > z_2 \\ m_t(x) = 0, & x \leq z_2 \\ s_t(x) = 1, & z_1 \leq x \leq z_2 \\ s_t(x) = 0, & elsewhere \end{cases}$$

The proof of this proposition follows directly from the fact that $p_t(x)$ is increasing in x.

It is worthwhile to note, however, that for some parameter values, there may be no self-employed people in the economy. Alternatively, for some parameterizations, there may be no full-time entrepreneurs.

2.4 *Computing the equilibrium*

The competitive equilibrium for this problem is somewhat complex, since at any date t, individuals x earn different incomes and face different budget constraints. The solution is simplified, however, since all consumers have identical, homothetic preferences, and since they differ only in income. By standard aggregation theorems, this implies that the competitive equilibrium has the same prices and aggregate consumption as an alternative model with a representative consumer. This allows us to abstract from the consumption decisions of individuals in the economy, although on the production side, it is important that individuals of different entrepreneurial ability choose employment and allocate their labor optimally.

A convenient way to compute the equilibrium with a representative consumer is to begin with the period-by-period problem of solving for the aggregate output obtained from any level of aggregate capital stock. This is a straightforward competitive problem: capital and labor must be allocated across firms in such a way as to equalize marginal products. Each entrepreneur chooses which technology to operate — the self-employment technology or the full-time technology. Capital and labor inputs are chosen to minimize costs.

As a practical matter, it is computationally intensive but not conceptually difficult to solve this single-period problem. Given a wage, w, and a rental rate for capital services, r, it is simple to find the marginal self-employed person, z_1, and the marginal full-time manager, z_2, assuming that both exist. Thus, it remains only to search for the wage and rental rate at which markets clear. This is straightforward. The solution to the single-period problem can be obtained for any start-of-period capital stock. This effectively defines a map from aggregate capital stock into aggregate production, which can be denoted as $F_i(K)$. Given this production function, the representative consumer's problem takes on a standard form; it can be written as a simple dynamic program:

$$V(K) = \max_{\{K'\}} \quad u\left(F_i(K) + (1-d)K - K'\right) + b\,V\left(K'\right)$$
$$s.t. 0 \leq K' \leq F_i(K) + (1-d)K \tag{11}$$

2.5 Solving for the steady state

Hornstein and Prescott (1993) have shown that span-of-control models of this type exhibit nice properties in spite of heterogeneity among producers. In particular, the feasible production set for this economy can be represented as a McKenzie-type convex cone. Together with the standard preferences used in the model, this is sufficient to ensure that a span-of-control model will behave in the aggregate much like any other growth model with an aggregate constant returns to scale production technology. In particular, the model economies will display stable steady states.

For each model economy (where model economies differ by the level of capital and labor productivity, A_i), the steady state is characterized by a value K^* of aggregate capital stock (the only state variable in the aggregate production map) such that consumers choose to save K^* units of capital for the next period; i.e., K^* is the fixed point in the representative consumer's policy function. In the steady state, aggregate capital and output remain constant, along with consumption, labor supply, and all other variables of interest. In particular, the cutoff point between workers and managers remains fixed, as does the cutoff point between self-employed and full-time managers.

Computationally, it is straightforward to identify the steady state. We can evaluate the value function numerically and search for a fixed point in the related policy function. Through successive refinements of the state space, it is possible to compute the steady state to any desired degree of precision.

3. Quantitative Experiment

Using this model as an analytic framework, it is possible to ask the kinds of questions outlined above. In particular, I investigate the empirical properties of the model when it is calibrated to reproduce specified features of the data.

I begin by calibrating the model to data from the Japanese time series. During the 20th century, Japan's economy has grown at a remarkable rate, and its structural transformation has included striking changes in firm size and the structure of employment. In 1930, for example, almost one-third of Japanese workers were self-employed or full-time entrepreneurs, including 29.1 percent of manufacturing workers. By 1992, only 8.6 percent of manufacturing workers were self-employed. Thus, Japan's experience over time mirrors the phenomenon observed in comparisons of rich and poor countries today.

To calibrate the model, I use data on per capita income, capital stock, and factor shares at two moments in time (1930 and 1992) to determine parameter values for the production function used in the model. In addition, I choose two key parameter values to match data on the prevalence of self employment at those dates. Output from the calibrated model is then compared with data on the Japanese economy.

After exploring the time series data for a single country, I then ask how well the calibrated model succeeds in replicating key features of international cross-section data and time series data from other countries. This part of the quantitative experiment can be seen as a test of the model's robustness.

Finally, I explore the sensitivity of the model to changes in certain parameters.

3.1 *Assigning functional forms*

To compute solutions for the model, functional forms must be specified and parameter values assigned. For simplicity, this paper takes $u(c) = \log(c)$. For the production technology, it uses $f(n,k) = [g n^{r} + (1-g)k^{r}]^{\frac{1}{r}}$, which is a standard CES form. As noted above, then, a full-time manager in country *i* with ability *x* gets output $A_i\, x\, [g n^{r} + (1-g)k^{r}]^{\frac{q}{r}}$, where $0 < q < 1$.

I also need to select a functional form for the distribution of entrepreneurial ability, *D*(*x*). In this model, entrepreneurial ability enters the production technology in a linear fashion, and it is indexed to the [0,1] interval. I choose *D*(*x*) to be a beta distribution. This is a logical choice because the beta distribution has the useful property that its support can be limited to the [0,1] interval (in contrast to the normal or lognormal distributions, for example). For added simplicity, I constrain my parameterization to be a symmetric bell curve with mean 0.5 and variance 0.25. This is satisfied by any beta distribution b (a, b) such that $a = b$. The choice of *a* and *b* does affect the higher moments of the distribution. I arbitrarily set $a = b = 18$, giving a distribution that is illustrated in Figure 1. I offer some analysis below on the effects of changing this parameterization.[12]

3.2 *Empirical counterparts to model variables*

The model economy has the following empirical counterparts. Output and capital stock in the model are measured in thousands of constant U.S. 1985 dollars. Output is real per capita GDP. The capital stock in the model is gross non-residential fixed capital stock per person employed. I exclude residential capital because there is no home sector in the model. I take real per capita GDP for Japan in 1930 from Maddison (1991), along with an estimate of the capital stock in 1930. Real per capita GDP in Japan in 1992 is taken from the Penn World Tables v. 5.6.

---

[12] In some sense, the choice of distribution is equivalent to choosing the units of measurement for ability and the representation of ability in the production technology. Thus, conceptually and theoretically, it is clear that the results described below are robust to the specification of the distribution.

In the model economy, people may choose to work for a wage, to be self-employed, or to be full-time entrepreneurs. The fraction of people who are self-employed plus the fraction who are full-time entrepreneurs corresponds to the share of "entrepreneurs and own account workers" in the manufacturing workforce, as reported in the 1940 and 1992 editions of the ILO *Yearbook of Labour Statistics*. I use data for the manufacturing sector to abstract from changes in the sectoral composition of output.

Wages paid to workers in the model economy correspond to employee compensation in the national income and product accounts. Returns to capital in the model economy, plus the labor income of the self-employed, plus entrepreneurial rents correspond to the national income accounting category of operating surplus. Values for national accounts aggregates are taken from the United Nations *National Income Statistics 1938-1948* and the OECD *National Accounts: Main aggregates, 1960-1992.*

3.3 *Calibration procedures*

Given a value for q, the exponent on the managerial technology, the observations described above identify the values of all other model parameters. The calibration follows the following procedure: First, the values for d and b are obtained from the steady state conditions of the model and the observed factor shares and capital stock. Second, the parameters of the production function, g and r, are obtained from the profit-maximization conditions of the model and from aggregate observations on factor shares and values of the aggregate capital-labor ratio, K/N. Third, the values of a and A_{SE} are chosen to match aggregate observations on the fraction of entrepreneurs in the workforce in economies with two different levels of aggregate productivity.

The parameter q gives the returns to scale associated with the CES production function. In the model, the fraction (1 - q) represents the share of output retained as rents by entrepreneurs. It is essentially impossible to find macro data that distinguish effectively between entrepreneurial rents and returns to capital, for any economy. There is substantial evidence, however, that capital and labor shares are relatively constant both across countries and over time, with labor shares around 0.65 to 0.70 and capital shares around 0.20 to 0.25 in many observations.[13] These figures suggest that entrepreneurial returns could be in the neighborhood of 0.10 of output, which corresponds to a value of $q = 0.90$. This is the value I use for the calibration. I explore below the sensitivity of the model to modest changes in the value of q, as well as to changes in other parameter values.

3.4 *Assigning parameter values*

Given a value for q, data on the Japanese economy and the steady-state conditions of the model determine the values of b and d. In this model economy, it must be the case that in a steady state, capital accumulation should exactly offset depreciation, so that the capital stock remains unchanged. Thus, $dK = x$, where x is investment. Japan's average gross investment share of GDP for 1982-88 was 0.283, and its net investment share was 0.146. De-trending the data to account for real growth and population growth, this implies a steady-state ratio of *K/Y* of 2.879.[14] Together with the depreciation share of GDP of 0.1373, this implies a depreciation rate of 0.0477.

---

[13] Gollin (1997) shows evidence that labor shares — as distinct from employee compensation shares — are relatively constant across countries, with most countries in the range 0.6 to 0.8. This finding contrasts with the widely held perception that labor shares are lower in poor countries than in rich, a perception based on confusion of labor shares with wage shares. Because of the importance of self employment in poor countries, *wage* shares are typically quite low. But when the data are adjusted to reflect the labor income of the self employed, poor and rich countries are essentially indistinguishable in terms of labor shares.

[14] The estimate of *K/Y* obtained in this fashion is very close to Maddison's estimates of 2.77 for 1987 and 3.02 for 1992.

Given this value for d, it is straightforward to compute b by noting that the standard steady-state condition must hold, namely that $\frac{1}{b} = r + (1-d)$. To find the appropriate value of r, I need to calculate the steady state share of capital income in GDP. This is not given directly in national income and products accounts. In the model, however, there are three factors of production: labor, capital, and entrepreneurial ability. I begin by computing total product as GDP less net indirect taxes.[15] The assumed value of q directly implies that entrepreneurial rents are 0.10 of total product. The labor share consists of employee compensation plus some fraction of the residual, which represents the labor income of entrepreneurs (as distinct from their rents). I assume that ten percent of this residual is labor income. This gives a labor share, $\frac{wN}{Y}$, of 0.6315 and a capital share, $\frac{rK}{Y}$, of 0.2685. Combined with the estimated capital stock above, this implies a value for r of 0.0933 and hence a value for b of 0.9564.

Two additional parameters of interest relate to the production function. The parameter g is the coefficient on the labor input in the production function, and r is related to the elasticity of substitution between capital and labor. The calibration is sensitive to the value of r. Lucas (1978) showed that in a model with only two occupational choices (workers and full-time entrepreneurs), capital accumulation would result in a declining fraction of entrepreneurs if and only if the elasticity of substitution was less than unity. In the current model, the dynamics are more ambiguous, but it remains important to the results that the elasticity of substitution be less than unity.

For this paper, I rely on the structure of the model and solve for g and r from aggregate data for Japan. The first-order conditions from the steady state of the model imply that we need any two observations on the aggregate capital-labor ratio, *K/N*, and the labor and capital shares of income. In particular, it follows from the firm's problems that for all establishments in an economy:

$$\left(\frac{g}{1-g}\right)\left(\frac{rK}{wN}\right) = \left(\frac{K}{N}\right)^{r} \qquad \textbf{(12)}$$

Since this equation holds for each firm, it also holds for aggregates. Any two aggregate observations allow us to solve two equations in two unknowns.

For Japan, I use the average capital share of 0.2685 and the labor share of 0.6315, as described above. Following an identical procedure, it is possible to compute the ratio of $\frac{rK}{wN}$ for Japan in 1938.[16] The labor share of total product (GDP less indirect business taxes) was 0.399 and the capital share was 0.501, giving a value for $\frac{rK}{wN}$ of 1.257.

Using Maddison's estimate (1991) that *K/N* for Japan was $3,704 in 1930 and normalizing the units of output and capital to thousands of 1985 U.S. dollars, Equation (12) then implies that $r = -0.4393$ and $g = 0.3095$.[17] This value for r implies an elasticity of substitution

---

[15] Note that this approach to computing net output is equivalent to assuming that net indirect taxes are borne by labor and capital in proportions equivalent to their share of total output. Although this may not be strictly accurate, there is no obvious alternative.

[16] I assume that the same figures apply to 1930, but I can find no national income accounts for years closer to 1930.

[17] The data given by Maddison (1991) may seem high to those accustomed to the figures given in some other data sources, such as Summers and Heston's Penn World Tables v. 5.6. The difference between the two sources is that Summers and Heston employ a straight-line depreciation technique to value capital assets over the expected lifetime of each class of assets, whereas Maddison assigns each asset class its full value for the duration of its working lifetime. These differing approaches to valuation yield different assessments of the value of the capital stock, with differences of about a factor of two across the two data sets. The two approaches also yield slightly different estimates for Japan's rate of capital accumulation. Maddison's estimates give a growth rate of capital per worker for 1950-87 of 6.92 percent. The PWT estimates imply a growth rate for 1965-92 of 7.92 percent. My calibration of r depends on the relative levels of capital per worker in 1930 and 1992, rather than on absolute levels, while the calibration of g is somewhat

between capital and labor of s = 0.695, well within the range considered plausible by many economists.

There are two additional parameters in the model: the size constraint on the businesses of the self employed, a, and the managerial efficiency advantage of the self employed, A_{SE}. Given the parameter values above, I calibrate a and A_{SE} to match the observed rates of entrepreneurship in Japanese manufacturing in 1930 and 1992. The relevant facts are that in 1930, per capita GDP in Japan was $1,539 and the fraction of employers and own-account workers in the manufacturing workforce was 0.292. In 1992, per capita GDP was $15,105 and the fraction was 0.086. Specifically, I guess values for the aggregate productivity parameter, A_i, to give steady-state output levels of 1.539 and 15.105. I then calibrate a and A_{SE} so that both economies have a fraction of employers and own-account workers that matches the data. I update my guesses of A_i, and I iterate on this process until it "converges" in the sense that the two steady states match the data on entrepreneur-workforce ratios.

As a practical matter, a and A_{SE} have different effects in the model. Since a essentially places a limit on the time worked by a self-employed person, it can be interpreted as reflecting the opportunity cost of self employment in terms of lost labor income. This becomes a relatively more important effect as wage rates rise in the economy. Thus, lowering the value of a, holding everything else constant, is likely to decrease the attractiveness of self employment in all economies – but relatively more so in economies with high wage rates (i.e., high values of A_i). By contrast, A_{SE} shifts the advantage of self employment equally across all economies. The two instruments are thus sufficient to match the data.

My calibration yields a value for a of 0.425 and a value for A_{SE} of 1.31. These values suggest that self employed people use between a third and a half of their work time to perform physical production activities (e.g., sewing, hammering, etc.) but are about one-third more

sensitive to absolute levels. I use the Maddison data here because they extend back beyond 1930, whereas productive than firms of comparable size operated by full-time managers. Although there is no obvious test of these parameters, they both appear to fall within plausible ranges.[18]

Table 4 summarizes the parameter values used in the quantitative experiments described below.

3.5 *Description of the experiment*

The procedure followed was to consider a number of separate economies for which all parameters were identical except for the aggregate productivity level A_i. For a given economy, A_i was fixed and a steady state was found computationally. Corresponding to the steady state are levels of capital and product per capita, K_i^* and Y_i^*, along with all other equilibrium elements. From this exercise, it is possible to create a map from steady-state values of output per capita, Y_i^*, to steady-state measures of entrepreneurs, factor shares, and other variables of interest.

The model does not attempt to describe the process of technical change; instead, the paper takes cross-country productivity differences as given. In other words, an economy is defined by an aggregate productivity level, A_i, that remains fixed through time. Implicitly, this implies that productivity changes are neutral between capital and labor. The virtue of this approach is that it makes it possible to model differences in productivity across economies without imposing restrictive assumptions about the form or process of growth. The

---

the PWT figures for Japan's capital stock go back only to 1965.

[18] A number of empirical studies purport to show that small firms are less "efficient" than larger firms (e.g., Uribe-Echevarria 1992, cited in Fisher *et al*. 1997). It is unclear, however, whether such studies are in fact documenting inefficiency or whether they are instead reflecting differences if factor intensity, unobserved heterogeneity, joint production, or other phenomena. Other studies, such as a careful analysis of Indian manufacturing enterprises by I.M.D. Little *et al*. (1987) report no systematic differences in total factor productivity across firms of different size. Strikingly, a long-standing literature in agricultural economics supports the notion that small farms are more productive than large farms, with incentive issues playing an important explanatory role. (See, for example, Hayami and Ruttan 1985). Tybout (1998) notes, however, that most studies attempting to address this issue have used outdated methodologies.

disadvantage of this approach is that it does not do a good job of representing the behavior of people in economies that are experiencing rapid technological change.[19]

4. Results of Quantitative Experiment

By construction, the calibrated model exactly replicates the entrepreneur-workforce ratios for the Japanese manufacturing sector in 1930 and 1992. Perhaps more surprising, the model economy also reproduces other features of the Japanese time series data, such as factor shares. For example, the employee compensation shares of GDP in the model economy track relatively closely to those observed in the data. In 1930, the employee compensation share for the model economy was 0.4080, while the data give a figure of 0.3435. For 1992, the model economy gives 0.6287, while the data show 0.6040.

Perhaps a better test of the model, however, is how useful it is in explaining data other than those to which it was calibrated. The following paragraphs report several different tests. First, entrepreneur-workforce ratios from the model economy are compared to time series data for three groups of countries: rapidly growing economies in East and Southeast Asia, OECD countries, and the world's poor countries. Second, entrepreneur-workforce ratios from the model are compared to cross-section data for all countries with available data. Third, the entrepreneur-workforce ratios from the model are compared to pooled cross-section and time series data from all available observations. Next, similar comparisons are made using factor shares from the model economy and from a number of actual economies. In all these cases, the model economy offers a good representation of the data. Finally, the model outputs are compared to the predictions of standard growth models.

[19] This problem is in some sense unavoidable: theory does not offer a good alternative. To assume geometric exogenous growth is to assume that Ghanaians today should make decisions based on the

4.1 *Entrepreneur-workforce ratios*

Several types of data allow us to evaluate the usefulness of the model as a description of self employment and entrepreneurship across countries.

4.1.1 TIME SERIES DATA

The model presented in this paper is designed to illuminate the relationship between growth and the structure of employment, it is particularly useful to see how well the model succeeds in characterizing the changes observed in a number of rapidly growing economies. Figure 2 shows time series data for the ratio of employers and own-account workers to the total manufacturing workforce in a number of East and Southeast Asian economies that experienced rapid growth in the period since the Second World War. These data are compared to output from the model.

The results are striking. The model economy appears to display roughly the same pattern as the data for Thailand and Malaysia, and it parallels the data for Korea. Across this set of countries and over time, there appears to be a relatively uniform trend in the entrepreneur-workforce ratio, and the model economy displays a similar trend. The model's predictions are too high, almost uniformly, but the shape of the graph corresponds well to the data.[20]

---

certainty that they will (relatively soon) be living in an economy that exactly corresponds to today's United States.

[20] In the discussion that follows, two goodness-of-fit measures will be reported for the model. First, it is possible to compute an R-squared value for the model output, based on the calculation $R^2 = 1 -$ (sum of squared errors)/(total sum of squares). Note that for an arbitrary model, as opposed to a least-squares-minimizing approach, it is no longer the case that the R-squared is bounded below by 0. In this particular case, the predicted values from the model yield an R-squared of 0.246, compared to an R-squared of 0.655 for an OLS regression of the entrepreneur-workforce ratio on a constant, real per capita GDP, its inverse, its square, and its cube. Thus, the model captures more than a third of the variation that could be picked up by a fitted polynomial regression line.

An alternative measure of goodness of fit is given by regressing the actual values on model predicted values and a constant. In general, a model fits the data well if the coefficient on the constant is close to zero, the coefficient on the model predicted values is close to1, and the R-squared is high. For this particular case, Does the model perform equally well in matching entrepreneur-workforce ratios from rich countries? Figure 3 presents the model output in relation to time series data for OECD countries. The model appears to overpredict the share of entrepreneurs in the workforce for these countries – in some cases dramatically. But a number of countries display data that parallel the model output reasonably closely, including Denmark and Italy. In general, the model predicts that the fraction of entrepreneurs should remain fairly flat for countries with per capita income in excess of $5,000. This corresponds to time series observations for most rich countries.[21]

A similar exercise can be undertaken for the poorest countries in the data. Figure 4 compares the model output to time series data for a group of 10 of the poorest countries in the data. Again, the data display a strong negative relationship between levels of GDP per capita and the fraction of the workforce consisting of employers and own account workers. In this set of countries, the relationship appears to be fairly strong, though somewhat erratic: the time series data do not show monotonic trends in either GDP per capita nor in the entrepreneur-workforce ratio. Nonetheless, the model appears to reproduce the essential pattern – namely, a rapid drop in the fraction of entrepreneurs in the economy as economies grow.[22]

---

a regression of actual values on a constant term and model predictions yields an adjusted R-squared of 0.593. The estimated coefficient on model predictions is 0.983 with a standard error of 0.179, and the estimated coefficient on the constant is –0.057 with a standard error of 0.050. These results suggest that the model predictions track the data reasonably well but with a substantial amount of noise. The negative coefficient on the constant term confirms the visual observation that the model overpredicts the data.

[21] The predicted values of the model yield an R-squared of –2.28, compared with an R-squared of 0.529 for an OLS regression of the entrepreneur-workforce ratio on a constant, real per capita GDP, its inverse, its square, and its cube. As noted above, it is possible for the model to have a negative R-squared value. A negative value implies that the model does less well as a predictor than would the mean value of the entrepreneur-workforce ratio. In this case, the model systematically overshoots the data. Regressing the actual values on model predictions and a constant term yields an adjusted R-squared of 0.461, with a coefficient on model predictions of 0.618 (standard error 0.086) and a coefficient on the constant of -0.017 (standard error of 0.011). The implication is that the model tracks the pattern of the data reasonably well but strongly overpredicts the actual data.

[22] The predicted values of the model yield an R-squared of –0.126, compared with an R-squared of 0.435 for an OLS regression of the entrepreneur-workforce ratio on a constant, real per capita GDP, its inverse, its

Looking across these separate sets of countries, then, the model appears to capture some of the central features of the time series data on entrepreneur-workforce ratios. It is worthwhile to ask also whether it performs equally well in matching the cross-section data and the pooled time series and cross-section data.

4.1.2 CROSS-SECTION AND PANEL DATA

Instead of comparing the model output to time series data, we can ask how well it matches observations across countries at a particular moment in time. Does the model accurately convey the relationship between GDP per capita and employment structure that we find in the cross-section data? Figure 5 compares the model output to data on the fraction of employers and own account workers in the manufacturing workforce across countries. The observations included are the most recent ones available for all 50 countries with available data from the years 1988-92. The model does extremely well in replicating the key features of these cross-section data.[23]

Similarly, the model does an excellent job of accounting for the pattern displayed in the panel created by pooling all available time series and cross section data, as shown in Figure 6. Although the model slightly underpredicts the fraction of entrepreneurs in the workforce in poor

---

square, and its cube. In this case, the model substantially underestimates two extreme values from Pakistan. As a result, the sum of squared errors is 12 percent higher than would be obtained from predicting the mean. Regressing the actual values on model predictions and a constant term yields an adjusted R-squared of 0.192, with a coefficient on model predictions of 0.936 (standard error 0.296) and a coefficient on the constant of 0.090 (standard error of 0.090). The implication is that the model does a reasonably good job of accounting for fairly noisy data, though it overpredicts the data slightly.

[23] The predicted values of the model yield an R-squared of 0.673, compared with an R-squared of 0.768 for an OLS regression of the entrepreneur-workforce ratio on a constant, real per capita GDP, its inverse, its square, and its cube. This implies that the model captures almost 90 percent of the variation that can be captured by the best-fit line passing through the data. Regressing the actual values on model predictions and a constant term yields an adjusted R-squared of 0.700, with a coefficient on model predictions of 1.233 (standard error 0.117) and a coefficient on the constant of –0.043 (standard error of 0.023). The implication is that the model does a very good job of accounting for the data, though it underpredicts the data significantly.

countries and overpredicts the fraction in rich countries, the model succeeds in capturing the general shape and pattern of the data.[24]

4.2 *Factor shares*

Another dimension in which the model appears to perform well is in matching cross-section and time series data on factor shares.

4.2.1 EMPLOYEE COMPENSATION SHARES

In the United States and most other rich countries, the wage share of output is often found to be between 0.65 and 0.75, with the capital share generally computed as the residual. The wage share has shown remarkably little variation over time.

Across countries, however, employee compensation as a share of output is substantially lower in poor countries. This is occasionally interpreted as implying that labor shares are lower in poor countries than in rich countries, but in fact employee compensation is only a partial measure of labor income. Part of the income of the self-employed also should be viewed as labor income and included in calculations of the labor share. Gollin (1998) argues that the apparent disparities in labor shares are related to differences across countries in the importance of self employment and the corresponding differences in the share of national income accruing to business proprietors. The model presented here helps to account for the observed patterns of factor shares.

---

[24] The predicted values of the model yield an R-squared of 0.581, compared with an R-squared of 0.628 for an OLS regression of the entrepreneur-workforce ratio on a constant, real per capita GDP, its inverse, its square, and its cube. This implies that the model captures about 93 percent of the variation that can be captured by the best-fit line passing through the data. Regressing the actual values on model predictions and a constant term yields an adjusted R-squared of 0.620, with a coefficient on model predictions of 1.315 (standard error 0.059) and a coefficient on the constant of -0.080 (standard error of 0.014). The implication is that the model does a very good job of accounting for the data, though it significantly underpredicts low values of the data and overpredicts high values.

Figure 7 shows employee compensation shares of national income across countries and compares data with the output of the model. The model does a reasonably good job of matching the data. Most of the observations from actual economies are relatively close to the path predicted for the model economies.[25] The model slightly overpredicts the employee compensation share, particularly for rich countries, but it shows that changes in productivity alone can generate substantial changes in the share of employee compensation in output.

As with the entrepreneur-workforce data, it is striking that the model predicts relatively flat employee compensation shares for rich countries. This is consistent with the time series data for current rich countries, which show little trend over time in the employee compensation share. At the same time, the model predicts a rapid increase in the employee compensation share for poor countries. Thus, the model's predictions are consistent with both cross-section and time series data on factor shares.

It is important to note that the behavior of the employee compensation share is not directly determined by the fraction of employees in the economy, since it also depends on wage rates. Thus, the employee compensation share is independent of the data reported above on the fraction of entrepreneurs in the workforce. The model offers a useful framework for understanding observations on factor shares across countries and over time.

4.2.2 OPERATING SURPLUS OF PRIVATE UNINCORPORATED ENTERPRISES

Another share that can be observed in the model economy is the fraction of output accruing to the owners of sole proprietorships as operating surplus. Operating surplus is

[25] The predicted values of the model yield an R-squared of 0.140, compared with an R-squared of 0.467 for an OLS regression of the entrepreneur-workforce ratio on a constant, real per capita GDP, its inverse, its square, and its cube. This implies that the model captures about 30 percent of the variation that can be captured by the best-fit line passing through the data. Regressing the actual values on model predictions and a constant term yields an adjusted R-squared of 0.443, with a coefficient on model predictions of 0.751 (standard error 0.093) and a coefficient on the constant of 0.052 (standard error of 0.047). The implication is that the model does well in accounting for the data, though it significantly overpredicts the data.

defined as value added less net indirect taxes, less employee compensation, less gross fixed capital formation. For actual economies, the operating surplus of private unincorporated enterprises (OSPUE) is often reported in the national income and product accounts. For the model economy, there is no category of business establishments that directly corresponds to "private unincorporated." As a proxy, however, it is reasonable to assume that the establishments operated by self-employed people are primarily private and unincorporated.[26]

Figure 8 shows the operating surplus of self-employed people in the model economy, as a share of total product. The line representing the model economy is contrasted with data on OSPUE for a sample of actual economies. The model economy generally understates the observed levels of OSPUE/GDP, as we would expect. Interestingly, however, the model matches the general trend and curvature of the data, and the magnitudes in the model economy are somewhat close to those in the data.[27]

4.3 *Growth facts*

The model economy is broadly consistent with the Kaldor-Solow stylized growth facts. In particular, it displays essentially constant real prices of capital services,[28] capital-output ratios that decline slightly with income per capita (arguably consistent with the data) and fairly stable capital and labor shares for countries across a wide range of GDP per capita.

---

[26] We might reasonably expect that some other businesses would be private and unincorporated as well, but there is no obvious way to make this distinction in the model.

[27] The predicted values of the model yield an R-squared of 0.144, compared with an R-squared of 0.617 for an OLS regression of the OSPUE share on a constant, real per capita GDP, its inverse, its square, and its cube. This implies that the model captures about 23 percent of the variation that can be captured by the best-fit line passing through the data. Regressing the actual values on model predictions and a constant term yields an adjusted R-squared of 0.562, with a coefficient on model predictions of 1.281 (standard error 0.232) and a coefficient on the constant of -0.189 (standard error of 0.079). The implication is that the model does a decent job of accounting for the data, though it significantly overpredicts OSPUE at high levels of GDP.

[28] In fact, these should be perfectly constant, but they are subject to small computational errors.

The output from the model economies makes clear how improvements in factor productivity bring about changes in firm size and the structure of employment. Figure 6, which shows the entrepreneur-workforce ratios in model and actual economies, can be interpreted as showing how growth creates incentives for large fractions of the population to exit from self-employment and to move into wage labor. Productivity growth increases the marginal product of labor (and hence the wage rate), making wage work more remunerative than self-employment. In the model economies considered here, these effects are large.

5. Sensitivity

The following paragraphs report the sensitivity of the model's output to changes in key parameters. It also shows that a "stripped-down" version of the model yields similar qualitative results.

5.1 *Changes in parameter values*

The key parameters in the model are those characterizing the production technology (specifically, r and g) – and, in particular, the two parameters relating to the relative performance of the self-employed (a and A_{SE}). The model clearly responds to changes in the values of these parameters, but possibly in non-linear ways. The approach followed in this paper is to consider the effects on the model's output from increasing or decreasing these four parameters by an arbitrarily chosen 20 percent.

Qualitatively speaking, none of the changes alters the basic result of the model – namely, that the fraction of entrepreneurs in the workforce falls as productivity rises. The key to this result is that r must remain negative, as shown in Lucas (1978).[29] Thus, the qualitative

[29] Intuitively, this condition requires that the elasticity of substitution between capital and labor lies on the Leontief side of the Cobb-Douglas case. This means that increases in productivity induce increases in steady-state capital, which in return increases the return to labor and induces people to move from

implications of the model are robust to minor changes in parameter values. Nonetheless, it is worth considering the effects of minor perturbations.

Figure 9 shows the sensitivity of the model to changes in g. Recall that g is the coefficient on labor in the CES production technology. Not surprisingly, an increase in g reduces the fraction of entrepreneurs in the workforce, since it reduces the return to labor. Conversely, a decrease in g tends, *ceteris paribus*, to increase the fraction of entrepreneurs. Figure 9 shows the baseline value of g = 0.3095 against a low value of approximately 0.25 and a high value of 0.37.

Figure 10 shows the model output under the baseline value of r = –0.4393, compared with a "low" value of –0.3514 and a "high" value of –0.5272. Again, in a qualitative sense, the model's output is not greatly affected by the change. An increase in the absolute value of r shifts the curve downward. This corresponds to a decrease in the substitutability between capital and labor, and intuitively such a change implies that as productivity rises and steady-state capital stocks rise, there will be a higher return to labor than in a world where the two inputs are more closely substitutable. Consequently, more workers are pulled out of the ranks of the entrepreneurs. Conversely, a decrease in the absolute value of r has the effect of shifting the curve upward for high values of A.

Figures 11 and 12 show the sensitivity of the model to changes in A_{SE} and a. Both of these parameters have large effects in shifting the output of the model. Recall that these parameters have been chosen jointly to match the two observations from the Japanese data, rather than having been derived from the data or the model. Thus, we are less interested in sensitivity analysis with respect to these parameters than with understanding how they affect the model's output. The point to be noted from Figures 11 and 12 is that the shape of the curve

---

entrepreneurship into labor. Consider the extreme case in which machines and workers are perfect complements; then an increase in the number of machines demands a one-for-one increase in the number of workers. The only source of additional workers in this economy is from the ranks of the entrepreneurs.

remains relatively similar even when the levels of A_{SE} and a are changed. This suggests that the general tendency of the model to replicate the overall pattern of the data is quite robust.

5.2 *Sensitivity to model specification*

This section reports the results of an experiment in which a "stripped-down" version of the model is simulated quantitatively. This experiment is designed to achieve two purposes. First, it shows that the essential qualitative result of the model is fairly robust to specification and parameterization: the proportion of entrepreneurs in the economy will fall as productivity rises, so long as the elasticity of substitution between capital and labor is less than unity. Second, this experiment underscores the point that a serious model of the structural transformation of production must incorporate more features than the "stripped-down" model. Without an explicit self-employment sector, and without making some assumptions about certain parameters, the model will not provide a useful framework for considering real-world policy questions.

The model considered here is the same in most respects as the one described above in Section 3. The main difference is that self-employment is no longer included as an explicit alternative. All firms face the same technology; *i.e.*,

$$y = xA_i\left[f(n,k)\right]^q , \qquad \textbf{(13)}$$

For this experiment, the distribution $D(x)$ is taken to be uniform on [0,1]. The production technology has three parameters: q, r, and g. I take $q = 0.9$, $r = -0.5$, and $g = 0.5$. Preferences are the same as in Section 3, and the discount and depreciation rates are kept the same as in Section 4. The main difference between this experiment and the previous ones, then, is that the self-employment sector is no longer modeled explicitly, and the distribution of entrepreneurial ability is no longer bell-shaped.

Figure 13 shows the results of this experiment for three different values of the productivity parameters, A. For each value of A, the time path of the entrepreneur-workforce ratio is shown plotted against the date. It is clear that even for the stripped-down model, the accumulation of capital along the time path leads to a corresponding reduction in the fraction of entrepreneurs in the workforce, consistent with the theoretical prediction. The magnitude of the change is relatively small, however. Even for the lowest level of productivity, with initial capital less than 10 percent of its steady-state value, the reduction in the fraction of entrepreneurs is modest. And the steady-state differences in the fraction of entrepreneurs, across different values of A, are not large.

Another way to view the results of this experiment is by plotting the fraction of entrepreneurs against output along the time path. (See Figure 14.) The time path is characterized by increases in output, gradually arriving at a steady-state value; the fraction of entrepreneurs falls as predicted, characterized by a fairly steep pattern along the time path. These graphs show what would happen to the fraction of entrepreneurs in a stripped-down economy as capital accumulation drives up the productivity of labor.

The output of the stripped-down model makes clear that the essential qualitative relationship between productivity and entrepreneurship holds for a broad class of models, as demonstrated by Lucas (1978). Although the model from Section 3 is sensitive to changes in parameters, functional forms, and other specifications, the qualitative result is robust.

5.3 *Tax policy effects*

Productivity differences can thus affect the structure of production and the fraction of entrepreneurs in the workforce. As noted above, however, a considerable literature suggests that policies may also have important effects on the size distribution of firms. For example, larger firms may face higher effective tax rates than the self-employed (perhaps due to the technology of taxation, which may make it unprofitable for authorities to enforce tax laws against self-employed). This model offers a useful framework for considering the effects of such policies.

In the simplest scenario, consider a policy regime that can be summarized by two effective tax rates – one for the self-employed, and one for firms operated by full-time managers. Consider these to be technological taxes, such that the output of a full-time manager of ability x can be written as:

$$y = (1 - t_{FT})\, x A_i \left[f(n,k) \right]^q , \qquad \textbf{(14)}$$

and the output of a self-employed person can be written as:

$$y = (1 - t_{SE})\, x A_{SE} A_i \left[f(n,k) \right]^q . \qquad \textbf{(15)}$$

Assume for simplicity that all tax revenues are used to produce a good that enters the utility function of consumers in an additively separable way.

Note that the tax rate is not identifiable from productivity rates in (14) and (15). Even if we normalize t_{SE} to zero, we cannot identify t_{FT} from A_{SE}. Qualitatively speaking, however, it is clear that as t_{FT} rises, fewer individuals will choose to be full-time managers. This also reduces the demand for wage labor. As a result, the ranks of the self-employed will increase from two sources: former full-time entrepreneurs and former workers.

Figure 15 shows the relationship between tax rates and the fraction of entrepreneurs in the workforce, for different values of A_i. In this figure, each value of A_i corresponds to a specific vertical line in the figure. Points along each line represent different values of the tax rate t_{FT} , with the highest point reflecting a value of t_{FT} = 0.35 and the lowest point given by the baseline case, with t_{FT} = 0.0. It is clear that differential tax rates on firms of different sizes have the potential dramatically to alter the fraction of entrepreneurs in the workforce – with implications for both the size distribution of firms and the level of self employment. With A_i = 1.5, the fraction of entrepreneurs in the economy rises from 0.21 at a tax rate of zero to 0.86 when the tax rate on large firms rises to 0.35. At a higher level of productivity (A_i = 5.5), the fraction of entrepreneurs rises from an undistorted figure of 0.097 to the much higher value 0.76.

It is also possible to measure the consequences of such distortionary taxes for steady-state aggregate output. For countries with high productivity (A_i = 5.5), moving the tax rate from 0.0 to 0.35 leads to only a 10 percent reduction in steady-state output. For countries with lower productivity, however, the repercussions are more severe. At A_i = 1.5, increasing the tax on large firms from 0.0 to 0.35 leads to almost a 40 percent reduction in steady-state output. This reflects the fact that distortionary taxes, in the model, simply shift the locus of production from large firms to small ones. In a world with pure constant returns to scale, of course, there would be no loss associated with this shift. In the model, however, production losses stem primarily from the reduction in skill levels of the average manager.

6. Conclusions and Implications

Previous theories of development have largely abstracted from questions of establishment size, despite substantial evidence that average establishment size — and particularly the level of self-employment — changes dramatically as economies grow. This paper asks to what extent we can account for the observed changes in establishment size in a standard theoretical framework. It then asks to what extent we can improve our understanding of various phenomena by explicitly modeling changes in establishment size.

The conclusion of this research is that a model with explicit treatment of establishment size and self-employment can reconcile a number of disparate features of the data. Not only can such a model mimic the data on entrepreneur-workforce ratios across a wide range of countries, but the model also performs well in explaining cross-country observations of factor shares and other national income accounting statistics.

The model fits the data quite well, both in predicting the fraction of employers and own-account workers and in predicting factor shares. It is not, of course, a perfect fit. Some deviations from the model's predictions may arise from policies that affect the incentives for self employment. As Section 5.3 illustrates, such policies can generate substantial variation in the entrepreneur-workforce ratio among countries at similar income levels. Given that the model without policies accounts for about two-thirds of the variation in the cross-section data (as measured by the R-squared of 0.673), there is substantial scope for policy and market imperfections to play a role in explaining the size distribution of firms. For example, Table 1 shows that Bolivia, with a real per capita GDP of $1,721, had an entrepreneur-workforce ratio of more than 50 percent in the manufacturing sector, while the Philippines, with essentially the same level of real per capita GDP, had an entrepreneur-workforce ratio of only 29 percent. Policies and regulation may play an important part in accounting for such differences.

Nonetheless, the model reminds us that we need not invoke policy distortions to account for the broad prevalence of self employment in poor countries. Even in the absence of distortions, countries like Bolivia and the Philippines should be expected to have higher levels of entrepreneurship – and more small firms – than would be found in rich countries.[30]

This insight has important implications for development policies aimed at small enterprises and the informal sector. Policies aimed at favoring large firms over small ones in poor countries, in the interests of promoting "efficiency" or "modernization," are likely to be misguided. Indeed, any efforts to alter the prevailing size distribution of firms should be appraised critically. There may be value in programs that redress missing markets or remove distortions, such as micro-credit schemes or liberalization of laws that inhibit the formation and expansion of firms. But in the poorest countries, it is unreasonable to imagine that such policies

[30]In a separate paper (Gollin 1995), I investigate the effect of distortionary policies that impose different tax rates on firms of different sizes in Ghana. I find that such policies play a significant role in skewing the size

will make the "informal sector" disappear or lead to huge reductions in self-employment rates. Moreover, distortions aimed at altering the size distribution of firms may be costly, in terms of aggregate output, for poor countries.

distribution of firms, and I find that they are costly in the aggregate. The model predicts, however, that even in the absence of such policies, Ghana would display high rates of self employment.

Table 1: Proportion of workforce consisting of entrepreneurs, own-account workers, and unpaid family laborers: manufacturing sector and entire economy. Countries are ordered by real GDP per capita.

Country	GDP per Capita	Manuf. Sector	Total Labor Force
Central Af. Rep.	514	0.571	0.834
Nigeria	978	0.780	0.753
Honduras	1385	0.407	0.471
Pakistan	1432	0.389	0.614
Bangladesh	1510	0.792	0.745
Philippines	1689	0.279	0.508
Bolivia	1721	0.502	0.413
Egypt	1869	0.277	0.474
El Salvador	1876	0.399	0.346
Peru	2092	0.249	0.393
Morocco	2173		0.254
Paraguay	2178	0.287	0.305
Botswana	2198	0.286	0.236
Sri Lanka	2215		0.352
Guatemala	2247	0.464	0.504
Ecuador	2830	0.514	0.501
South Africa	3068		0.070
Tunisia	3075	0.302	0.289
Panama	3332	0.232	0.328
Colombia	3380	0.244	0.293
Costa Rica	3569	0.207	0.271
Iran	3685	0.397	0.407
Turkey	3807	0.311	0.573
Poland	3826	0.069	0.259
Brazil	3882	0.127	0.330
Thailand	3942	0.300	0.695
Syria	3994	0.384	0.440
Hungary	4645	0.100	0.133
Chile	4890	0.228	0.296
Uruguay	5185	0.229	0.248
Malaysia	5746	0.156	0.381
Mexico	6253	0.245	0.435
Greece	6783	0.305	0.444
Venezuela	7082	0.204	0.301
Korea, Rep.	7251	0.156	0.383
Portugal	7478	0.119	0.246
Ireland	9637	0.056	0.196
Spain	9802	0.125	0.214
Israel	9843	0.111	0.166
New Zealand	11363	0.104	0.191
Finland	12000	0.055	0.135
Singapore	12653	0.051	0.132
Italy	12721	0.141	0.252
U. K.	12724	0.133	0.106
Austria	12955	0.052	0.135
Netherlands	13281	0.027	0.103
Belgium	13484	0.059	0.162
France	13918	0.049	0.136
Sweden	13986	0.053	0.091
Denmark	14091	0.050	0.102
Australia	14458	0.062	0.149
Germany, W.	14709	0.044	0.099
Japan	15105	0.119	0.197
Norway	15518	0.029	0.095
Canada	16362	0.016	0.094
Hong Kong	16471	0.105	0.118
U.S.A.	17972	0.019	0.082

Source: Data on real GDP per capita are taken from the Penn World Tables, Mark 5.6. Figures are given in constant dollar terms, using 1985 as a base year, and following a Chain Index. Data on labor force structure are taken from International Labor Organization Yearbook, 1993.

Table 2: Employers and own account workers as share of manufacturing workforce in Japan.

Year	Real per capita GDP	Entrepreneurs as share of manufacturing workforce
1930	1539	0.292
1947	1400	0.163
1950	1430	0.135
1955	2053	0.104
1960	2954	0.089
1965	4491	0.085
1970	7307	0.105
1975	8381	0.099
1980	10072	0.106
1985	11771	0.086
1992	15105	0.086

Source: ILO Yearbooks of Labour Statistics, various years; PWT v. 5.6; and Maddison (1991).

Table 3: Operating surplus of unincorporated enterprises (all sectors), selected countries.

Country	Operating surplus of private unincorporated enterprises, as share of GDP	Real per capita GDP, in $1985 at international prices
Burundi	0.593	559
India	0.347	1,204
Côte d'Ivoire	0.307	1,419
Jamaica	0.101	2,443
Peru	0.453	2,724
Ecuador	0.610	2,830
Thailand	0.365	2,972
Colombia	0.306	3,231
Hungary	0.117	5,562
Korea, Rep. of	0.249	5,607
Portugal	0.251	6,010
Spain	0.243	8,759
New Zealand	0.181	11,501
Italy	0.282	11,918
Belgium	0.176	12,319
United Kingdom	0.103	12,969
Japan	0.112	13,156
France	0.146	13,259
Finland	0.110	13,377
Sweden	0.087	14,408
Norway	0.085	14,674
Australia	0.134	14,704
Canada	0.065	17,258
United States	0.104	17,710

Source: United Nations, *National Accounts Statistics: Main Aggregates and Detailed Tables: 1988* (New York: UN Publishing Division, 1990), and PWT v. 5.6.

Table 4: Parameter values for quantitative experiment.

Parameter	Value	Description
b	0.9564	Discount factor
d	0.0477	Depreciation rate
q	0.90	Exponent on $g \Rightarrow$ entrepreneur’s share = 0.10
g	0.3095	Labor coefficient in f
r	−0.4393	Exponent on $f \Rightarrow s = 0.7016$
$D(x)$	b (18, 18)	Distribution of entrepreneurial ability
a	0.425	Upper bound on labor input of the self-employed
A_{SE}	1.31	Managerial productivity advantage of the self-employed

REFERENCES

Alchian, A. and H. Demsetz. 1972. Production, information costs, and economic organization. *American Economic Review* 62: 777-95.

Aryeetey, Ernest and William Steel. 1992. *Incomplete linkage between informal and formal finance in Ghana*. Industry and Energy Department Working Paper, Industry Series No. 62. Washington, DC: The World Bank.

Aryeetey, Ernest, Amoah Baah-Nuakoh, Tamara Duggleby, Hemamala Hettige, and William F. Steel. 1994. *Supply and demand for finance of small enterprises in Ghana*. World Bank Discussion Papers: Africa Technical Department Series, No. 251. Washington, DC: The World Bank.

Biggs, Tyler and Pradeep Srivastava. 1996. *Structural aspects of manufacturing in sub-Saharan Africa: Findings from a seven-country enterprise survey.* World Bank Discussion Papers: Africa Technical Department Series, No. 346. Washington, DC: The World Bank.

Birch, David L. 1987. Job creation in America : how our smallest companies put the most people to work. New York : Free Press.

Coase, R. 1937. The nature of the firm. *Economica* 4: 386-405.

De Soto, Hernando. 1989. *The other path: The invisible revolution in the Third World.* New York: Harper and Row.

Evans, David and Boyan Jovanovic. 1989. An estimated model of entrepreneurial choice under liquidity constraints. *Journal of Political Economy* 97 (4): 808-27.

Fafchamps, Marcel. 1994. Industrial structure and microenterprises in Africa. *Journal of Developing Areas* 29 (October): 1-30.

Fisher, Thomas and Vijay Mahajan, with Ashok Singha. 1997. *The forgotten sector: Non-farm employment and enterprises in rural India*. London: Intermediate Technology Publications.

Gollin, Douglas. 1995. Do taxes on large firms impede growth? Evidence from Ghana. Economic Development Center Bulletin Number 95-9, Economic Development Center, University of Minnesota.

Gollin, Douglas. 1997. Getting income shares right: self employment, unincorporated enterprise, and the Cobb-Douglas hypothesis. Manuscript, Williams College, Department of Economics.

Hart, O. and B. Holmström. 1987. The theory of contracts. In *Advances in economic theory*, Fifth World Congress, ed. Truman Bewley. Cambridge: Cambridge University Press.

Hart, O. and J. Moore. 1990. Property rights and the theory of the firm. *Journal of Political Economy* 98 (December): 1119-58.

Hayami, Y. and V. Ruttan. 1985. *Agricultural development*: *an international perspective*. Baltimore: Johns Hopkins University Press.

Hirschman, Albert O. 1958. *The strategy of economic development.* New Haven: Yale University Press.

Holmström, B. and J. Tirole. 1989. The theory of the firm. In *Handbook of industrial organization*, eds. R. Schmalansee and R. Willig. Amsterdam: North-Holland.

Hopenhayn, Hugo. 1992. Entry, exit, and firm dynamics in long-run equilibrium. *Econometrica* 60: 1127-50.

Hornstein, A. and E.C. Prescott. 1993. The plant and the firm in general equilibrium theory. In *General equilibrium and growth: The legacy of Lionel McKenzie*, eds. R. Becke, M. Boldrin, R. Jones, and W. Thompson. New York: Academic Press.

International Labour Office. 1993. *Year book of labour statistics.* Geneva: International Labour Organisation.

International Labour Office. 1990. *Year book of labour statistics retrospective edition on population censuses, 1945-89*. Geneva: International Labour Organisation.

International Labour Office. 1940. Year-book of Labour Statistics 1940. Geneva: International Labour Office.

Jovanovic, Boyan. 1982. Selection and the evolution of industry. *Econometrica* 50: 649-70.

Jovanovic, Boyan. 1994. Firm formation with heterogeneous management and labor skills. *Small Business Economics* 6: 185-91.

Kaldor, N. 1957. A model of economic growth. *Economic Journal* 67: 591-624.

Kremer, Michael. 1993. The O-Ring Theory of Economic Development. *Quarterly Journal of Economics* 108(3): 551-75.

Kuznets, Simon. 1966. *Modern economic growth: Rate, structure, and spread.* New Haven: Yale University Press.

Lewis, W. Arthur. 1965. *Theory of economic growth.* New York: Harper Torchbooks.

Liedholm, Carl. 1993. Pages 86-92 in *Agricultural transformation in Africa: Proceedings of the seminar on Agricultural Tranformation in Africa held in Baltimore, Maryland, May 27-29, 1992*, ed. David Seckler. Arlington, VA: Winrock International Institute for Agricultural Development.

Liedholm, Carl and Donald C. Mead. 1999. *Small enterprises and economic development*. New York: Routledge Publishing Co.

Little, I.M.D., D. Mazumdar, and J.M. Page, Jr. 1987. *Small manufacturing enterprises: A comparative study of India and other economies*. New York: Published for the World Bank by Oxford University Press.

Lucas, Robert E. Jr. 1978. On the size distribution of business firms. *Bell Journal of Economics* 9 (2): 508-23.

Maddison, Angus. 1991. *Dynamic forces in capitalist development: A long-run comparative view*. Oxford: Oxford University Press.

Organisation for Economic Co-Operation and Development (OECD). 1994. *National Accounts, 1960-1992: Main Aggregates Volume I*. Paris: OECD Statistics Directorate.

Republic of Ghana. 1991. *Ghana industrial census 1987: Phase II report, background and results.* Accra, Ghana: Statistical Service.

Republic of Ghana. 1987. *Population census of Ghana 1984: Demographic and economic characteristics, total country.* Accra, Ghana: Statistical Service.

Rostow, W. W. 1960. *The stages of economic growth.* Cambridge: Cambridge University Press.

Stigler, G. 1968. *The Organization of industry*. Homewood, Ill.: Irwin.

Teal, Francis. 1995. *Real wages and the demand for labour in Ghana's manufacturing sector.* Manuscript. Oxford: Centre for the Study of African Economies, University of Oxford, and St. John's College, Oxford.

Teal, Francis. 1994. *The size and sources of economic rents in a developing country labour market.* Manuscript. Oxford: Centre for the Study of African Economies, University of Oxford, and St. John's College, Oxford.

Tybout, James. 1998. *Manufacturing firms in developing countries: How well do they do, and why?* Manuscript, Georgetown University.

United Nations Statistical Office. 1948. *National income statistics of various countries, 1938-1947*. Lake Success, New York: Statistical Office of the United Nations.

United Nations. 1990. *National accounts statistics: Main aggregates and detailed tables, 1988.* Parts I and II. New York: United Nations Publishing Division.

U.S. Department of Commerce. 1987. *Census of manufacturing.* Vol. I, Summary. Washington, D.C.

U.S. Department of Commerce, Bureau of Economic Analysis. 1990. *National income and product accounts, 1959-88: Statistical tables.* Washington, D.C.: U.S. Department of Commerce.

U.S. Department of Commerce, Bureau of Economic Analysis. 1986. *National income and product accounts, 1929-82: Statistical tables.* Washington, DC: U.S. Government Printing Office.

Uribe-Echavarria, F. 1992. *Small-scale industrial development: policy and strategic issues*. Institute of Social Studies Working Paper No. 117. The Hague, Netherlands.

Williamson, O. 1985. *The economic institutions of capitalism: Firms, markets, relational contracting*. New York: The Free Press.

Williamson, O. 1989. Transaction cost economics. In *Handbook of industrial organization*, eds. R. Schmalansee and R. Willig. Amsterdam: North-Holland.

APPENDIX 1

The United Nations classification system divides the civilian labor force into five mutually exclusive categories: employers and own-account workers; employees; unpaid family workers; members of producer cooperatives; and others not classifiable by status. These categories are defined as follows:

- *Employers and own-account workers*
  Persons who operate their own economic enterprises or engage independently in a profession or trade. Employers are those who hire one or more worker; own-account workers hire no employees.

- *Employees*
  Persons who work for a public or private employer and receive remuneration in wages, salaries, tips, piece-rates or pay in kind.

- *Unpaid family workers*
  Persons who work without pay in an economic enterprise operated by a related person living in the same household. Where it is customary for young persons, in particular, to work without pay in an economic enterprise operated by a related person who does not live in the same household, the requirement of "living in the same household" may be eliminated.

- *Members of producer cooperatives*
  Persons who are active members of producer cooperatives, regardless of the industry in which it is established. (This group is in practice dropped in many countries where it is not numerically important.)

- *Persons not classifiable by status*
  Experienced workers whose status is unknown or inadequately described and unemployed persons not previously employed (i.e., new entrants).[31]

Source: International Labour Office, *Year book of labour statistics* (Geneva: International Labour Organisation, 1993)

[31]An alternative approach to classifying workers is given by the ICSE-93 Group approach, which provides guidelines for aggregating from standard employment classifications into the categories of employees; employers; own-account workers; members of producers' cooperatives; contributing family workers; and workers not classifiable by status. The formal guidelines for classifying workers into these groups differ slightly from the ones in the 1958 convention.

Appendix 2: Share of entrepreneurs in manufacturing workforce, all available years, for countries with more than 10,000 manufacturing workers (excluding former socialist economies). Countries ordered alphabetically by continent according to UN conventions.

	Year	Real per capita GDP	Share of entrepreneurs in manufacturing workforce
Algeria	1966	1548	0.242
Algeria	1977	2518	0.125
Angola	1960	931	0.135
Botswana	1991	2300	0.286
Burundi	1979	487	0.384
Cameroon	1976	888	0.553
Cent. Af. Rep.	1988	588	0.555
Egypt	1960	809	0.169
Egypt	1966	1015	0.190
Egypt	1976	1371	0.150
Egypt	1989	1906	0.178
Gambia	1983	721	0.914
Ghana	1960	894	0.755
Ghana	1984	785	0.767
Lesotho	1976	837	0.370
Liberia	1962	734	0.581
Liberia	1974	1053	0.684
Liberia	1984	869	0.557
Mali	1976	495	0.293
Mauritius	1962	3016	0.173
Mauritius	1972	2566	0.142
Morocco	1960	815	0.421
Morocco	1971	1367	0.336
Mozambique	1970	1497	0.125
Nigeria	1986	973	0.775
Reunion	1961	1134	0.199
Reunion	1967	1600	0.146
Reunion	1982	3074	0.101
Rwanda	1978	693	0.455
Sierra Leone	1963	1040	0.688
Sudan	1973	705	0.494
Tanzania	1967	397	0.363
Togo	1981	683	0.654
Tunisia	1956	1090	0.457

Appendix 2: Share of entrepreneurs in manufacturing workforce, all available years, for countries with more than 10,000 manufacturing workers (excluding former socialist economies). Countries ordered alphabetically by continent according to UN conventions.

	Year	Real per capita GDP	Share of entrepreneurs in manufacturing workforce
Tunisia	1975	2050	0.360
Tunisia	1984	2727	0.361
Tunisia	1989	2771	0.243
Zambia	1980	971	0.226
Argentina	1960	4462	0.223
Argentina	1970	5637	0.157
Argentina	1980	6506	0.179
Bolivia	1950	1274	0.412
Bolivia	1976	1950	0.534
Bolivia	1991	1696	0.406
Brazil	1960	1784	0.112
Brazil	1970	2434	0.107
Brazil	1980	4303	0.084
Brazil	1989	4271	0.107
Chile	1952	2582	0.298
Chile	1960	2885	0.230
Chile	1970	3605	0.190
Chile	1982	3460	0.149
Chile	1992	4890	0.214
Colombia	1951	1480	0.370
Colombia	1964	1861	0.304
Colombia	1992	3380	0.231
Ecuador	1950	1194	0.318
Ecuador	1962	1454	0.517
Ecuador	1974	2498	0.433
Ecuador	1982	3193	0.364
Ecuador	1990	2755	0.493
Paraguay	1972	1471	0.459
Paraguay	1982	2414	0.410
Paraguay	1991	2146	0.287
Peru	1961	2134	0.439
Peru	1972	2784	0.349
Peru	1981	3062	0.311
Peru	1991	2170	0.226
Uruguay	1963	3799	0.236

Appendix 2: Share of entrepreneurs in manufacturing workforce, all available years, for countries with more than 10,000 manufacturing workers (excluding former socialist economies). Countries ordered alphabetically by continent according to UN conventions.

	Year	Real per capita GDP	Share of entrepreneurs in manufacturing workforce
Uruguay	1975	4310	0.223
Uruguay	1985	3969	0.182
Uruguay	1991	4766	0.215
Venezuela	1961	6387	0.314
Venezuela	1971	7589	0.226
Venezuela	1981	7209	0.107
Venezuela	1991	6621	0.197
Canada	1951	6511	0.055
Canada	1961	7261	0.030
Canada	1971	10599	0.014
Canada	1981	14555	0.014
Canada	1986	16029	0.015
Canada	1992	16362	0.016
Costa Rica	1963	2270	0.231
Costa Rica	1973	3232	0.134
Costa Rica	1984	3213	0.165
Costa Rica	1992	3569	0.199
Dominican Republic	1960	1195	0.328
Dominican Republic	1970	1536	0.211
Dominican Republic	1981	2285	0.168
El Salvador	1961	1407	0.295
El Salvador	1971	1815	0.304
El Salvador	1991	1853	0.324
Guatemala	1964	1771	0.433
Guatemala	1973	2193	0.418
Guatemala	1981	2534	0.368
Guatemala	1989	2137	0.357
Haiti	1950	950	0.520
Haiti	1971	894	0.671
Haiti	1982	933	0.444
Honduras	1950	981	0.367
Honduras	1961	1031	0.384
Honduras	1974	1266	0.381
Honduras	1992	1385	0.342
Jamaica	1960	1773	0.431

Appendix 2: Share of entrepreneurs in manufacturing workforce, all available years, for countries with more than 10,000 manufacturing workers (excluding former socialist economies). Countries ordered alphabetically by continent according to UN conventions.

	Year	Real per capita GDP	Share of entrepreneurs in manufacturing workforce
Mexico	1960	2836	0.180
Mexico	1970	3987	0.199
Mexico	1980	6054	0.161
Mexico	1991	6018	0.175
Nicaragua	1963	1928	0.372
Nicaragua	1971	2344	0.337
Panama	1950	1309	0.371
Panama	1960	1575	0.244
Panama	1970	2584	0.235
Panama	1980	3392	0.117
Panama	1991	3103	0.221
United States	1950	8772	0.027
United States	1960	9895	0.020
United States	1970	12963	0.013
United States	1980	15295	0.013
United States	1992	17945	0.019
Bangladesh	1961	972	0.503
Bangladesh	1974	968	0.401
Bangladesh	1981	1084	0.223
Bangladesh	1989	1375	0.187
Hong Kong	1961	2353	0.127
Hong Kong	1966	3715	0.083
Hong Kong	1971	4844	0.055
Hong Kong	1976	6312	0.043
Hong Kong	1981	9341	0.042
Hong Kong	1986	11520	0.041
Hong Kong	1991	15601	0.096
India	1951	608	0.621
India	1961	751	0.624
India	1971	808	0.319
India	1981	908	0.252
Indonesia	1971	737	0.302
Indonesia	1980	1281	0.405
Iran	1956	2220	0.316
Iran	1966	3522	0.273

Appendix 2: Share of entrepreneurs in manufacturing workforce, all available years, for countries with more than 10,000 manufacturing workers (excluding former socialist economies). Countries ordered alphabetically by continent according to UN conventions.

	Year	Real per capita GDP	Share of entrepreneurs in manufacturing workforce
Iran	1976	6496	0.213
Iran	1986	3590	0.346
Iran	1986	3590	0.145
Iraq	1977	6518	0.238
Israel	1961	3781	0.172
Israel	1972	7126	0.111
Israel	1983	8259	0.085
Israel	1991	9524	0.108
Japan	1947	1400	0.163
Japan	1950	1430	0.135
Japan	1955	2053	0.104
Japan	1960	2954	0.089
Japan	1965	4491	0.085
Japan	1970	7307	0.105
Japan	1975	8381	0.099
Japan	1980	10072	0.106
Japan	1985	11771	0.086
Japan	1992	15105	0.086
Jordan	1961	1309	0.370
Jordan	1979	3219	0.236
Korea	1960	904	0.285
Korea	1966	1163	0.211
Korea	1970	1680	0.164
Korea	1975	2323	0.118
Korea	1980	3093	0.125
Korea	1992	7300	0.119
Malaysia (Peninsular)	1957	1291	0.311
Malaysia (Peninsular)	1980	3799	0.153
Malaysia	1988	5746	0.126
Nepal	1961	611	0.546
Nepal	1971	686	0.404
Pakistan	1951	614	0.773
Pakistan	1961	659	0.607
Pakistan	1972	898	0.421
Pakistan	1981	1101	0.375

Appendix 2: Share of entrepreneurs in manufacturing workforce, all available years, for countries with more than 10,000 manufacturing workers (excluding former socialist economies). Countries ordered alphabetically by continent according to UN conventions.

	Year	Real per capita GDP	Share of entrepreneurs in manufacturing workforce
Pakistan	1992	1432	0.276
Philippines	1960	1133	0.451
Philippines	1970	1403	0.369
Philippines	1975	1625	0.294
Philippines	1992	1689	0.227
Singapore	1957	1400	0.189
Singapore	1970	3017	0.109
Singapore	1980	7053	0.063
Singapore	1992	12653	0.049
Sri Lanka	1946	1000	0.480
Sri Lanka	1963	1211	0.265
Sri Lanka	1971	1251	0.185
Sri Lanka	1981	1632	0.166
Syria	1960	1575	0.219
Syria	1970	2294	0.240
Syria	1981	4664	0.237
Syria	1991	3994	0.294
Thailand	1960	943	0.328
Thailand	1970	1526	0.247
Thailand	1980	2178	0.227
Thailand	1990	3580	0.200
Austria	1951	3125	0.124
Austria	1961	5388	0.085
Austria	1971	7851	0.059
Austria	1981	10407	0.048
Austria	1991	12850	0.040
Belgium	1947	4300	0.129
Belgium	1961	5752	0.081
Belgium	1970	8331	0.048
Belgium	1981	10829	0.045
Belgium	1990	13232	0.049
Denmark	1950	5263	0.127
Denmark	1955	5434	0.109
Denmark	1960	6760	0.088
Denmark	1965	8436	0.083

Appendix 2: Share of entrepreneurs in manufacturing workforce, all available years, for countries with more than 10,000 manufacturing workers (excluding former socialist economies). Countries ordered alphabetically by continent according to UN conventions.

	Year	Real per capita GDP	Share of entrepreneurs in manufacturing workforce
Denmark	1970	9670	0.064
Denmark	1981	11153	0.043
Denmark	1985	12969	0.035
Denmark	1991	14015	0.042
Finland	1960	5291	0.071
Finland	1970	8108	0.027
Finland	1976	9431	0.017
Finland	1980	10851	0.021
Finland	1985	12051	0.030
Finland	1992	12000	0.055
France	1954	4565	0.114
France	1962	6401	0.079
France	1968	8228	0.071
France	1975	10297	0.041
France	1982	11970	0.049
France	1991	13870	0.049
Germany	1961	6817	0.061
Germany	1970	9425	0.042
Germany	1992	14709	0.041
Greece	1951	1474	0.273
Greece	1961	2318	0.325
Greece	1971	4506	0.289
Greece	1981	5903	0.256
Greece	1990	6768	0.256
Iceland	1950	3808	0.102
Iceland	1960	4964	0.076
Ireland	1951	2730	0.114
Ireland	1961	3479	0.059
Ireland	1966	4005	0.042
Ireland	1971	5130	0.039
Ireland	1981	6985	0.033
Ireland	1991	9395	0.055
Italy	1951	2941	0.159
Italy	1961	4919	0.129
Italy	1971	7603	0.124

Appendix 2: Share of entrepreneurs in manufacturing workforce, all available years, for countries with more than 10,000 manufacturing workers (excluding former socialist economies). Countries ordered alphabetically by continent according to UN conventions.

	Year	Real per capita GDP	Share of entrepreneurs in manufacturing workforce
Italy	1981	10285	0.114
Italy	1991	12602	0.122
Luxembourg	1947	5900	0.132
Luxembourg	1960	7921	0.086
Luxembourg	1966	8447	0.064
Luxembourg	1970	9782	0.039
Luxembourg	1981	11842	0.026
Malta	1957	1271	0.154
Malta	1967	1751	0.126
Netherlands	1947	4300	0.102
Netherlands	1960	6077	0.068
Netherlands	1971	9466	0.031
Netherlands	1981	11079	0.028
Netherlands	1991	13196	0.023
Norway	1946	4250	0.134
Norway	1960	5610	0.072
Norway	1970	8034	0.045
Norway	1980	12141	0.026
Norway	1992	15518	0.026
Portugal	1950	1208	0.159
Portugal	1960	1869	0.134
Portugal	1970	3306	0.091
Portugal	1981	5017	0.083
Portugal	1992	7500	0.114
Spain	1950	1913	0.129
Spain	1970	5861	0.071
Spain	1992	9802	0.106
Sweden	1950	5807	0.117
Sweden	1960	7592	0.052
Sweden	1965	9402	0.043
Sweden	1970	10766	0.026
Sweden	1975	11958	0.021
Sweden	1985	13451	0.014
Sweden	1992	13986	0.052
Switzerland	1960	9409	0.082

Appendix 2: Share of entrepreneurs in manufacturing workforce, all available years, for countries with more than 10,000 manufacturing workers (excluding former socialist economies). Countries ordered alphabetically by continent according to UN conventions.

	Year	Real per capita GDP	Share of entrepreneurs in manufacturing workforce
Switzerland	1980	14301	0.051
Turkey	1970	2202	0.290
Turkey	1975	2838	0.216
Turkey	1980	2874	0.191
Turkey	1985	3077	0.170
Turkey	1992	3807	0.232
United Kingdom	1966	7789	0.012
United Kingdom	1971	8655	0.015
United Kingdom	1981	10017	0.024
United Kingdom	1992	12724	0.133
Australia	1954	7049	0.066
Australia	1961	7576	0.052
Australia	1966	9145	0.044
Australia	1971	10886	0.028
Australia	1976	11742	0.039
Australia	1981	12689	0.050
Australia	1986	13608	0.080
Australia	1992	14458	0.058
New Zealand	1945	6400	0.073
New Zealand	1951	6263	0.090
New Zealand	1956	6772	0.076
New Zealand	1961	8066	0.049
New Zealand	1966	9121	0.039
New Zealand	1971	9726	0.024
New Zealand	1976	10631	0.034
New Zealand	1981	10815	0.035
New Zealand	1986	11704	0.080
New Zealand	1992	11363	0.100

Figure 1: Distribution of entrepreneurial ability in the model economy
(beta distribution, with parameters a= b= 18)

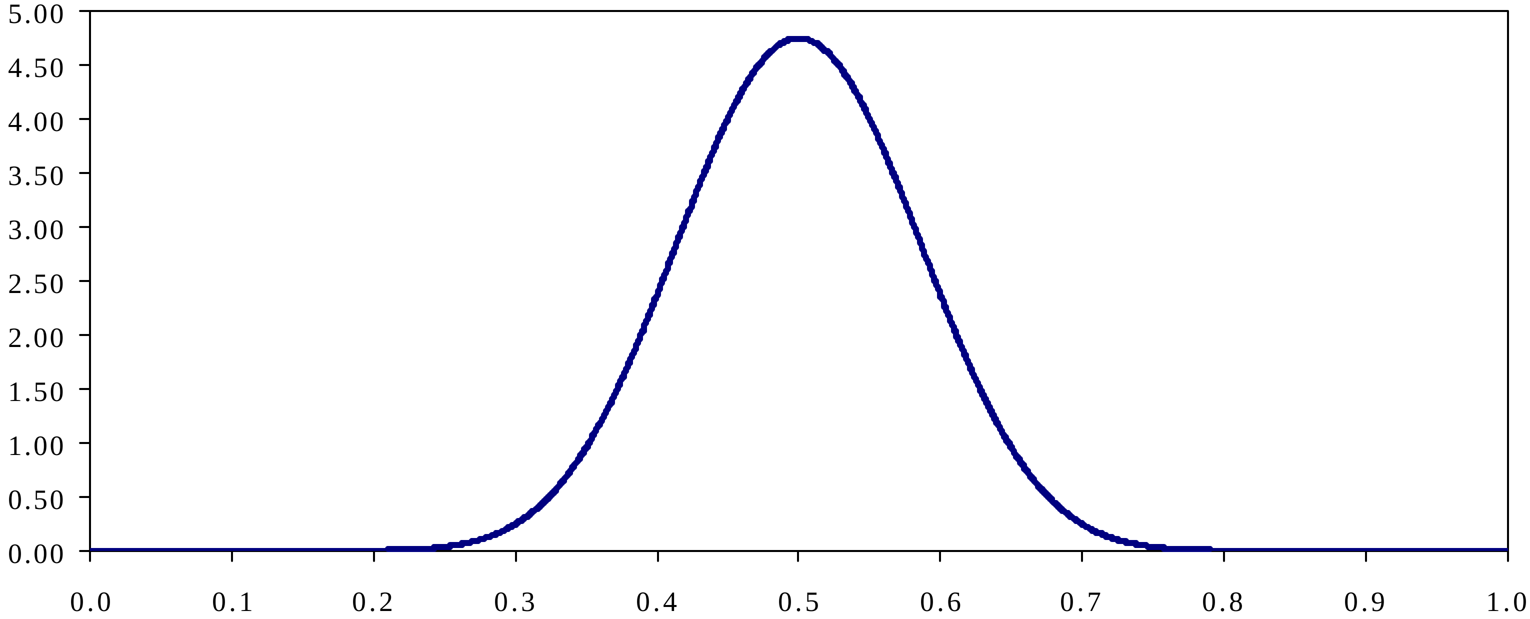


Figure 2: Employers and own-account workers as share of manufacturing workforce, six East Asian economies and model economy.

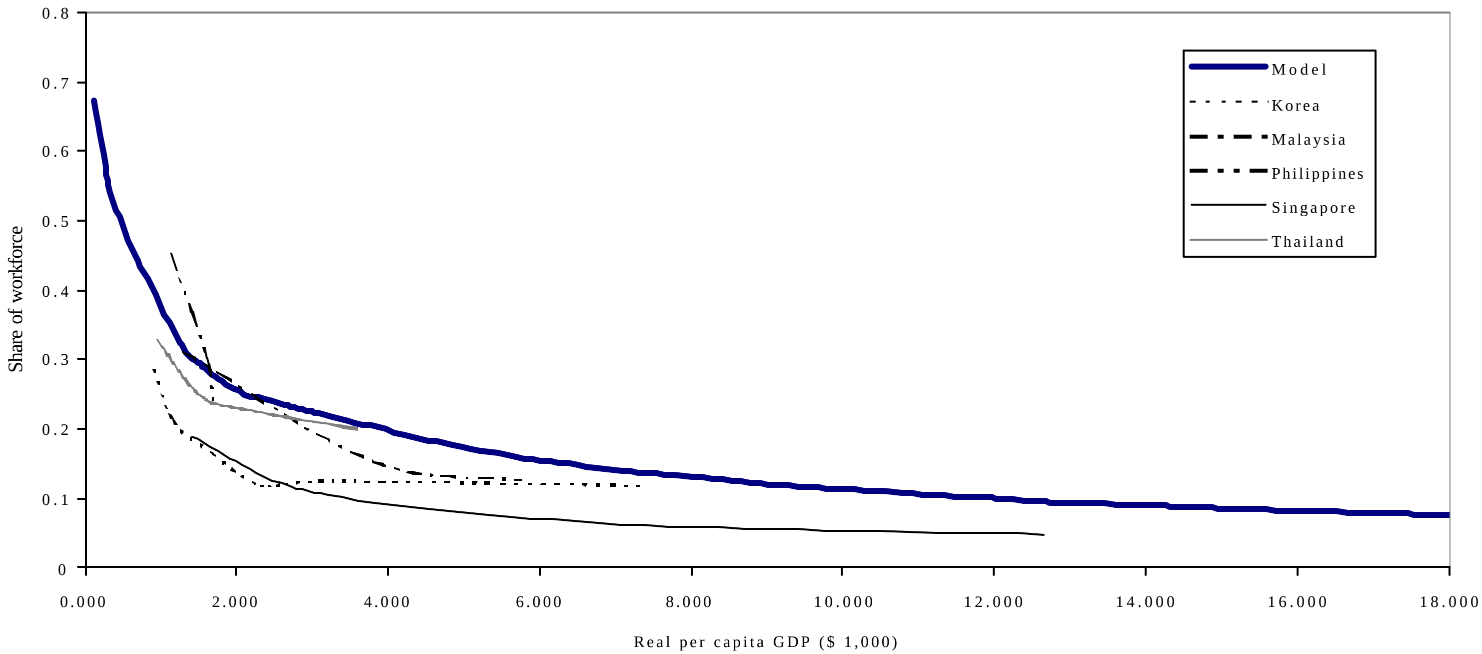


Figure 3: Entrepreneurs and own account workers as share of manufacturing workforce: time series data for rich countries, compared to calibrated model economy

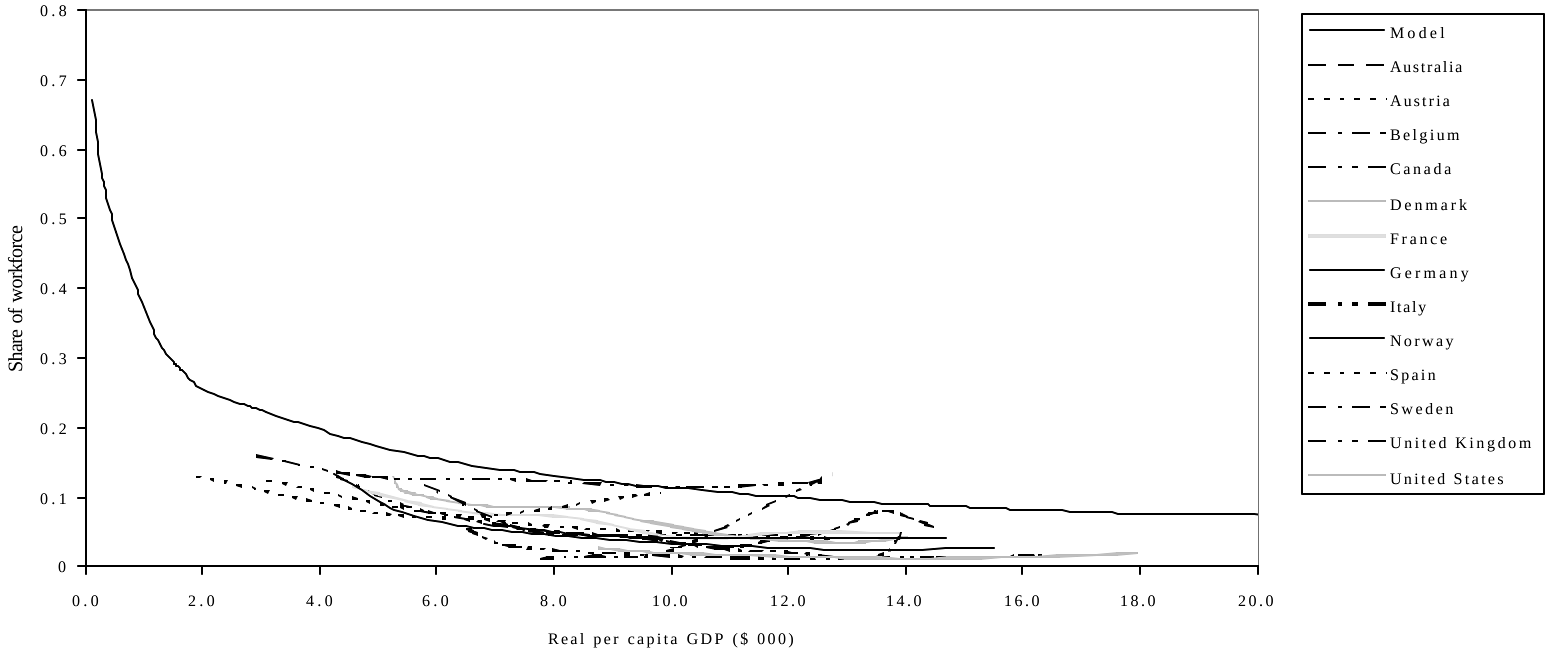


Figure 4: Entrepreneurs and own account workers as share of manufacturing workforce: time series data for poor countries, compared to calibrated model economy

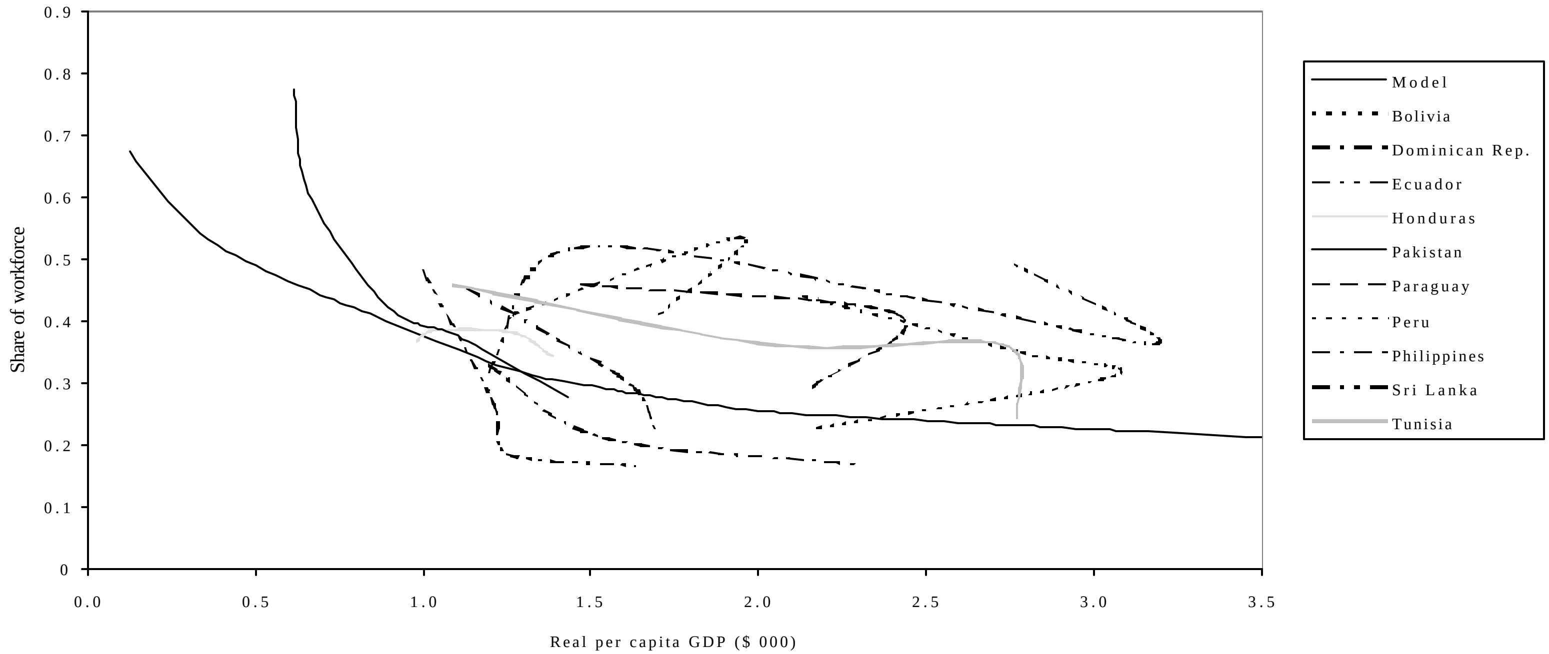


Figure 5: Entrepreneurs and own account workers as share of total workforce: cross section data and model economy, calibrated to Japanese time series data

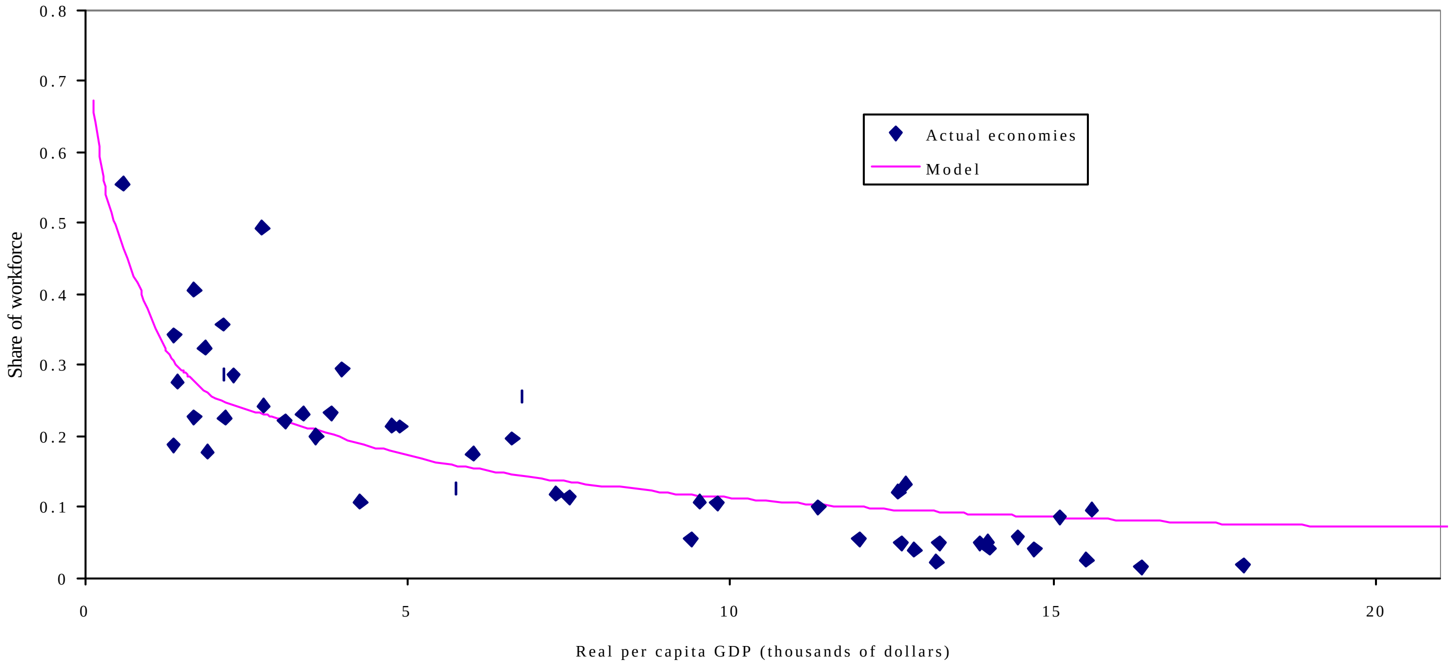


Figure 6: Entrepreneurs and own account workers as share of total workforce: panel data and model economy, calibrated to Japanese time series data

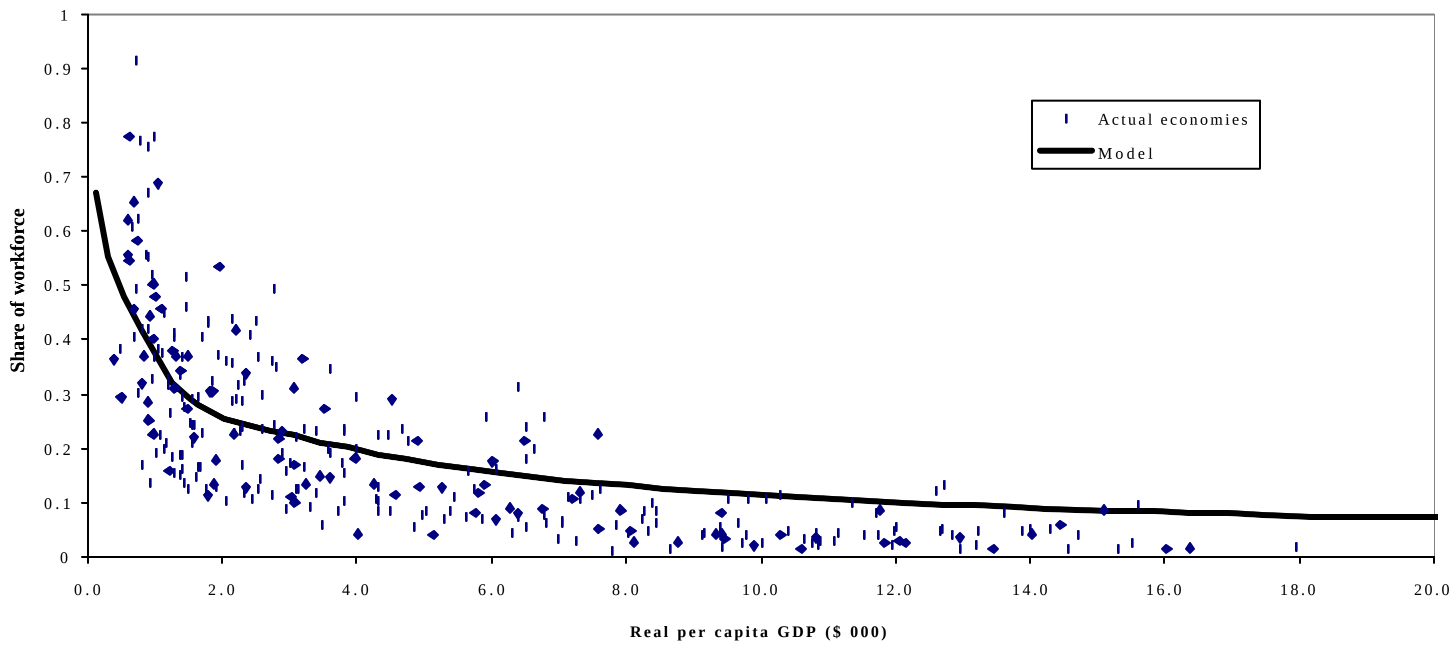
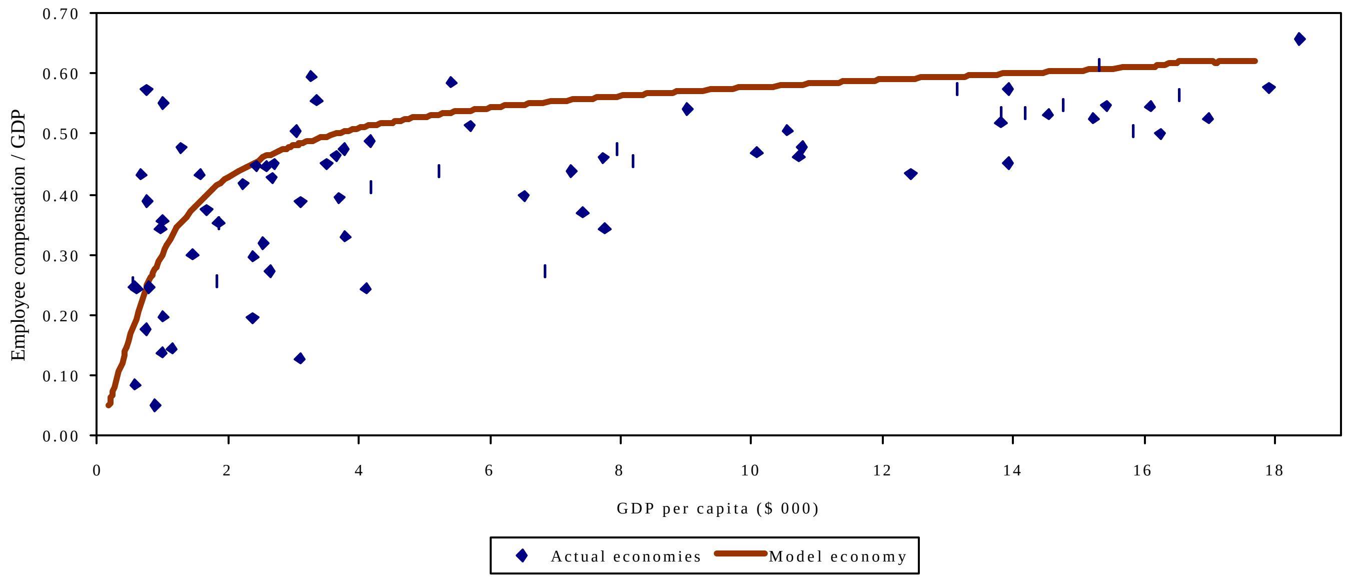
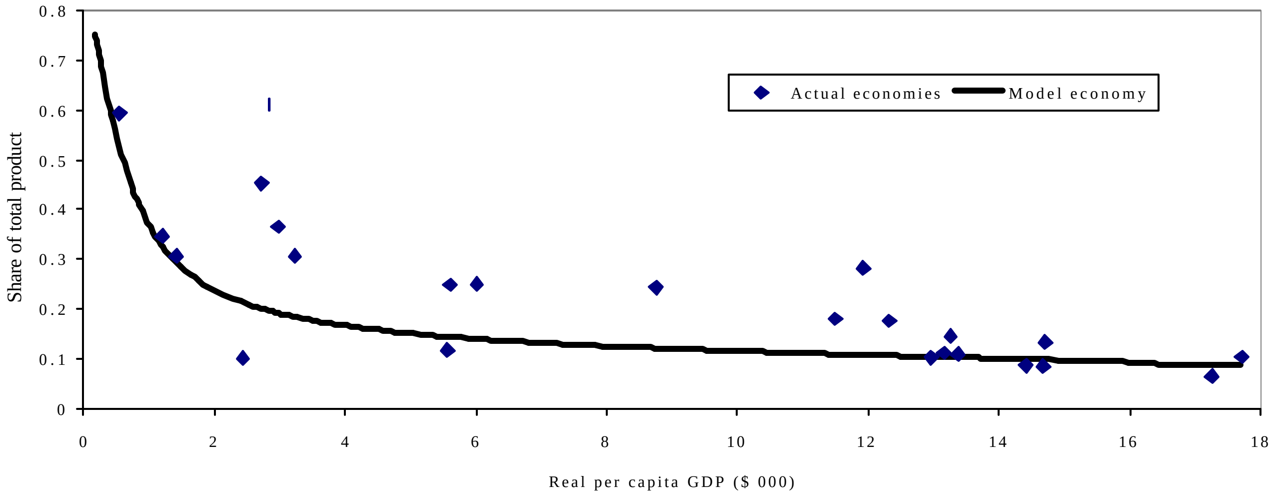


Figure 7: Employee compensation as a share of total product, model economy and actual economies



Source: Data on employee compensation shares in actual economies are taken from United Nations, *National Accounts Statistics: Main Aggregates and Detail[ed] Tables, 1992, Parts I and II* (New York: United Nations Publishing Division, 1994). Data on real per capita GDP are from Penn World Tables v. 5.6 for 199[…] appropriate year. Data on model economy are taken from model output.

Figure 8: Operating surplus of private unincorporated enterprises for actual economies compared with mixed income of the self-employed for the model economy.



Source: Data on operating surplus of private unincorporated enterprises are taken from United Nations, *National Accounts Statistics: Main Aggregates and Detail Tables, 1990,* Parts I and II (New York: United Nations Publishing Division, 1992). Data on model economy are taken from model output. Mixed income of th employed includes labor income, capital income, and entrepreneurial rents accruing to the self-employed. Data on real GDP per capita are from Penn World Tab 5.6, for the appropriate year.

Figure 9: Model sensitivity to changes in gamma

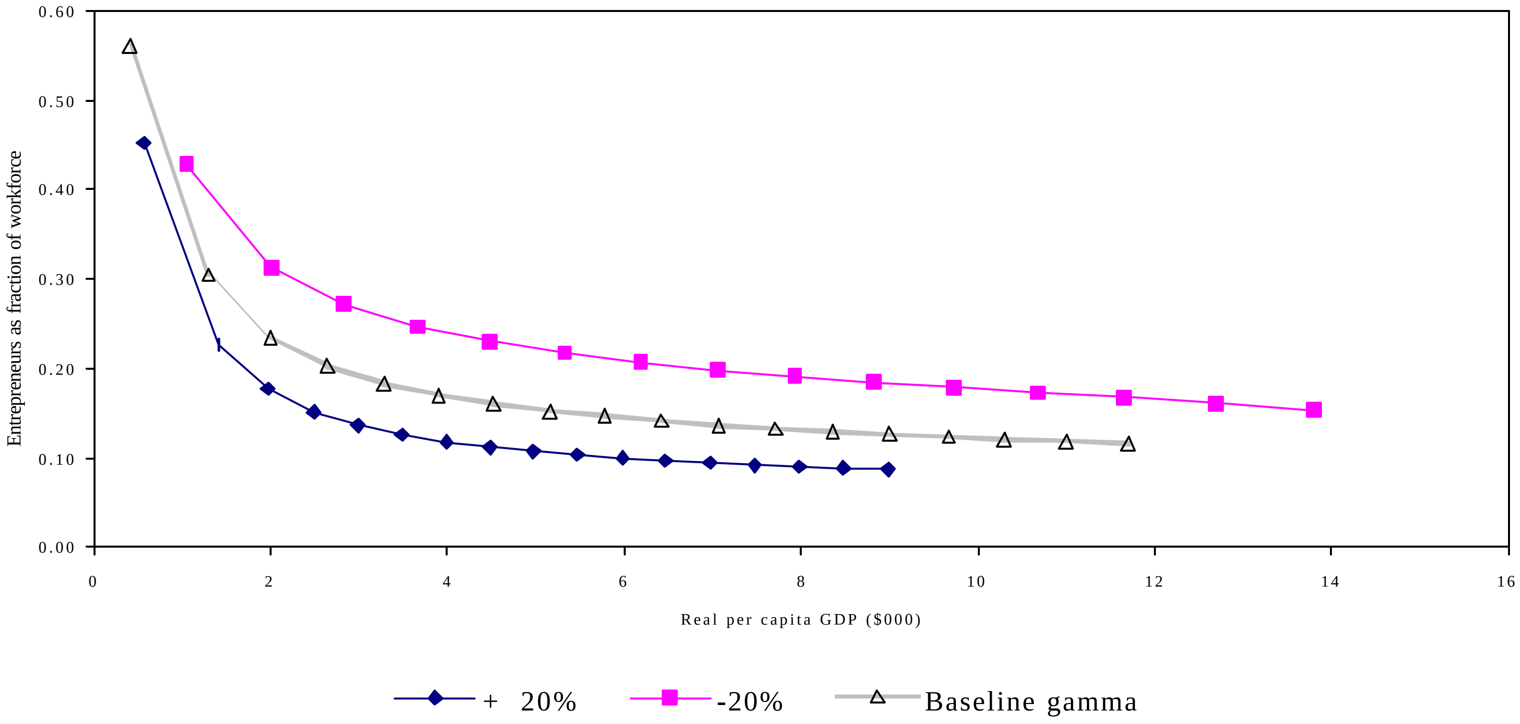


Figure 10: Sensitivity to changes in rho

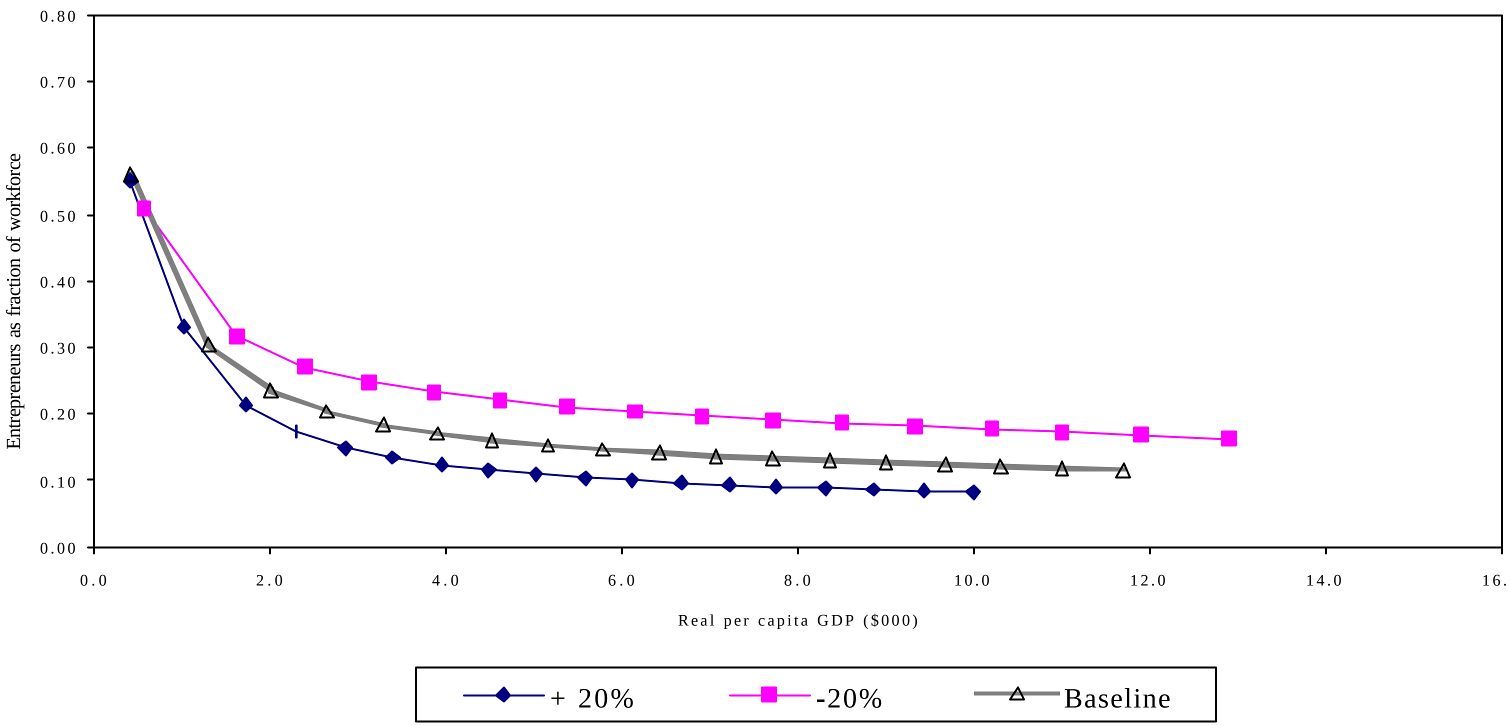


Figure 11: Model sensitivity to changes in A_{SE}

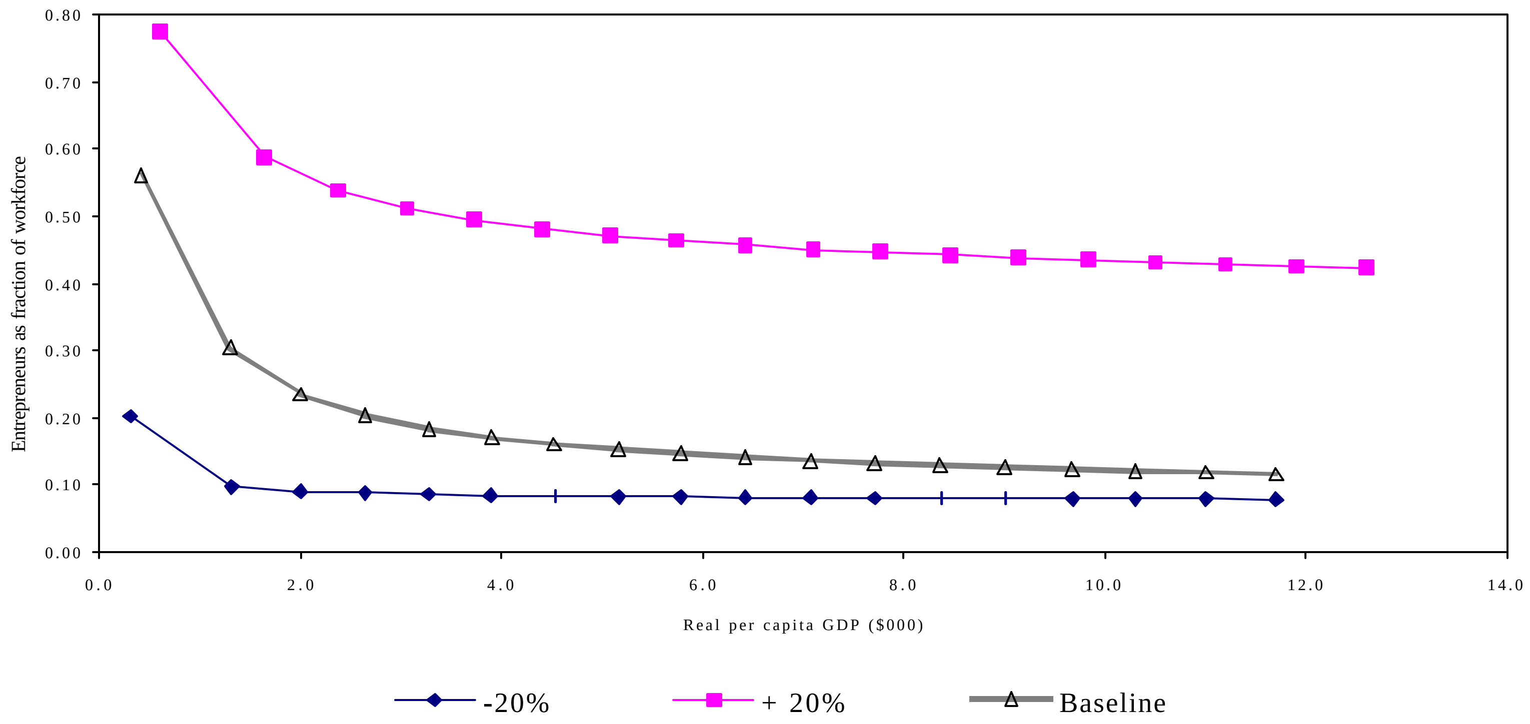


Figure 12: Model sensitivity to changes in alpha

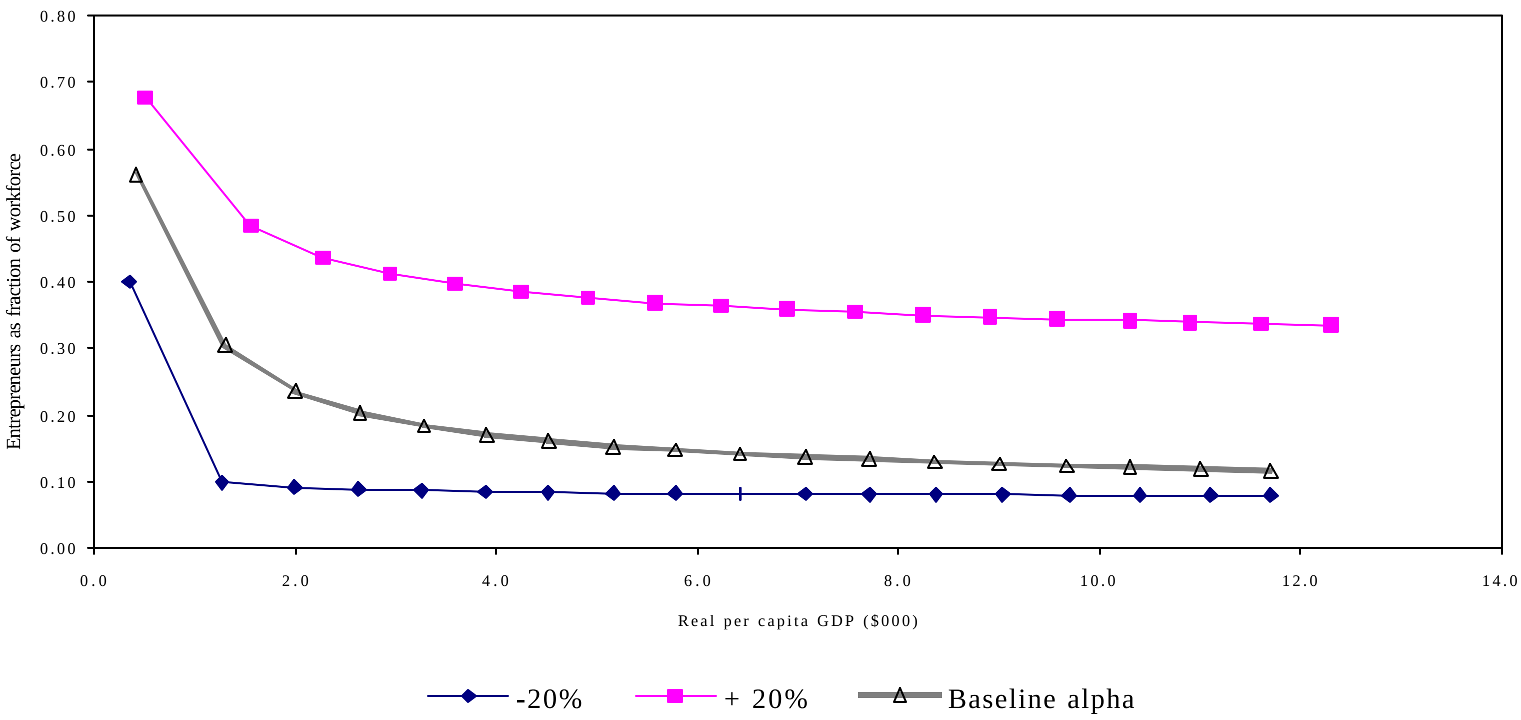


Figure 13: Time paths of "stripped-down" economy

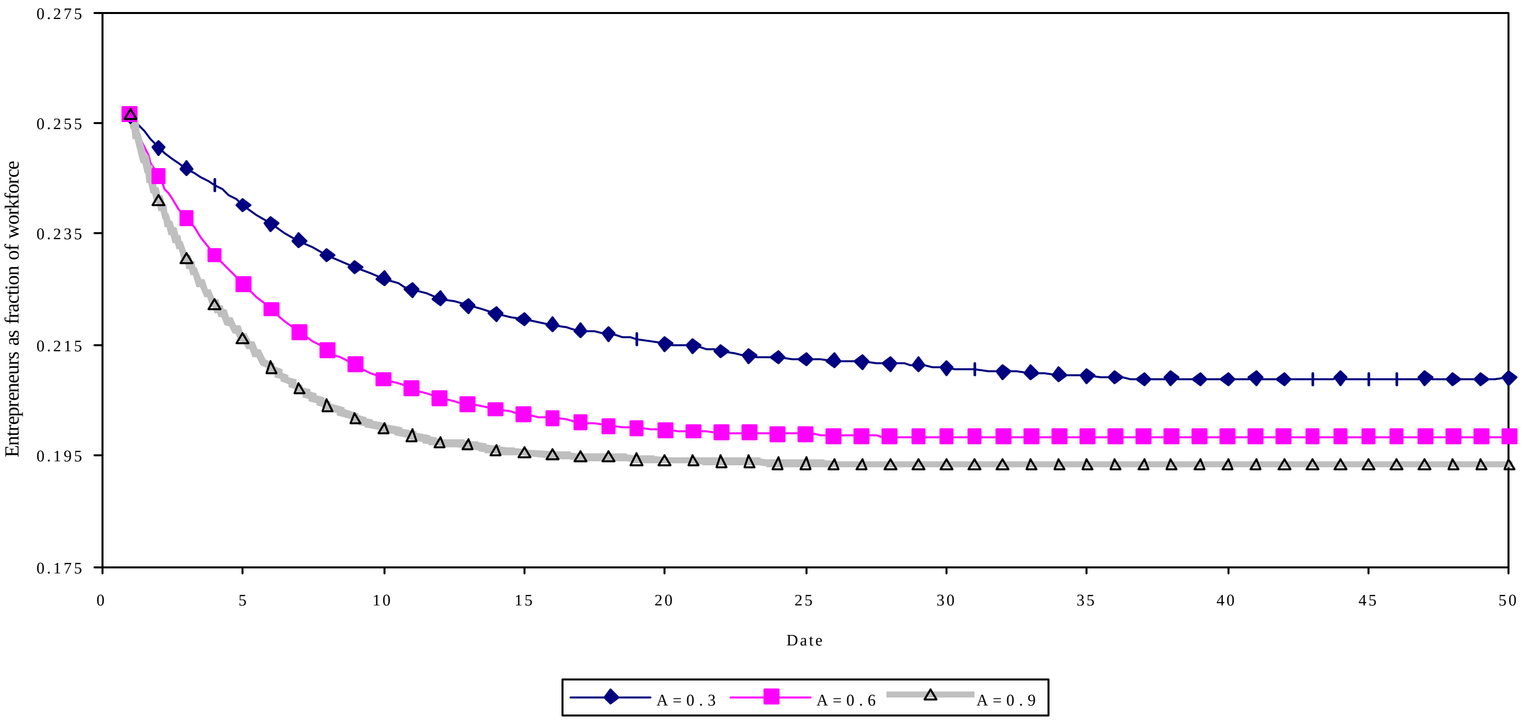


Figure 14: Fraction of entrepreneurs in time paths of stripped-down model, plotted against output.

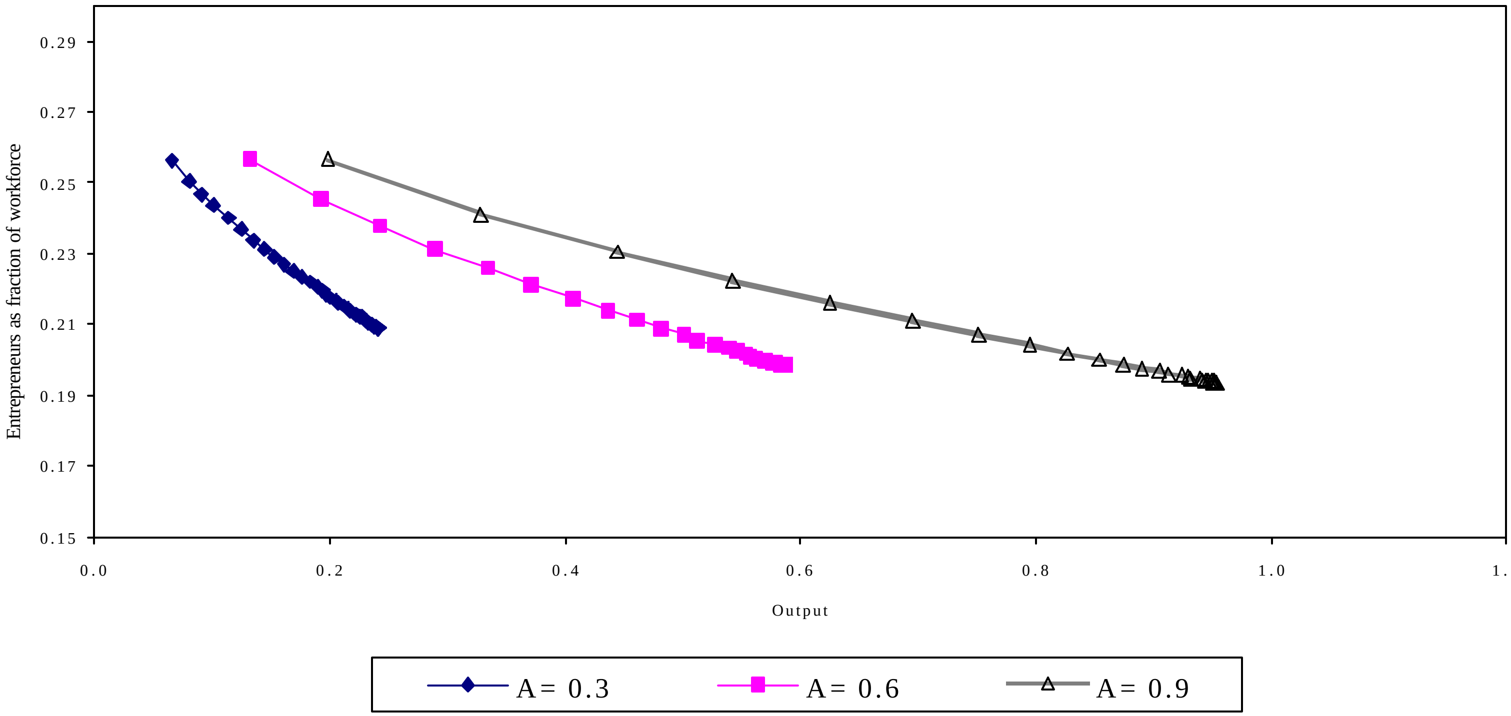


Figure 15: Effects of changes in the tax rate charged to large firms -- from 0.0 to 0.35 -- on the fraction of entrepreneurs in the workforce, for different values of aggregate productivity (A).