DECLINING SHARE OF SMALL FIRMS IN U.S. OUTPUT: CAUSES AND CONSEQUENCES

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We develop a dynamic general equilibrium model, with large and small firms, to examine possible causes and welfare implications of a declining trend in small firms' share of U.S. output since 1958. Numerical experiments indicate that recent technological advances and government tiering policies that have reduced fixed set-up costs of production benefit the emergence of small firms, but lower their output share due to competition for resources among firms. However, this outcome is welfare improving. Therefore, if the policy objective is to raise small firms' output share and economic welfare simultaneously, it is desirable to concentrate on increasing anti-trust and deregulatory efforts. (*JEL* L11, L16, E23)

I. INTRODUCTION

According to the Small Business Administration's (SBA) calculations, as shown in Table 1, the contribution of small firms to U.S. national income was 58% in 1958, which then declined steadily to 51% in 1982 and stabilized around this value until 1992, the latest year for which the figures are available.[1] This decline is quite puzzling in light of recent changes in technological factors, market competition, and government policies that were supposed to benefit small businesses.[2] In this article, we construct a dynamic general equilibrium model with two production sectors, representing large and small firms, to examine possible causes and welfare implications of this declining trend of small firms' output contribution in the U.S. economy. Moreover, this study brings into focus the role of government policies such as the Justice Department's anti-trust efforts and the "tiering" programs whereby many regulations impose lighter requirements on smaller firms in order to maintain their viability.[3]

Recently there have been several developments that can be considered beneficial towards the emergence of small firms. Shephard (1982) has estimated that, since 1958, government deregulatory efforts have raised the level of competition in the U.S. economy by eliminating entry barriers and lowering transaction costs. These factors in turn have contributed to the viability of small firms

*This paper was completed while Dhawan was Director of Econometric Forecasting at UCLA Anderson Forecast. We thank Costas Azariadis, Robert Breunig, Michael Devereux, Roger Farmer, Andrew Filardo, Larry Kimbell, Kevin Lansing, Federico Sturzenegger, two anonymous referees, and seminar participants at UCLA, UC Riverside, and the 1997 WEA Conference for helpful comments and suggestions. Any remaining errors are our own.

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1. A small firm, according to the SBA definition, is a firm that has 500 employees or less. The contribution to national income is based on the gross product originating (GPO) in a firm or a sector. In practice, it is equal to the sum of employment compensation, indirect business taxes, profit income and capital consumption allowance net interest.

2. Accompanying this downward trend in output share is a relative slowdown in the productivity of small firms. Specifically, while the average labor productivity of large and small firms has been rising over the sample period, small-firm productivity grew at a slower rate than that of large firms. In 1958, the average labor productivity (measured in 1992 dollars) of small and large firms were $39,096.24 and $34,950.75 respectively. These figures became $48,976.78 and $52,509.98, respectively, in 1992.

3. The main rationale for tiering is that scale economies arise because regulations impose fixed costs in compliance, thereby increasing the regulatory burden on small firms. For example, the Federal Home Loan Bank Board has found that savings and loan institutions with less than $10 million in assets have 13 times the regulatory cost per million dollars of assets compared to those with $100–200 million assets.

Economic Inquiry
(ISSN 0095-2583)
Vol. 39, No. 4, October 2001, 651–662

TABLE 1
Importance of Small Firms in U.S. Economy

Year	Employment	Numbers (Millions)	Numbers (Proportion)	GPO
1958	55.2	3.303	99.76	58
1963	53.0	3.457	99.74	55
1967	53.2	3.510	99.69	54
1972	53.0	3.541	99.67	54
1977	52.5	4.352	99.73	53
1982	55.8	4.633	99.72	51
1987	54.5	5.937	99.77	52
1992	53.0	6.296	99.76	51
Average, 1958–92	53.78	4.375	99.73	53.5

Source: Figures on employment are collected from various issues of the SBA's *The State of the Small Business: A Report of the President*. The number of small firms is based on authors' calculation using data from the *County Business Patterns* which also uses the SBA's definition of small firms. Data on Gross Product Originating (GPO) is taken from the Joel Popkin and Company, "Small Business Share of Private, Nonfarm Gross Product," prepared under contract for the SBA's Office of Advocacy, SBAHQ-95-C-0021, June 1997, Table 1.

in the marketplace. Furthermore, the emergence of new computer-based technologies in the last two decades has improved the quality and flexibility of small-scale production relative to standardized mass-production techniques since they reduce the fixed capital or fixed-cost requirements (see Shephard [1982]; Piore and Sable [1984]; Carlsson [1989b]; and Carlsson, Audretsch, and Acs [1994]).[4] Another factor that improves the viability of small firms is their higher innovation rate as documented by Acs and Audretsch (1990). The shift of consumers' taste from standardized mass-produced goods towards stylized and personalized products also promotes small-firm growth. Given their flexible production structure, small firms have become important suppliers for these new goods and services (see Carlsson [1989a]).

In light of these favorable developments, one would expect to observe the number of small firms, as well as their share in national income, to rise in the U.S. economy. However, this has not been borne out by the data regarding small firms' output share. This article examines this issue in a dynamic general equilibrium framework. Extending Romer's (1987) model of specialization, we develop an infinite-horizon representative agent model with two production sectors that are made up of large and small firms, respectively. The two sectors differ from each other with respect to the level of fixed (set-up) costs and returns-to-scale parameters of their production functions. Each sector has an intermediate-good segment in which monopolistically competitive firms operate using fully mobile capital and labor inputs. The number of these intermediate firms is determined endogenously from the condition of free entry and exit. A final good is produced in each sector from the set of available intermediate goods in a perfectly competitive environment. These two final goods are then aggregated into a single output (GDP) that can be consumed or invested by the representative household. In a symmetric perfect-foresight equilibrium, these features result in an unequal number of large and small firms, which can then be used to analyze the effects of technological changes and government policies.

The sectoral structure of our model in which GDP is produced by combining outputs of large and small firms is different from a typical two-sector model with distinct consumption and investment goods. In fact, our two-sector economy with identical factor intensities behaves exactly like a standard one-sector model in which the representative household allocates resources across the two sectors to equate marginal products to factor prices. This parsimonious structure with one good and two technologies is motivated by the fact that both large and small firms exist side by side in many industries while practically producing the same commodity. Recent empirical industrial organization literature posits that small firms exist as they are more flexible in handling market fluctuations (see Mills and Schuman [1985]; Feigenbaum and Karnani [1991]). In addition, Nguyen and Reznek (1991; 1993) have shown that in the U.S. manufacturing industries, large firm size is not a necessary condition for efficient production. Specifically, Phillips (1991) found that small firms have played a dominant role in the growth of high-technology industries. For example, scientific breakthroughs in the bio-technology industry have reduced

4. Carlsson (1989a) argued that another reason for the decline in firm size was the process of "de-glomeration" whereby firms concentrated on their primary business activities and divested subsidiary businesses in order to free up scarce management resources.

the minimum efficient scale of production required for screening and development of new drugs, thus resulting in a large number of small firms in that industry (see Zucker and Darby [1996]). Moreover, it is not only in the high-technology sectors such as bio-chemicals and computers that we observe a lot of small firms coexist with large firms, but also in telecommunications, apparel, retail business, and airlines where numerous small firms are either competing directly with large firms, or living in their shadow by carving out their own niches (see Dhawan and Prabhu [1998]). In this article, we are mainly interested in studying what proportion of the economy's total output can be attributed to large and small firms, respectively.

We begin our analysis by calibrating the model to reflect the fact that small firms have accounted for slightly more than half of national income in the U.S. economy from 1958 to 1992. A novel feature of this calibration exercise is that the model also reproduces the employment share and relative proportion of small firms observed in the data. We then conduct two numerical experiments based on the reasoning that recent technological and market-related developments, together with government policies, have added to small firms' viability. The first experiment takes the form of lowering fixed costs for a given technology in the small-firm sector, which mimics a favorable technological improvement or the government tiering policy. For instance, the Office of Federal Contract Compliance exempts firms with less than 50 employees from filing affirmative action plans. Another example is that the Securities Exchange Commission tiers reporting requirements for security issues according to the size of the issue.[5] We find that although lowering fixed costs benefits the emergence of small firms, it also reduces their share in national income because of the competition for capital and labor resources with the large-firm sector. Nevertheless, this outcome is welfare improving, which implies that the declining share of small firms in U.S. output is an optimal response of the economy to the changing nature of technology and government tiering policy.

The second experiment examines the effects of changing the level of competition (or the monopoly power) in the economy. This experiment captures the impact of government anti-trust and deregulatory efforts.[6] It turns out that a higher level of monopoly power reduces the individual size and total number of small firms. As a result, the small firms' share in total output as well as the economy's total output both decrease, generating a welfare loss. These findings imply that if the policy goal is to increase the share of small firms in national income and economic welfare simultaneously, then giving exclusive tax or other administrative breaks to small firms alone cannot achieve the twin objectives. Instead, it is desirable to focus on increasing anti-trust and deregulatory efforts.

This article is related to the recent literature that incorporates increasing returns-to-scale and imperfect competition into dynamic general equilibrium models (see Hornstein [1993]; Chatterjee and Cooper [1993]; Devereux, Head, and Lapham [1996a; 1996b])[7]. In particular, we extend the one-sector model of Devereux, Head, and Lapham (1996a; 1996b) to a two-sector framework. As in our article, these authors allow the number and size of intermediate firms to be endogenously determined by the assumption of free entry and exit. However, our model differs from theirs in two important respects. First, Devereux et al. used a stochastic one-sector model to examine the effects of productivity disturbances and government spending shocks on the business cycle fluctuations, whereas our analysis is conducted within a deterministic framework with two production sectors. Second, the fixed-cost parameters in their model do not play any role except to pin down the individual size and

5. For a summary of tiered federal regulations, see Brock and Evans (1986).

6. Government deregulatory policies that raise industry-wide competition have occurred in many sectors such as banking, securities, commodity brokers, trucking and telecommunications. The breakup of AT&T in 1984 and the recent repeal of the 1930 Glass Steagall Act that separated brokerage/equity activities from banking are two noteable examples. A partial list of deregulatory actions and their timing can be found in Table 4 of Shepherd (1982), who also noted that anti-trust efforts were the stimulus for deregulation in numerous cases.

7. Hornstein (1993) showed that in an otherwise standard one-sector real business cycle model with fixed number of firms, monopolistic competition and increasing returns slightly reduce the importance of technology shocks in accounting for economic fluctuations. On the other hand, Chatterjee and Cooper (1993) explored the impact of entry and exit of firms on the dynamic responses of the economy to various exogenous shocks.

total number of firms. In contrast, by appropriately calibrating the two fixed-cost parameters, the steady state of our model matches not only the observed share of small firms in total output, but also the employment share and relative proportion of small firms in the U.S. economy. Furthermore, in our analysis, experiments involving changes in fixed costs are used to examine the effects of technological improvements and government tiering policy.

The remainder of this article is organized as follows. Section II describes the model and equilibrium conditions. The calibration of model parameters is discussed in section III. Section IV presents the quantitative results, and section V concludes.

II. THE ECONOMY

We consider an infinite-horizon, one-good, and two-sector dynamic general equilibrium model with increasing returns and monopolistic competition. Households live forever and derive utility from consumption and leisure. Large and small firms produce output using technologies with identical factor intensities, but subject to different fixed set-up costs and returns-to-scale in production. We assume that there are no uncertainties present in the economy.

Firms

The production side of the economy is comprised of two sectors indexed by $i = 1, 2$, where sector 1 is populated by large firms and sector 2 consists of small firms. Since firms are solving a static profit maximization problem, the time-subscripts have been suppressed for notational convenience in this subsection. The final good in each sector Y_i is produced from a continuum of intermediate inputs X_{ij}, $j \in [0, M_i]$, using the following constant returns-to-scale technology:

$$(1) \quad Y_i = \left(\int_0^{M_i} X_{ij}^{\lambda} \right)^{1/\lambda}, \quad 0 < \lambda < 1,$$

where M_i represents the measure of intermediate inputs available in sector i. The final-good segment of each sector is assumed to be perfectly competitive, and we denote P_{ij} as the price of the jth intermediate input relative to the final good in sector i.[8] The final-good producers' profit maximization condition yields the following demand function for X_{ij}:

$$(2) \quad X_{ij} = P_{ij}^{1/(\lambda-1)} Y_i,$$

where the price elasticity of demand is equal to $1/(1-\lambda)$.

Each intermediate good is produced by a monopolist, who uses a production function that allows for increasing returns:

$$(3) \quad X_{ij} = \left(K_{ij}^{\alpha} L_{ij}^{1-\alpha}\right)^{\gamma_i} - Z_i, \quad 0 < \alpha < 1, \quad \gamma_i \geq 1, Z_i > 0,$$

where K_{ij} and L_{ij} are capital and labor inputs employed by the jth intermediate producer in sector i. Here, Z_i represents a constant amount of intermediate goods that must be used in sector i as fixed costs of production before any sale is made. In our analysis, these costs are identified with expenses that firms must incur at the outset to set up the production facility in order to comply with various government regulations. They are postulated to be exogenous technological or government policy variables that are outside the control of intermediate producers. The presence of such costs implies that the intermediate technology exhibits increasing returns-to-scale. When $\gamma_i > 1$, additional increasing returns exist in (3) because of increasing marginal productivity.

Using equations (2) and (3), the profit function of the intermediate producer j in sector i is given by

$$(4) \quad \Pi_{ij} = Y_i^{1-\lambda} X_{ij}^{\lambda} - w_i L_{ij} - r_i K_{ij},$$

where w_i is the real wage rate, and r_i is the capital rental rate in sector i. With competitive factor markets in each sector, the first-order conditions for maximizing (4) are

$$(5) \quad w_i = \frac{(1-\alpha)\lambda\gamma_i(X_{ij} + Z_i)P_{ij}}{L_{ij}}, \quad \text{where } \frac{\partial w_i}{\partial Z_i} > 0 \text{ and } \frac{\partial w_i}{\partial \lambda} > 0,$$

8. As a result, there exist an arbitrary number of identical final-good producers in each sector.

$$(6) \quad r_i = \frac{\alpha\lambda\gamma_i(X_{ij} + Z_i)P_{ij}}{K_{ij}}, \quad \text{where } \frac{\partial r_i}{\partial Z_i} > 0 \text{ and } \frac{\partial r_i}{\partial \lambda} > 0.$$

We further assume that both capital and labor inputs are fully mobile across the two sectors.[9]

Under the assumption of free entry and exit in the intermediate-good segment of both sectors, Π_{ij} is equal to zero in each period.[10] This zero-profit condition in conjunction with (5) and (6) yield the equilibrium quantity of intermediate input X_{ij}:

$$(7) \quad X_{ij} = \frac{\lambda\gamma_i Z_i}{(1 - \lambda\gamma_i)}, \quad \text{where } \frac{\partial X_{ij}}{\partial Z_i} > 0 \text{ and } \frac{\partial X_{ij}}{\partial \lambda} > 0.$$

This expression also represents the *size* of an intermediate firm. Notice that it is a constant independent of any endogenous variable. Since Z_i is a positive constant, equation (7) implies that $\lambda\gamma_i$ must be strictly less than 1 in each sector to ensure that the profit maximization problem of intermediate producers is well defined. Using Z and γ to characterize the two types of firms in the economy, we postulate that on the technological side, it requires higher fixed costs to set up a large firm, i.e., $Z_1 > Z_2$. This formulation is in accordance with the recent literature on the flexibility and size of firms, which hypothesizes that small firms are more flexible in handling market fluctuations as they rely more on variable factors of production (see Mills and Schumann [1985]). By contrast, large firms employ more fixed factors, making them less flexible but more cost-efficient. As a result, large firms' production technology displays a higher degree of returns-to-scale. To capture this feature, we postulate that large firms are more productive than small firms, $\gamma_1 > \gamma_2$.

In what follows, we restrict the analysis to a symmetric equilibrium within each sector in which

$$(8) \quad P_{ij} = P_i, \quad X_{ij} = X_i, \quad K_{ij} = \frac{K_i}{M_i},$$

and

$$L_{ij} = \frac{L_i}{M_i}, \qquad \text{for all } j \in [0, M_i],$$

where K_i and L_i represent the total capital stock and labor hours employed in sector i. In addition, the equilibrium number of intermediate firms in sector i can be derived from substituting (8) into (3) and (7):

$$(9) \quad M_i = K_i^{\alpha} L_i^{1-\alpha} \left[\frac{(1 - \lambda\gamma_i)}{Z_i}\right]^{1/\gamma_i},$$

where $M \equiv M_1 + M_2$. It follows that in a symmetric equilibrium, the sectoral production function for the final good is

$$(10) \quad Y_i = M_i^{1/\lambda} X_i = A_i K_i^{\alpha/\lambda} L_i^{(1-\beta)/\lambda},$$

$$\text{where} \quad A_i = \lambda\gamma_i \left[\frac{(1-\lambda\gamma_i)}{Z_i}\right]^{(1-\lambda\gamma_i)/(\lambda\gamma_i)}.$$

Finally, the total output (GDP) for the economy Y is given by the CES aggregator function:

$$(11) \quad Y = \left(a_1 Y_1^{\rho} + a_2 Y_2^{\rho}\right)^{1/\rho}, \quad a_1, a_2 > 0 \text{ and } -\infty < \rho < 1,$$

where the elasticity of substitution between Y_1 and Y_2 is $1/(1 - \rho)$.[11] Notice that the shadow price of Y_i relative to the final output Y is:

$$(12) \quad SP_i = \frac{\partial Y}{\partial Y_i} = a_i \left(\frac{Y}{Y_i}\right)^{1-\rho},$$

and $Y = SP_1 \times Y_1 + SP_2 \times Y_2$ since (11) displays constant returns-to-scale. Under the assumption of full factor mobility, wage and rental rates will be equalized across the two

9. It is more common to assume that additions to capital stock are composed of the same commodity, but that capital in place cannot be consumed or transferred; this is referred to as a "putty-clay" assumption. As long as there is a positive net investment in both sectors, our economy will behave in the same way as the model with a putty-clay technology. Here, we choose to work with the assumption of transferable capital as it facilitates the exposition of our model.

10. This implies that price must be equal to average cost. In a one-sector version of this model, Devereux et al. (1996a; 1996b) obtained the same result under the free entry and exit assumption. By contrast, the measure of intermediate firms in Hornstein (1993) is fixed at one. Hence, zero profits can only exist at the steady state in his model.

11. When $\rho = 1$, GDP is simply the sum of sectoral outputs, i.e., $Y = Y_1 + Y_2$. In this case, there exists a generic corner solution in which only large firms will produce. This possibility is ruled out since it is not consistent with the empirical evidence.

sectors, $SP_1 \times w_1 = SP_2 \times w_2 = w$ and $SP_1 \times r_1 = SP_2 \times r_2 = r$. Moreover, using equations (5), (6), and (8), and the above equalities of factor prices, it is straightforward to show that both sectors exhibit identical capital to labor ratios, i.e., $K_1/L_1 = K_2/L_2$.

Households

The economy is populated by a unit measure of identical infinitely-lived households, each endowed with one unit of time, and maximizes a discounted sum of lifetime utility:

$$(13) \qquad \max \sum_{t=0}^{\infty} \beta^t \left[\log c_t - \frac{\phi \ell_t^{1+\chi}}{(1+\chi)} \right], \quad 0 < \beta < 1, \phi > 0,$$

where β is the discount factor, ϕ is a preference parameter, and χ denotes the inverse of the intertemporal elasticity of substitution in labor supply. In addition, c_t and ℓ_t represent the individual household's consumption and labor hours at time t, respectively. The budget constraint faced by the representative household is:

$$(14) \qquad c_t + k_{t+1} - (1-\delta)k_t = w_t \ell_t + r_t k_t, \quad k_0 \text{ is given},$$

where k_t is the household's capital stock, and $\delta \in [0, 1]$ denotes the capital depreciation rate. Households derive their income from supplying labor and capital services to intermediate firms, taking factor prices w_t and r_t as given. The first-order conditions for the household's optimization problem are

$$(15) \qquad \phi c_t \ell_t^{\chi} = w_t,$$

$$(16) \qquad \frac{1}{c_t} = \frac{\beta(1-\delta+r_{t+1})}{c_{t+1}},$$

and

$$(17) \qquad \lim_{t\to\infty} \frac{\beta^t k_{t+1}}{c_t} = 0,$$

where (15) is an intra-temporal condition that equates the household's marginal rate of substitution between consumption and leisure to the real wage rate. Equation (16) is the standard Euler equation for intertemporal consumption choices, and (17) is the transversality condition.

Perfect-Foresight Equilibrium

We focus on a symmetric perfect-foresight equilibrium in which producers of final and intermediate goods maximize profits, and households maximize utilities. The equilibrium is symmetric since all intermediate firms charge the same price, and produce the same amount of output within each sector. In equilibrium, the aggregate consistency condition requires

$$(18) \qquad c_t = C_t, \quad k_t = K_t, \text{ and } \ell_t = L_t,$$

where the upper-case letters represent economy-wide quantities. Moreover, the market-clearing conditions in the capital and labor markets are given by:

$$(19) \quad K_t = K_{1t} + K_{2t}, \text{ and } L_t = L_{1t} + L_{2t}.$$

Let μ_{Kt} and μ_{Lt} denote the fraction of aggregate capital stock and labor hours used in sector 1 at time t. Using the equalities of factor prices and capital to labor ratios across the two sectors, it can be shown that for all t,

$$(20) \qquad \mu_{Kt} = \mu_{Lt} = \frac{\eta^{\lambda/(1-\lambda)}}{1+\eta^{\lambda/(1-\lambda)}} \equiv \mu,$$

where

$$\eta = \frac{\gamma_2}{\gamma_1}\left[\frac{Z_1}{(1-\lambda\gamma_1)}\right]^{(1-\lambda\gamma_1)/(\lambda\gamma_1)} \times \left[\frac{Z_1}{(1-\lambda\gamma_2)}\right]^{(1-\lambda\gamma_2)/(\lambda\gamma_2)}.$$ [12]

Substituting (20) into (10) and (11) yields the following expression for total output of the economy:

$$(21) \qquad Y_t = A K_t^{\alpha/\lambda} L_t^{(1-\alpha)/\lambda},$$

where

$$A = \left[a_1 (A_1 \mu^{1/\lambda})^{\rho} + a_2 (A_2 (1-\mu)^{1/\lambda})^{\rho}\right]^{1/\rho}.$$ [13]

12. This result relies on the factor intensities being identical in the two sectors (the same parameter α appears in both technologies).

13. It can easily be shown that the necessary condition for the model to exhibit multiple equilibria is $(1-\alpha)/\lambda - 1 > \chi$, which says that the "aggregate" labor demand schedule slopes up and is steeper than the labor supply curve. This is exactly the same condition as in Benhabib and Farmer (1994) for a one-sector real business cycle model. In the following quantitative analysis, we restrict our discussion to the cases with a unique equilibrium.

In this article, we restrict our attention to the case where $\alpha < \lambda$, which implies that the economy does not exhibit sustained endogenous growth.[14]

Steady State

We derive the unique interior steady state for the model using the household's equilibrium conditions (14)–(16). The steady-state rental rate, hours worked, and capital stock are given by

$$(22) \qquad \bar{r} = \frac{1}{\beta} - (1-\delta), \quad \overline{L} = \left\{ \frac{(1-\alpha)\bar{r}}{[\phi(\bar{r} - \alpha\delta)]} \right\}^{1/(1+\chi)}, \quad \overline{K} = \left(\frac{\alpha A}{\bar{r}} \right)^{\lambda/(\lambda-\alpha)} \overline{L}^{(1-\alpha)/(\lambda-\alpha)}.$$

With equation (22), it is straightforward to obtain the steady-state total output, consumption, and wage rate:

$$(23) \quad \overline{Y} = A\overline{K}^{\alpha/\lambda}\overline{L}^{(1-\alpha)/\lambda}, \quad \overline{C} = \overline{Y} - \delta\overline{K},$$

and

$$\overline{w} = \frac{(1-\alpha)\overline{Y}}{\overline{L}}.$$

Moreover, the capital and labor inputs allocated to sector 1 at the steady state are

$$(24) \qquad \overline{K}_1 = \mu\overline{K} \quad \text{and} \quad \overline{L}_1 = \mu\overline{L}$$

and the steady-state number of firms, output, and shadow price in each sector are calculated using (9), (10), and (12).

III. MODEL CALIBRATION

To perform quantitative welfare experiments, we need to assign values to model parameters such that the steady-state values of key variables in the model match up with the long-run features of the U.S. economy.[15] These include that, for the post-Korean War U.S. data, the average annual capital to output ratio is equal to 2.54, investment as a share of output is 0.26, share of capital in total income is 0.36, the annual real rate of interest is close to 4%, and households devote approximately one-third of their productive time to market activity (see Prescott [1986]). Given the annual time-period in the model, we set the discount factor β to be 0.96 and the capital depreciation rate δ to be 0.10, both of which are commonly used in the real business cycle literature. Following King, Plosser, and Rebelo (1988), we choose the intertemporal elasticity of labor supply to be 4, which implies that $\chi = 0.25$. The preference parameter ϕ is set to be 3.85 so that the fraction of time each household spends on working is approximately one-third at the steady state. Finally, the parameter of capital share in national income α is chosen to be 0.36, the same as in Kydland and Prescott [1982].[16]

To get a fix on the parameter λ, we use the fact that $1/\lambda$ is equal to the markup ratio of price over marginal cost for which empirical evidence exists. Although there are several studies that measure the markup ratio, the estimates range in a wide spectrum. For example, Hall (1986) estimated the markup ratio to be above 1.4 for seventeen of his twenty-eight industries, whereas Domowitz, Hubbard, and Petersen (1988) estimated markups in the range of 1.4 to 1.7. On the other hand, Morrison (1990) reported estimates for markups (value-added based) ranging from 1.2 to 1.4 for sixteen out of her eighteen industries under consideration; Basu and Fernald (1994) estimated the same markup to be at most 1.2 in the U.S. manufacturing sector. Finally, the estimates of markups presented by Chirinko and Fazzari (1994) using firm-level manufacturing data lie between 1 and 1.45. Based on these studies, we choose a price-cost markup close to 1.1 ($\lambda = 0.91$) as the benchmark value, which is at the lower end of the empirically plausible range.[17]

14. This condition guarantees the existence of a steady state as it implies diminishing marginal product of capital. When α is equal to λ, the model will behave like an AK economy with sustained economic growth.

15. This procedure known as calibration has become popular in the general equilibrium macroeconomics literature since Kydland and Prescott (1982), and is described in details by Cooley and Prescott (1995).

16. Regardless of the degree of returns-to-scale in each sector, the capital share of sectoral income is given by α, that is, $rK_1/Y_1 = rK_2/Y_2 = \alpha$. Hence, the capital share of national income rK/Y is also equal to α.

17. Our welfare analysis presented in the next section is not sensitive to the choice of the baseline markup value. We obtain qualitatively similar results with markups between 1.03 and 1.7.

Sector-specific returns-to-scale parameters (γ_1 and γ_2) are chosen based on the estimates of Dhawan (1996), who has estimated the production structures for small and large firms from a large sample of publicly traded U.S. firms. He found that for most measures of firm size (asset- or employee-based), the degree of returns-to-scale is higher for large firms. Since his definition of capital is somewhat different from the one used in this paper, his estimates cannot be directly used here. However, the directional or relative value of returns-to-scale can be exploited to calibrate γ_1 and γ_2. We normalize the scale parameter for small firms γ_2 to 1, and set the scale parameter for large firms γ_1 to be 1.05. Notice that this parameterization ensures that $\lambda\gamma_i < 1$ in each sector, thus the profit maximization problem of intermediate firms is well defined.

Unlike previous studies such as Hornstein (1993), and Devereux, Head, and Lapham (1996a; 1996b), the fixed-cost parameters (Z_1 and Z_2) play an important role in our analysis since they directly determine the size and number of intermediate firms (see equations 7 and 9). As presented in Table 1, small firms on average account for 54% of output and employment, and more than 99% of existing firms in the U.S. economy during the 1958 to 1992 time period. We calibrate Z_1, Z_2, together with the three technology parameters a_1, a_2 and ρ such that (i) the steady-state values of our model match with these three ratios observed in the data, (ii) the wage and rental rates are equalized across the two sectors, and (iii) the CES aggregator function (11) is concave. Table 2 summaries the benchmark values of all model parameters and the resulting key steady-state ratios.[18]

TABLE 2
Benchmark Parameter Values and Key Steady-State Ratios

Parameter Values						Steady-State Ratios	
α	0.36	λ	0.91	a_1	0.92	$(SP_2 \times Y_2)/Y$	0.54
β	0.96	γ_1	1.05	a_2	0.94	L_2/L	0.54
δ	0.10	γ_2	1.00	ρ	0.896	M_2/M	0.99
χ	0.25	Z_1	203.89			C/Y	0.74
ϕ	3.85	Z_2	3.95			K/Y	2.54

IV. QUANTITATIVE RESULTS

In this section, we examine welfare consequences of the declining trend of small firms' relative contribution to U.S. output since 1958. To measure the welfare effects of each numerical experiment, we compute the increment to consumption (positive or negative) in each period that would equate household utility under different assumptions regarding the fixed-cost or markup parameters to the benchmark specification. We follow the procedure laid out in Cooley and Ohanian (1997) to account for the transition path. First, we derive the equilibrium decision rules for the economy with new parameter combinations. Second, we use the steady state under the baseline parameter values as the starting point, and iterate the decision rules forwards to the new steady state. Finally, the consumption increment x_i (for experiment i) is calculated from the following expression:

$$(25) \quad \overline{U} = \sum_{t=0}^{T} \beta^t \left[\log(C_{it} + x_i) - \frac{\phi L_{it}^{1+\chi}}{(1+\chi)} \right],$$

where $\overline{U}$ is the steady-state level of household utility in the baseline model, C_{it} and L_{it} are consumption and hours worked under the alternative parameterization i, and T is set to be 500.[19] Table 3 presents the effects of three numerical experiments, each of which generates a one percent change in the small firms' share of the steady-state total output.

The first experiment (Experiment #1) that we undertake is reducing the fixed costs for small firms Z_2 by 4.4 percent in order to examine the effects of a favorable technological improvement or the government tiering policy that have helped small firms. For example, the 1980 Regulatory Flexibility Act encouraged government agencies to minimize the disproportionate impact of regulatory requirements on small businesses.

18. Notice that the output share of small firms in our model is equal to the value of small firms' output ($SP_2^* Y_2$) divided by total output (Y), not just Y_2/Y. We thank an anonymous referee for pointing this out.

19. This makes β^T close to zero. The results reported in Table 3 remain virtually unchanged with $T = 100$ or 1,000 since the transition path does not last long. In all three experiments, 50% (half-life) of adjustment in capital stock is completed at the 5th period.

TABLE 3
Results of Three Numerical Experiments

	Experiment #1 Lower Z_2	**Experiment #2 Lower λ**	**Experiment #3 Higher λ**
Change in the steady-state value of the large firms' output $[SP_1 \times Y_1]$	2.84%	1.20%	−1.28%
Change in the steady-state value of the small firms' output $[SP_2 \times Y_2]$	−1.68%	−3.24%	3.31%
Change in the steady-state total output $[Y]$	0.40%	−1.20%	1.19%
Change in the small firms' share of the steady-state total output $[(SP_2 \times Y_2)/Y]$	−1.00%	−1.00%	1.00%
Change in the steady-state number of small firms $[M_2]$	2.58%	−1.61%	1.61%
Change in the proportion for the number of small firms $[M_2/M]$	0.00002%	−0.06%	0.05%
Change in the employment share of small firms $[L_2/L]$	−1.12%	−1.11%	1.13%
Welfare changes between steady states [including the transition path]	0.31%	−1.00%	0.97%

Moreover, as discussed in the introduction, this experiment also captures the spirit of technological advances that have lowered the firm size by reducing the need for fixed factors in setting up production. To better understand the workings of this experiment, we first consider the small-firm sector as a closed economy by itself. When the fixed-cost parameter Z_2 declines, the size of a small firm falls as the minimum efficient scale of production decreases (see equation 7). In this one-sector environment, this would augment the profits of an individual firm *ceteris paribus*. Under the assumption of free entry and exit, the total number of firms will increase (see equation 9), thereby generating a higher demand for labor and bidding up the wage rate. If this hypothetical economy has the same period utility function as in (13), then the income and substitution effects of this wage change will exactly balance out to make the steady-state labor hours a fixed constant.[20] Together with the fact that more firms are producing in the market, the labor input employed per firm will decrease. In addition, the rental rate for capital services stays unchanged because it is determined by condition (22) at the steady state, and none of the parameters (β and δ) has altered. Therefore, a higher wage rate in conjunction with a constant capital rental rate raise the steady-state relative factor price ratio, which in turn yields a higher capital to labor ratio. Since the aggregate labor hours are fixed, this will induce an increase in the aggregate capital stock to maintain equilibrium. Consequently, the economy's total output will also rise.

In the current model with two production sectors, the constancy of steady-state aggregate labor hours and capital rental rate will still hold. However, this framework leads to different results compared to those in the one-sector specification because of the competition for resources between the two sectors. When Z_2 declines, large firms can offer a higher wage rate than that offered by small firms, provided firms continue to operate at the same level of capital and labor inputs (see equation 5). Together with a constant aggregate labor supply, this implies that some workers will be hired away from small firms, hence L_2 falls. To maintain the equality of capital to labor ratios across the two sectors, K_2 also declines (see equation 19 where $\partial\mu/\partial Z_2 < 0$). Furthermore, more small firms will be created since the reduction in fixed costs raises their profitability. Since there are more firms with a lower level of capital stock

20. This period utility function is consistent with the balanced growth path which requires that hours worked cannot grow at the steady state. See King, Plosser, and Rebelo (1988).

and labor hours to use in sector 2, the per capita usage of both factors by small firms (K_2/M_2 and L_2/M_2) falls.[21]

To summarize, there are two opposing effects that occur when the fixed costs for small firms are reduced. The higher number of small firms contributes positively to the total small-firm output, whereas the lower size of each small firm works in the opposite direction. In our experiment, the second effect dominates. As a result, the net effect of a 4.4 percent reduction in Z_2 is a 1.68 percent decline in the value of small firms' output ($SP_2 \times Y_2$), and a 2.84 percent increase of the large-firm value ($SP_1 \times Y_1$). Consequently, the share of small firms in total output is reduced by one percent even though the combined output value of the two sectors (Y) has risen by 0.39 percent. On the other hand, the number of small firms (M_2) increases by 2.58% and their relative proportion (M_2/M) remains virtually unchanged. These features are consistent with the evidence shown in Table 1. However, the employment share of small firms (L_2/L) falls by 1.12% whereas there is no obvious trend observed in the data.[22] This result is due to the assumption of full factor mobility that leads to equalized wage and rental rates across the two sectors. By contrast, Brown and Medoff (1989) have presented evidence that large firms pay higher wages than small employers do to workers with the same level of observable skills. To account for this size-wage effect, these authors found some empirical support for the "labor quality" explanation whereby large firms employ higher-quality workers. Their finding suggests that in our theoretical model, allowing for differences in labor quality will yield wage differential in equilibrium. Therefore, workers in the small-firm sector need to acquire more skills (or human capital) before being hired by large firms. This reflects an adjustment cost for labor mobility, which will reduce the movement of L_2 in this experiment. Since the main focus of our analysis is on output shares, this is an interesting issue that we will leave to future research.[23]

With respect to the welfare effects, it turns out that Experiment #1 raises economic welfare by 0.31 percent of consumption each period in comparison with the baseline specification. The reasoning behind this result is straightforward. As described above, when Z_2 falls, the aggregate labor hours remain fixed while the aggregate capital stock rises at the new steady state. This will increase the total output and consumption along the transition path, thereby increasing the household utility.[24]

Experiment #2 shows that another mechanism, which also decreases the output contribution of small firms by one percent, is to increase the market power of intermediate firms, i.e., lowering the markup parameter λ to 0.9092. In this case, a higher level of monopoly power reduces the individual size and total number of small firms. As a result, the small firms' share in total output as well as the economy's total output both decrease, generating a welfare loss of 1.00 percent of consumption each period. Notice that although this experiment is capable of reproducing the empirical fact of a declining small-firm share of U.S. output, it is achieved by reducing the level of competition in the economy. This is counterfactual since the level of competition has been rising in U.S. rather than decreasing, due in large part to government deregulation policies (see Shephard [1982]).

21. The average number of workers employed by a small firm was 7.02 in 1958, 6.69 in 1963, 8.01 in 1967, 8.72 in 1972, 7.86 in 1977, 8.97 in 1982, 7.97 in 1987, and 7.83 in 1992. Hence the prediction of this experiment that L_2/M_2 falls is consistent with the declining trend of the data seen after 1982, although not with the overall cyclical pattern. Moreover, we are unable to compare our model with the evidence regarding K_2/M_2 since the data sources that make up Table 1 do not contain any capital stock series.

22. Specifically, this ratio first fell from 55.2% in 1958 to 53% in 1963, and stayed around that number throughout the 1970s. It rose sharply to 55.8% in 1982 and then fell again to 53% in 1992.

23. Although not reported in Table 3, the average labor productivity of both large and small firms ($SP_1 \times Y_1/L_1$ and $SP_2 \times Y_2/L_2$) increase in Experiment #1, which is consistent with the evidence described in footnote 2. However, the small-firm productivity grows at a faster rate than that of large firms, which is not consistent with the data. One way that may help match the model with this feature of the data is to incorporate the above-mentioned labor quality differential together with different exogenous productivity shocks into our analysis. We thank an anonymous referee for making this suggestion.

24. Another way to conduct the tiering experiment is to increase the fixed costs for large firms Z_1. When Z_1 is increased by 10 percent, the value of large firms' output rises by 2.08 percent and the value of small firms' output falls by 2.40 percent, resulting in a one percent reduction of the small-firm share of the steady-state total output. The welfare cost of this policy change is 0.29 percent of per-period consumption.

Not surprisingly, the above two experiments illustrate that lower fixed costs or a decline in the market power of individual firms will raise economic welfare since either change stimulates an increase in overall production. This is a result that is also valid in the one-sector framework studied by in Devereux, Head, and Lapham (1996a; 1996b). On the other hand, these experiments lead to a policy implication that is specific to our model with two production sectors whereby a lower fixed cost and more competition will generate opposite effect on the small firms' contribution to output. Therefore, if the policy goal is to simultaneously increase the share of small firms in national income and economic welfare, then as is shown in Experiment #1, reducing fixed costs for small firms alone cannot achieve these twin objectives. Instead, it is desirable to concentrate on anti-trust and deregulatory efforts that raise the level of competition in the economy. Experiment #3 considers this scenario in which the markup parameter λ is increased to 0.9108. In this case, the number of small firms rises by 1.61 percent, the small firms' share in total output increases by one percent, and the household welfare improves by 0.97 percent of consumption each period. Notice that this welfare gain is more than three times of that in Experiment #1, indicating that a very small reduction in the monopoly power leads to a relatively large gain in economic welfare. This implies that government anti-trust and deregulatory efforts are more effective than the tiering programs not only in terms of increasing economic welfare, but also in raising small firms' share in total output.

V. CONCLUSION

This article develops a dynamic, two-sector general equilibrium model to examine possible causes and welfare implications of the declining share of small firms in U.S. output since 1958. Our analysis suggests that the relative decline of fixed costs for small firms is a plausible explanation of this falling trend. In addition, such an outcome improves economic welfare measured by the household utility taking into account transitional dynamics over 500 periods. This implies that the economy responds optimally to the changing nature of technology and government actions such as the tiering policy. Our numerical experiments also highlight the tension between the twin objectives of increasing the small-firm share in national income and economic welfare simultaneously. This tension arises from the competition for capital and labor inputs between large and small firms. We find that the proper policy for achieving the goals of a greater output share of small firms and higher economic welfare is to put more emphasis on anti-trust and deregulatory efforts.

Finally, some qualifying remarks are in order regarding the limitations of our analysis. Although our model postulates free entry and exit to pin down the number firms in equilibrium, this assumption results in zero profit in the economy. This is equivalent to assuming that all firms dissolve at the end of each period and restart at the beginning of the next period. As a result, we are unable to examine the development of firm size over time. Moreover, our analysis does not include financial intermediation activity, an activity that has been shown to be fundamental in explaining the emergence and survival of small firms. In particular, small firms are bank dependent and unlike their large counterparts, suffer from borrowing constraints (see Fazzari, Hubbard, and Peterson [1988]; Whited [1992]; Martinelli [1997]). Incorporating these dynamic features into a framework with endogenously determined number and size of firms may well qualify the nature of our results. We plan to pursue this project in the near future.

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