Employment and Output Effects of Federal Regulations on Small Business*

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Abstract

This paper examines the disparate impact of U.S. federal regulations on small businesses. Using a two-sector dynamic general equilibrium model, we obtain two implications of higher regulation on small firms that have yet to be empirically tested by the literature. First, as regulations increase, small firms' share of employment shrinks. Second, as regulations rise, small firms' share of total output falls. Using a panel of industry-specific US regulatory restrictions, we find that a ten percent increase in federal regulations is associated with an approximate 0.8% reduction in small firms' share of industry employment and a nearly 1.5% decline in small firms' share of industry output.

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1. Introduction

It is well known that tracing the economic impact of federal regulations on households and firms is a difficult and contentious task. Well-designed regulations may enhance social welfare by reducing negative externalities and/or correcting market failures, while poorly conceived regulations ("red tape") may yield few if any benefits. Nonetheless, business regulations impose additional compliance costs on firms. For example, Dawson and Seater (2013) report that between 1949 and 2011, federal regulations resulted in an accumulated loss of goods and services totaling $38.8 trillion. Of additional concern, there is strong reason to suspect that these high costs have disproportionately burdened smaller firms, despite the enactment of federal laws that promote partial or complete small business exemptions (*e.g.* the Regulatory Flexibility Act of 1980 and the Small Business Regulatory Enforcement Fairness Act of 1996). Crain and Crain (2014) estimate that small businesses (with fewer than 50 employees) faced average compliance costs of $11,724 per employee as compared to $9,083 for large businesses (with more than 100 employees).[1]

Given the importance of small business as a source of economic dynamism, innovation, job growth and social mobility, it is surprising that few academic studies have investigated the outsized impact of regulations on these critically important businesses. Moreover, previous research that has examined this topic is primarily empirical, typically lacking formal theoretical models to motivate its regression specifications or results. Therefore, our paper seeks to partially fill this gap in the literature by analyzing a two-sector dynamic general equilibrium model that generates empirically testable predictions regarding the disparate impact of federal regulations on small and large firms. Consistent with our model, this paper presents empirical evidence that higher regulations reduce both small firms' share of employment and output within the U.S. economy.

Although it has been long understood that economies of scales in regulatory compliance costs may give larger firms an advantage over their smaller competitors, a lack of industry-specific regulation data has hampered the empirical examination of this topic. Early research either relied on crude proxies for the level of federal regulation like page counts in the *Code of Federal Regulations* (CFR) (see for example Dawson and Seater [2013]); or on potentially

[1] See Dixon *et al.* (2006) and Keefe *et al.* (2005) for discussions regarding the mixed track record of small business regulatory exemptions, the cost and complexity involved in obtaining an exemption, and the irregular standards used by regulators to define a qualifying "small business."

biased feedback from surveys sent to small business owners, as noted by Kitching *et al.* (2015). Fortunately, we are able to empirically test the effects of regulations on small businesses by utilizing a relatively new database called RegData, which was constructed using machine learning algorithms that mined the CFR for language consistent with regulations and probabilistically matched these regulations with the NAICS-coded industries to which they most likely apply (see McLaughlin and Sherouse [2017] for details). Indeed, several recent studies have used RegData to examine the general impact of federal regulations on entrepreneurship, with conflicting results. Bailey and Thomas (2017) find that greater industry-specific regulations are associated with a reduction in the entry of new firms, with the greatest impact affecting smaller firms. Similarly, Chambers *et al.* (2018) find that an increase in industry-specific regulations is associated with a reduction in both the number and employment of small firms, whereas large firms (with 500 or more employees) are unaffected. Gutierrez and Philippon (2019) demonstrate that lobbying and regulations are largely responsible for the decline in the elasticity of entry with repect to Tobin's Q, and that regulations have reduced both the entry and growth of small firms relative to their larger competitors. In a notable departure from the above-mentioned papers, Goldschlag and Tabarrok (2018) modify their dependent variables (new firm formation and hiring) by way of the Davis-Haltiwanger-Schuh (DHS) transformation, which is claimed to be a more robust measure of dynamism.[2] The resulting regression models, despite utilizing a right-hand-side structure very similar to Bailey and Thomas (2017) and Chambers *et al.* (2018) and the same underlying data sources (*i.e.* RegData and the Census of U.S. Business), fail to find a statistically significant association between federal regulations and the transformed measures of new firm formation or hiring. This lack of consensus, which may result from differences in the regression models' dependent variables, underscores the need for a theory to generate testable empirical hypotheses, which in turn may provide guidance for appropriate empirical specifications.

The analytical framework that forms the basis for our empirical work is Dhawan and Guo's (2001) dynamic general equilibrium macroeconomic model with two production sectors which are made up of large and small firms, respectively. The two sectors differ from each other with regard to the level of fixed set-up costs and returns-to-scale in their production functions. Each sector has an intermediate-good segment in which monopolistically

[2] For more details on the DHS transformation, see Davis *et al.* (1998).

competitive firms operate with fully mobile capital and labor inputs. The number of these intermediate-input firms is determined endogenously through 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. This parsimonious structure is motivated by the observation that both large and small firms exist side by side within many industries, while practically producing the same commodity.

In a calibrated version of the above model economy that matches the long-run features of the post Korean-War U.S. data, Dhawan and Guo (2001) show that at the model's steady state, an increase in government regulations will yield the following empirically testable implications: 1) the total number of small firms is reduced, 2) the employment share of small firms shrinks, and 3) small firms' share of total output declines. As discussed earlier, the first outcome has already been thoroughly studied by Bailey and Thomas (2017), Chambers *et al.* (2018), Gutierrez and Philippon (2019), and Goldschlag and Tabarrok (2018). However, the model's latter two predictions have not been empirically evaluated in the literature. Therefore, our empirical analysis tests for a reduction in both small firms' share of employment and output in response to higher federal regulations. With regard to both predictions, we find strong evidence in favor of our theoretical model. Specifically, we find that a ten percent increase in federal regulations reduces the employment share of small firms by approximately 0.8%, and that an equally large increase in federal regulations decreases the output share of small firms by nearly 1.5%.

The remainder of this paper is organized as follows. Section 2 presents the model economy and analyzes its equilibrium conditions. Section 3 describes our empirical models and discusses the estimation results. Section 4 concludes.

2. The Model

This section sketches the two-sector dynamic general equilibrium macroeconomic model developed by Dhawan and Guo (2001). The economy is inhabited by a unit measure of identical infinitely-lived households, together with two types of heterogeneous firms under increasing returns and monopolistic competition. In particular, large and small firms produce the same final good using technologies that exhibit identical factor intensities, but they are subject to different fixed set-up costs and returns-to-scale in production.

2.1 Firms

The macroeconomy's production side 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 will be suppressed for notational convenience in this subsection. The final good in each sector Y_i is produced from combining a continuum of intermediate inputs X_{ij}, $j \in [0, M_i]$, with the following constant returns-to-scale technology: $Y_i = \left[\int_0^{M_i} X_{ij}^{\lambda} dj\right]^{\frac{1}{\lambda}}$, $0 < \lambda < 1$, where M_i represents the endogenously determined measure of intermediate inputs that are utilized 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 j'th intermediate input relative to the final good in sector i. The final-good producers' profit maximization condition yields the demand function: $X_{ij} = \left(P_{ij}\right)^{\frac{1}{\lambda-1}} Y_i$, where the price elasticity of demand is $\frac{1}{1-\lambda}$. This in turn implies that $\frac{1}{\lambda} > 1$ is equal to the markup ratio of price over marginal cost which also characterizes the degree of market power for intermediate-good producers. It follows that our model economy will become more/less competitive when the monopolistic-markup parameter λ rises/falls. Since the deregulatory policies are primarily intended to raise the level of competition within an industry or a macroeconomy,[3] a higher(lower) value of λ can be interpreted as a decrease(an increase) in government regulations.

Each intermediate good is produced by a monopolist, who implements a production function that allows for increasing returns-to-scale:

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

where K_{ij} and L_{ij} are capital and labor inputs employed by the j'th intermediate-input producer in sector i. In addition, Z_i represents a constant amount of intermediate goods that must be expended in sector i as fixed costs for setting up production facilities before any sale is made. The presence of such costs implies that the intermediate-good technology (1) exhibits

[3] The breakup of AT&T in 1984, and the repeal of the 1930 Glass Steagall Act that separated brokerage/equity activities from banking are two notable examples. See Shepherd (1982, Table 4) for a partial list of U.S. deregulatory actions and their timing.

increasing returns in production. Next, in accordance with empirical findings, reported by Mills and Schumann's (1985) and Feigenbaum and Karnani (1991), that small/large firms are more/less flexible in handling market fluctuations since they rely more on variable/fixed factors of production, it is postulated that $Z_1 > Z_2$. On the other hand, additional increasing returns-to-scale will be present in (1) when $\gamma_i > 1$ because of rising marginal productivities. We also note that from a large sample of publicly traded U.S. firms, Dhawan (1996) finds that the degree of returns-to-scale in production is higher for large firms; therefore $\gamma_1 > \gamma_2$ is imposed.

Under the assumption that factor markets are perfectly competitive within each sector, the first-order conditions for intermediate-input firm j's profit maximization problem are given by

$$(2) \qquad w_i = \frac{(1-\alpha)\lambda\gamma_i(X_{ij}+Z_i)P_{ij}}{L_{ij}} \text{ and } r_i = \frac{\alpha\lambda\gamma_i(X_{ij}+Z_i)P_{ij}}{K_{ij}},$$

where w_i is the real wage rate and r_i be the real rental rate of capital in sector i. For analytical simplicity, we further postulate that (i) both capital and labor inputs are fully mobile across the two production sectors; and that (ii) firms can enter and exit the intermediate-good segment of each sector freely, hence they will not make any profit. Using this zero-profit condition and equation (2) yields the equilibrium size of intermediate firm j: $X_{ij} = \frac{\lambda\gamma_i}{1-\lambda\gamma_i} Z_i$, where $0 < \lambda\gamma_i < 1$. In what follows, our analysis is restricted to a symmetric equilibrium at which all intermediate-good produces make the same decisions within each sector:

$$P_{ij} = P_i,\ X_{ij} = X_i,\ K_{ij} = \frac{K_i}{M_i}, \text{ and } L_{ij} = \frac{L_i}{M_i}, \text{ for all } j \in [0, M_i],$$

where K_i and L_i represent the total capital stock and labor hours employed in sector i. It is then straightforward to show that the equilibrium number of intermediate-good producers in sector i is given by

$$(3) \qquad M_i = K_i^{\alpha} L_i^{1-\alpha} \left(\frac{1-\lambda\gamma_i}{Z_i} \right)^{\frac{1}{\gamma_i}},$$

where $M \equiv M_1 + M_2$; and that the sectoral production function for the final good is

$$(4) \qquad Y_i = M_i^{\frac{1}{\lambda}} X_i = A_i K_i^{\frac{\alpha}{\lambda}} L_i^{\frac{1-\alpha}{\lambda}}, \text{ where } A_i = \lambda\gamma_i \left(\frac{1-\lambda\gamma_i}{Z_i} \right)^{\frac{1-\lambda\gamma_i}{\lambda\gamma_i}}.$$

Finally, the total output (GDP) for the economy Y is generated through the following aggregator function:

(5) $$Y = \left[\phi_1 Y_1^{\rho} + \phi_2 Y_2^{\rho}\right]^{\frac{1}{\rho}},\ \phi_1,\ \phi_2 > 0 \text{ and } -\infty < \rho < 1,$$

where the elasticity of substitution between Y_1 and Y_2 is a constant that equals $\frac{1}{1-\rho}$.[4] It follows that the shadow price of Y_i relative to the aggregate output Y is given by $SP_i = \frac{\partial Y}{\partial Y_i} = \phi_i \left(\frac{Y}{Y_i}\right)^{1-\rho}$; and that $Y = SP_1*Y_1 + SP_2*Y_2$ because (5) displays constant returns-to-scale. Under the assumption of full factor mobility, wage and rental rates will be equalized across the two sectors: $SP_1*w_1 = SP_2*w_2 = w$ and $SP_1*r_1 = SP_2*r_2 = r$.

2.2 Households

The economy is also 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:

(6) $$\sum_{t=0}^{\infty} \beta^t \left[\log C_t - B\frac{L_t^{1+\chi}}{1+\chi}\right],\ 0 < \beta < 1,\ B > 0,\ \chi \geq 0,$$

where β is the discount factor, B 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 are the representative household's consumption and labor hours at time t, respectively. The budget constraint that it faces is given by

(7) $$C_t + K_{t+1} - (1-\delta)K_t = w_t L_t + r_t K_t,\ K_0 > 0 \text{ given},$$

where K_t is the household's capital stock, and $\delta \in (0,1)$ denotes the capital depreciation rate. The first-order conditions for the household's dynamic optimization problem are:

(8) $$BC_t L_t^{\chi} = w_t,$$

(9) $$\frac{1}{C_t} = \frac{\beta}{C_{t+1}}\left[1 - \delta + r_{t+1}\right],$$

(10) $$\lim_{t\to\infty} \beta^t \frac{K_{t+1}}{C_t} = 0,$$

[4] 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.

where (8) is an intra-temporal condition that equates the household's marginal rate of substitution between consumption and leisure to the real wage rate; equation (9) is the standard Euler equation for intertemporal consumption choices; and (10) is the transversality condition.

2.3 Symmetric Equilibrium and Steady State

We focus on the model's symmetric equilibrium in which producers of final and intermediate goods maximize profits; households maximize utilities; and the market-clearing conditions in capital and labor markets will hold: $K_t = K_{1t} + K_{2t}$ and $L_t = L_{1t} + L_{2t}$. It can be shown that the equilibrium fractions of aggregate capital stock and labor hours used in sector 1, denoted as μ_{Kt} and μ_{Lt}, are equal to the same constant for all t,

$$(11) \qquad \mu_{Kt} = \mu_{Lt} = \frac{\eta^{\frac{\lambda}{1-\lambda}}}{1+\eta^{\frac{\lambda}{1-\lambda}}} \equiv \mu, \text{ where } \eta = \frac{\gamma_2}{\gamma_1}\left(\frac{Z_1}{1-\lambda\gamma_1}\right)^{\frac{1-\lambda\gamma_1}{\lambda\gamma_1}}\left(\frac{1-\lambda\gamma_2}{Z_2}\right)^{\frac{1-\lambda\gamma_2}{\lambda\gamma_2}}.$$

Substituting (11) into (4) and (5) yields that the total output of the economy is given by

$$(12) \qquad Y_t = AK_t^{\frac{\alpha}{\lambda}} L_t^{\frac{1-\alpha}{\lambda}}, \text{ where } A = \left\{\phi_1\left[A_1\mu^{\frac{1}{\lambda}}\right]^{\rho} + \phi_2\left[A_2(1-\mu)^{\frac{1}{\lambda}}\right]^{\rho}\right\}^{\frac{1}{\rho}},$$

where $\alpha < \lambda$ to rule out the possibility of sustained endogenous growth.

Next, using the model's equilibrium conditions, it is straightforward to show that there exists a unique interior steady state at which the real rental rate, hours worked, and capital stock (expressed as bar variables) are

$$(13) \qquad \overline{r} = \frac{1}{\beta} - (1-\delta), \quad \overline{L} = \left[\frac{(1-\alpha)\overline{r}}{B(\overline{r}-\alpha\delta)}\right]^{\frac{1}{1+\chi}}, \quad \text{and} \quad \overline{K} = \left(\frac{\overline{r}}{\alpha A}\right)^{\frac{\lambda}{\alpha-\lambda}} \overline{L}^{\frac{1-\alpha}{\lambda-\alpha}}.$$

With equation (13), the corresponding steady-state expressions of all remaining endogenous variables can be easily derived.

3. Empirical Results

In a calibrated version of the above model economy that matches the long-run features of the post Korean-War U.S. data, Dhawan and Guo (2001; Table 3, Experiment #2) show that increased government regulations, represented by lowering the markup-ratio parameter λ, will result in three empirically testable outcomes on the model's steady state: 1) the total number of small firms $\overline{M}_2$ falls; 2) the employment share of small firms $\frac{\overline{L}_2}{\overline{L}}$ shrinks; and 3) the output share of small firms $\frac{\overline{SP}_2 * \overline{Y}_2}{\overline{Y}}$ declines.[5] Intuitively, a higher level of monopoly power decreases the individual size and total number of small firms (X_2 and M_2). As a result, the employment as well as the output shares of small firms will fall.

As previously mentioned, the first empirical outcome has been extensively investigated by Bailey and Thomas (2017), Chambers *et al.* (2018), Goldschlag and Tabarrok (2018), and Gutierrez and Philippon (2019), with the bulk of these papers finding empirical evidence that regulations reduce the number of small firms. Therefore, this paper focuses on the remaining two testable implications from our dynamic general equilibrium model described in section 2. Using regression equations similar to Bailey and Thomas (2017) and Chambers *et al.* (2018) to model the response to higher federal regulations, section 3.2 tests for a reduction in small firms' share of employment while section 3.3. tests for a reduction in small firms' share of output. However, before discussing these empirical results, we provide a brief description of the data.

3.1 Data

Using the Census Bureau's Census of U.S. Business (SUSB), we derive small firms' share of US domestic employment and output for each 5-digit NAICS code industry from data on total employment and gross receipts by firm size.[6] The resulting unbalanced employment share panel spans over 18 years (1998-2015) and 248 industries, yielding 3,846 observations.[7] Unfortunately, the monetary value of small firm output is only available during Economic Census years (*i.e.* years ending in 2 or 7), which limits the output share panel to three time periods: 2002, 2007 and 2012.

Using 5-digit NAICS codes, these small business data are matched with the Mercatus

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[5] We have managed to derive the associated analytical expressions, but found that their signs are theoretically ambiguous. For example, the impact of changing λ on the steady-state employment share of small firms is given by $\frac{\partial\left(\frac{\overline{L}_2}{\overline{L}}\right)}{\partial\lambda} = \frac{-\mu\log\left\{\eta\left[\left(\frac{Z_1}{1-\lambda\gamma_1}\right)^{\frac{1}{\gamma_1}}\left(\frac{1-\lambda\gamma_2}{Z_2}\right)^{\frac{1}{\gamma_2}}\right]^{\frac{\lambda-1}{\lambda}}\right\}}{(1-\lambda)^2\left(1+\eta^{\frac{\lambda}{1-\lambda}}\right)}$, whose sign is indeterminate.

[6] Following the U.S. Small Business Administration, we classify firms with 500 or more employees as large businesses and firms with fewer employees as small businesses.

[7] The majority of industries (148) have a full 18 observations, with another 82 industries having between 10 and 17 observations each. The remaining 18 industries each have fewer than 10 observations.

Center's RegData 3.0 database, which reports the number of U.S. federal regulatory restrictions that apply to each NAICS coded industry. To construct RegData, computers are used to search the U.S. *Code of Federal Regulations*, which is the consolidated repository of all U.S. federal regulations, for words signifying a regulatory obligation, such as *shall, must, may not, prohibited* and *required*, among others.[8] Each occurrence of a regulatory obligation is then weighted by the probability that it applies to each of the 5-digit NAICS coded industries covered by RegData. To estimate these industry-specific probabilities, the Mercatus Center employs natural language processing (NLP) machine learning algorithms that are trained using federal regulatory documents (*e.g.* the *Federal Register*, a guidance document) known to pertain to particular industries. These probability weighted obligations are then summed for each industry to derive a "regulatory restriction" measure for each industry in a given year (see McLaughlin and Sherouse [2017] for details).

Finally, as a robustness exercise, we include two additional covariates which measure U.S. business cycles: the unemployment rate and the GDP gap. The unemployment rate is taken from the St. Louis Federal Reserve's FRED II database. The GDP gap (expressed as a percentage of full-employment output) is derived by way of a Hodrick-Prescott (HP) filter using real GDP data from the St. Louis Federal Reserve's FRED II database.[9] Summary statistics for all of the data series are reported in Table 1.

To explore any underlying trends in the data, Figure 1 provides a time series plot of mean industry-specific regulatory restrictions from 1998 to 2015. Clearly, regulations grew steadily over this period, nearly doubling in magnitude. By contrast, Figure 2, which plots the mean share of small business employment, exhibits cyclical variation and generally trends lower after peaking in 2003. Finally, Figure 3 reveals that the mean industry output share of small businesses declined in each time period for which data are available. While the above evidence is anecdotal, it is consistent with the prediction of our theoretical model, whereby rising regulations coincide with declining small business employment and output shares. To examine the cross-sectional patterns in our panel, we turn to Figures 4 and 5.

Figure 4 provides scatter plots of the natural log of small firms' share of US domestic

[8] For example, Chapter 29, Part 1926, Section 416(a)(3) of the CFR contains one regulatory obligation: "Before work is begun the employer *shall* ascertain by inquiry or direct observation, or by instruments, whether any part of an energized power circuit, exposed or concealed, is so located that the performance of the work may bring any person, tool, or machine into physical or electrical contact with the power circuit."

[9] The H-P filter's smoothing parameter was set to 6.25.

employment by industry, against the natural log of regulations by industry. For each annual cross section (2002, 2007, 2012) and the pooled dataset (1998-2015), there is a clear negative correlation between small firms' share of industry employment and industry-specific regulation.[10] The inclusion of box and whisker plots adjacent to each axis reveals two additional insights. First, the variance of both the regulation and employment share series appear to be very stable over time. Second, outliers do not appear to drive the negative correlation between employment shares and regulations. Figure 5 provides scatter plots of the natural log of small firms' share of output by industry against the natural log of regulations by industry. The findings are very similar to those gleaned from Figure 4. Specifically, there is a clear negative correlation between small firms' share of industry output and industry-specific regulation that does not appear to be driven by outliers, and the variance of the output share series is very stable.

3.2 Employment Share of Small Firms

To test whether the employment share of small firms shrinks in response to rising regulation, we estimate the fixed effects panel model of Bailey and Thomas (2017), replacing their dependent variable (small firms' births and deaths) with the natural log of the employment share of small firms:[11]

$$\text{employment}_{it} = \alpha_i + \delta_t + \beta \cdot \text{reg}_{it} + u_{it}, \tag{14}$$

where employment_{it} is the natural log of the share of total industry i's employment by small firms in year t, α_i is the industry fixed effect, δ_t is a period fixed effect, reg_{it} is the natural log of total federal regulatory restrictions applicable to industry i in year t, and u_{it} is a mean zero error term. The industry fixed effects capture any differences in average employment shares of small firms across industries, while the period fixed effects capture common shocks to employment shares across industries, including business cycles and changes in government policy (which may be correlated with variation in industry-level regulations). Given the double-log specification of the model, the coefficient on industry regulations can be interpreted as an

[10] The cross-section years (2002, 2007, and 2012) were chosen to match the three available time periods from the small firms' output share panel, which is limited to Economic Census years (*i.e.* years that end in 2 or 7).
[11] Bailey and Thomas (2017) conduct extensive identification and robustness testing which strongly supports this regression model specification – *i.e.* the log dependent variable regressed on time and industry fixed effects and the log of regulations, hence we adopt it as our baseline model for testing purposes.

elasticity measure. Estimates of Equation (14) are provided in Table 2.

In our preferred specification (see column 1 of Table 2), the regulation coefficient is negative and statistically significant at the 1% level, implying that a one percent increase in federal regulations reduces the employment share of small firms by just over 0.08%. While this coefficient may seem small in magnitude, it implies that a 10% increase in federal regulations reduces the employment share of small firms within an affected industry by more than 0.8%. Given that nearly 59 million workers were employed by U.S. small businesses in 2015, the volume of affected workers is quite large.[12] Overall, the goodness of fit of this model is quite high, explaining 96% of the variation in the employment share of small firms. To demonstrate the robustness of these results, columns 2 through 4 of Table 2 provide estimation results of variants of Equation (14). In column 2, the period effects, which could be correlated with changes in federal policy embodied in regulatory statutes, are removed. The resulting regulation coefficient is very similar in value (-0.0684) and retains its 1% level of statistical significance, strongly suggesting that unobserved common shocks (which includes common macroeconomic conditions) are uncorrelated with the regulation series, as their omission would otherwise bias the regulation coefficient. In column 3, we follow Chambers *et al.* (2018) and replace the period fixed effects with direct measures of the business cycle. The coefficient on unemployment is positive and statistically significant at the 1% level, albeit economically insignificant with a coefficient value of 0.0108. In other words, a one percentage-point increase in the unemployment rate (*e.g.* an increase from 4% to 5% unemployment) increases the employment share of small firms by just over 0.01%. On the other hand, the GDP gap turns out to be statistically insignificant. Overall, the magnitude of the estimated regulation coefficient increases slightly (-0.1003), implying that a 1% increase in federal regulations reduces the employment share of small firms by just over 0.10%. Finally, column 4 eliminates both industry and time period fixed effects. The regulation coefficient is nearly identical to that of column 3, in which the period fixed effects are replaced by the business cycle covariates. Taken together, these results imply that (i) most of the variation in the employment share panel is cross sectional (not temporal); (ii) omitted variable bias does not appear to be a pressing problem; and (iii) increasing regulation exerts a negative and statistically significant impact on

[12] Based on SUSB data, Chambers *et al.* (2018) reports that 58,938,147 workers were employed by firms with fewer than 500 employees in 2015.

the employment share of small firms.

3.3 Output Share of Small Firms

To assess the final implication of our model, namely that greater federal regulations reduce the output share of small firms, we estimate a log-log fixed effects model very similar to Bailey and Thomas (2017):

$$(15) \qquad \text{output}_{it} = \alpha_i + \delta_t + \beta \cdot \text{reg}_{it} + u_{it},$$

where output_{it} is the natural log of the share of total industry i's output produced by small firms in year t, α_i is the industry fixed effect, δ_t is a period fixed effect, reg_{it} is the natural log of total federal regulatory restrictions applicable to industry i in year t, and u_{it} is a mean zero error term. The industry fixed effects capture any differences in average output shares of small firms across industries, while period fixed effects capture common shocks to output shares across industries. As with Equation (14), the coefficient on industry regulations has an elasticity interpretation. The estimates of Equation (15) are provided in Table 3.

In our preferred specification (see column 1 of Table 3), the regulation coefficient is negative and statistically significant at the 5% level, implying that a ten percent increase in federal regulations reduces the output share of small firms by nearly 1.5%.[13] As with the employment share regression, higher regulations appear to benefit large firms at the expense of their smaller competitors. The goodness of fit of this simple model is also quite high, explaining nearly 97% of the variation in share of small firm output. To verify the robustness of these results, we employ the same estimation strategy used in Section 3.2, and find that the results are similar to those from the employment share model, namely: (i) most of the variation in the output share panel is cross sectional (not temporal); (ii) our model does not suffer from any omitted variable bias; and (iii) increasing regulation has a negative and statistically significant impact on the output share of small firms.

In column 2, the period effects, which could be correlated with changes in federal policy embodied in regulatory statutes, are removed. The resulting regulation coefficient retains its 5% level of statistical significance and negative sign, declining slightly in magnitude to -0.0992. This implies that a ten percent increase in industry-specific federal regulations

[13] Due to the limited number of time periods (3), we cannot estimate robust standard errors clustered by time period. Instead, we report ordinary standard errors.

reduces small firms' share of output by just less than 1%. In column 3, we replace the period fixed effects with direct measures of the business cycle. Although both business cycle covariates are statistically insignificant, the regulation coefficient is identical in magnitude to our preferred specification in column 1. This strongly suggests that the period effects are capturing business cycle variations; but given the unchanging goodness of fit across columns 1 to 3, the business cycle plays no role in driving changes in small firms' output shares over time. Finally, column 4 eliminates both industry and time period fixed effects. The regulation coefficient is nearly identical to that of column 2, in which the period fixed effects are omitted.

4. Conclusion

In the context of a two-sector dynamic general equilibrium macroeconomic model developed by Dhawan and Guo (2001), we obtain three empirically testable hypotheses regarding the disparate impact of higher federal regulations on small and large firms: 1) a reduction in the total number of small firms, 2) the employment share of small firms shrinks, and 3) small firms' share of total output declines. Utilizing the relatively new RegData database, the first of these implications has already been confirmed by Bailey and Thomas (2017) and Chambers *et al.* (2018), while this paper is the first (to our knowledge) to provide empirical evidence in support of the latter two implications. Specifically, we find that a ten percent increase in federal regulations reduces the employment share of small firms by just over 0.8%, and an equally large increase in federal regulations (10%) reduces the output share of small firms by nearly 1.5%. Although these effects may seem small on the margin, these impacts are economically significant due to the sheer number of small businesses in the U.S. In addition, each regulation may operate like tossing an individually small pebble into a running stream, the cumulative long-run impact of many pebbles may dam the river. Therefore, when policy makers consider drafting new government regulations, they should exercise caution and carefully weigh any estimated benefits against the costs borne disproportionately by small businesses.

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Table 1 – Summary Statistics

Variables	Minimum	Maximum	Mean	Standard Deviation	Observations
Employment Share of Small Business (% of industry)	0.004	99.922	45.760	26.921	3,846
Output Share of Small Business (% of industry)	0.222	99.794	39.790	26.912	561
Regulations (industry-specific regulatory restrictions)	192	83,335	9,516	16,407	3,846
Unemployment (%)	4.0	9.8	6.2	1.8	18
GDP Gap (% full output)	-2.42	1.90	0.07	1.11	18

Notes: Small business employment and output shares derived from Census Bureau's SUSB dataset. Regulatory restrictions from Mercatus Center's RegData 3.0. Unemployment rate is from the St. Louis Federal Reserve (FRED II database). GDP Gap derived from annual real GDP data obtained from the St. Louis Federal Reserve (FRED II database).
All series span the period 1998 to 2015 except the output share of small business, which covers three time period (2002, 2007, 2012). Industries measured at the 5-digit NAICS code level.

Table 2 – Employment Share Panel Estimates

Variables	(1)	(2)	(3)	(4)
Log Regulations	-0.0803***	-0.0684***	-0.1003***	-0.1042***
	(0.0176)	(0.0249)	(0.0193)	(0.0046)
Unemployment	---	---	0.0108***	---
			(0.0014)	
GDP Gap	---	---	0.0053	---
			(0.0038)	
Industry Fixed Effects?	Yes	Yes	Yes	No
Time Period Fixed Effects?	Yes	No	No	No
Observations	3,846	3,846	3,846	3,846
Overall R^2	0.960	0.959	0.959	0.024

Notes: 1) Dependent variable is the natural log of the share of total 5-digit NAICS industry employment by small firms in a given year. Log Regulations equal the natural log of regulatory restrictions from RegData 3.0.

2) Intercept included but not reported

3) White robust standard errors clustered by time period in parenthesis

4) ***, **, and * denote 1%, 5%, and 10% statistical significance

Table 3 – Output Share Panel Estimates

Variables	**(1)**	**(2)**	**(3)**	**(4)**
Log Regulations	-0.1494**	-0.0992**	-0.1494**	-0.0966***
	(0.0675)	(0.0443)	(0.0675)	(0.0277)
Unemployment	---	---	0.0096	---
			(0.0095)	
GDP Gap	---	---	0.0065	---
			(0.0093)	
Industry Fixed Effects?	Yes	Yes	Yes	No
Time Period Fixed Effects?	Yes	No	No	No
Observations	561	561	561	561
Overall R^2	0.968	0.968	0.968	0.021

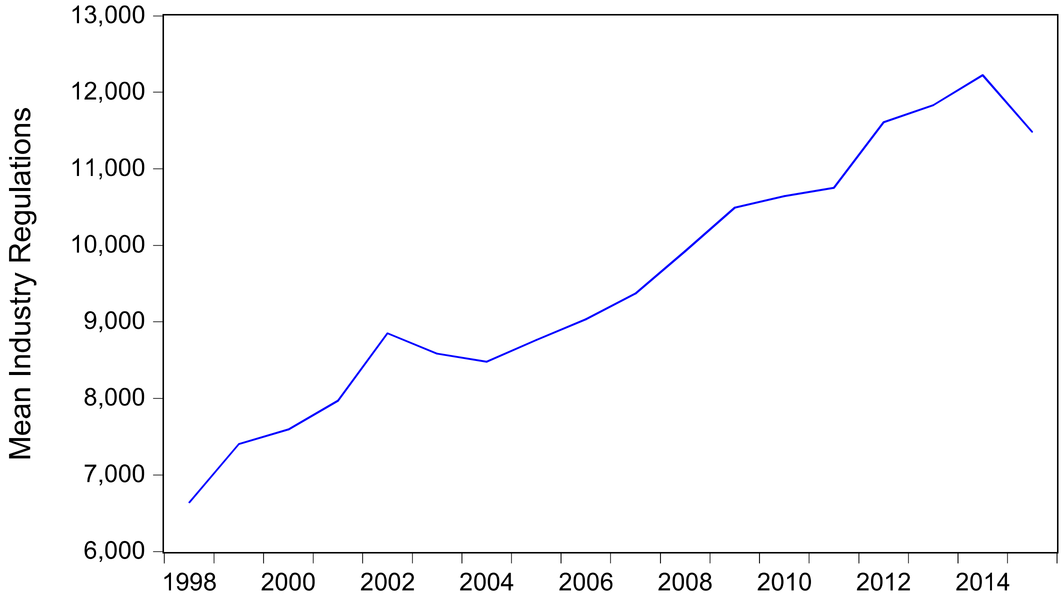
Notes: 1) Dependent variable is the natural log of the share of total 5-digit NAICS industry output produced by small firms in a given year. Log Regulations equal the natural log of regulatory restrictions from RegData 3.0.

2) Intercept included but not reported

3) Standard errors in parenthesis

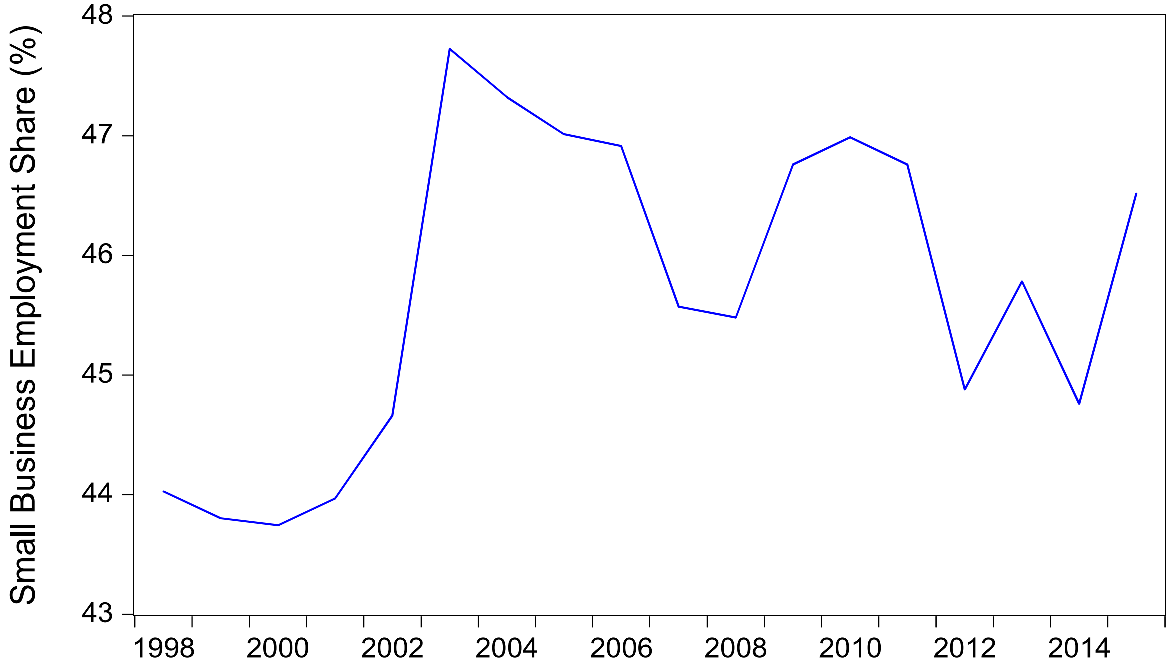
4) ***, **, and * denote 1%, 5%, and 10% statistical significance

Figure 1 – Mean Industry-Specific Regulatory Restrictions



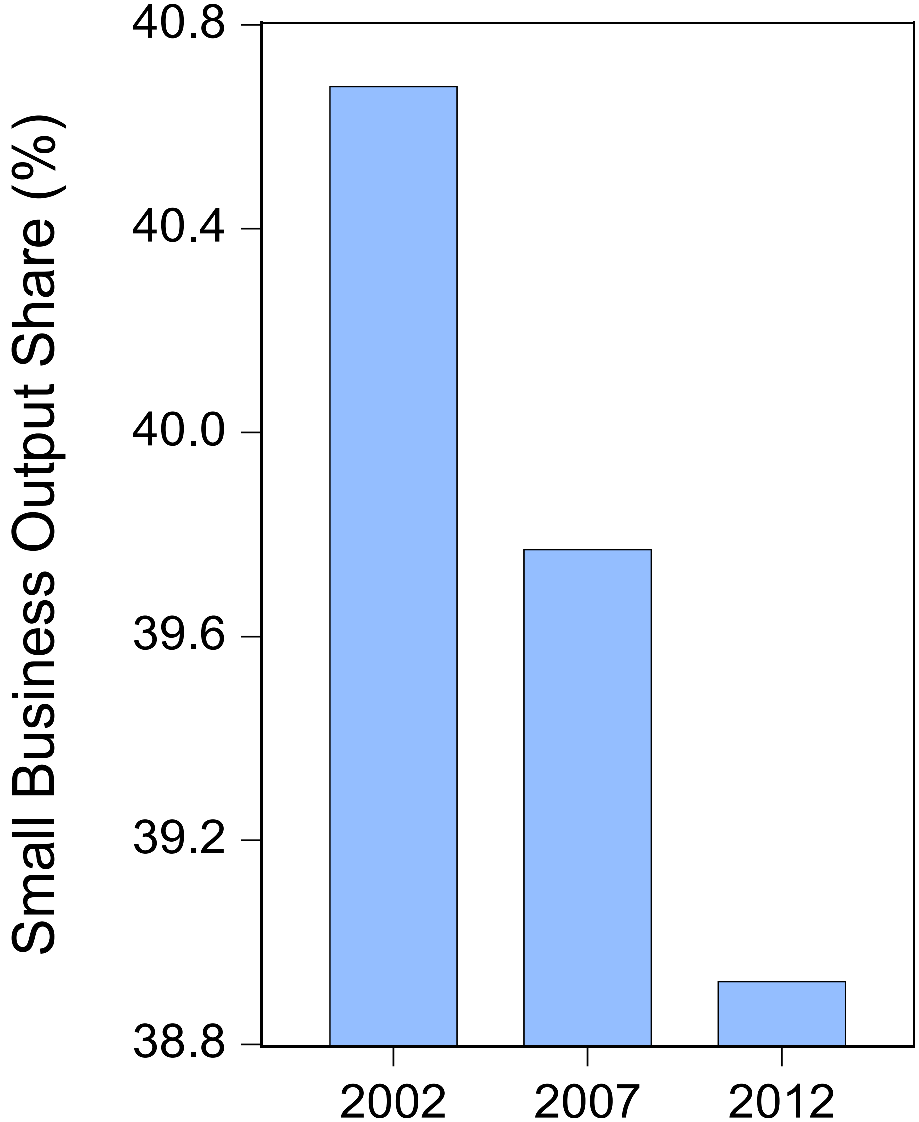
Notes: Industry-specific regulations equal regulatory restrictions at the 5-digit NAICS level from Mercatus Center's RegData 3.0 dataset.

Figure 2 – Mean Share of Industry-Specific Small Business Employment



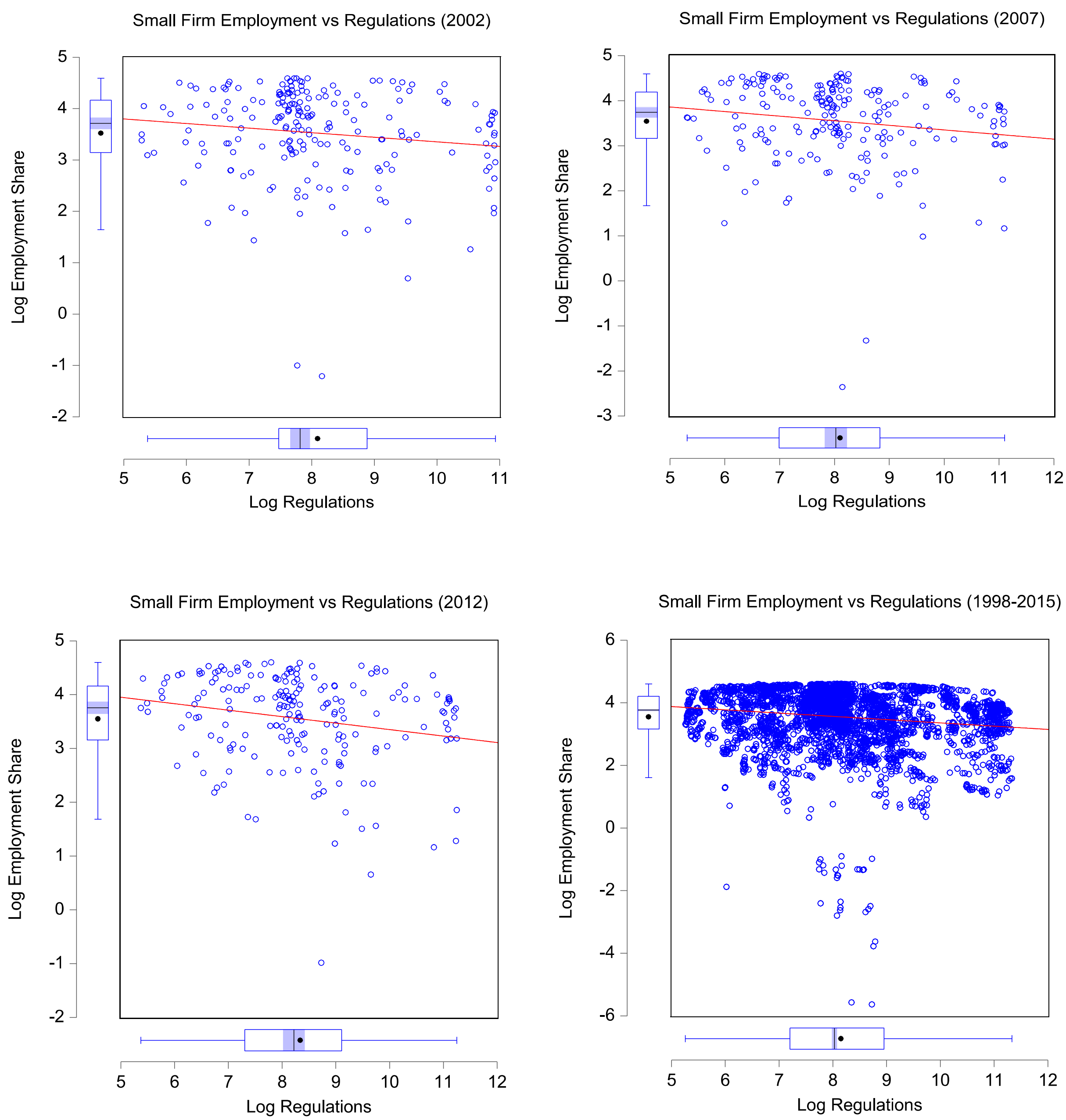
Notes: Small business employment shares derived from Census Bureau's SUSB dataset.

Figure 3 – Mean Share of Industry-Specific Small Business Output



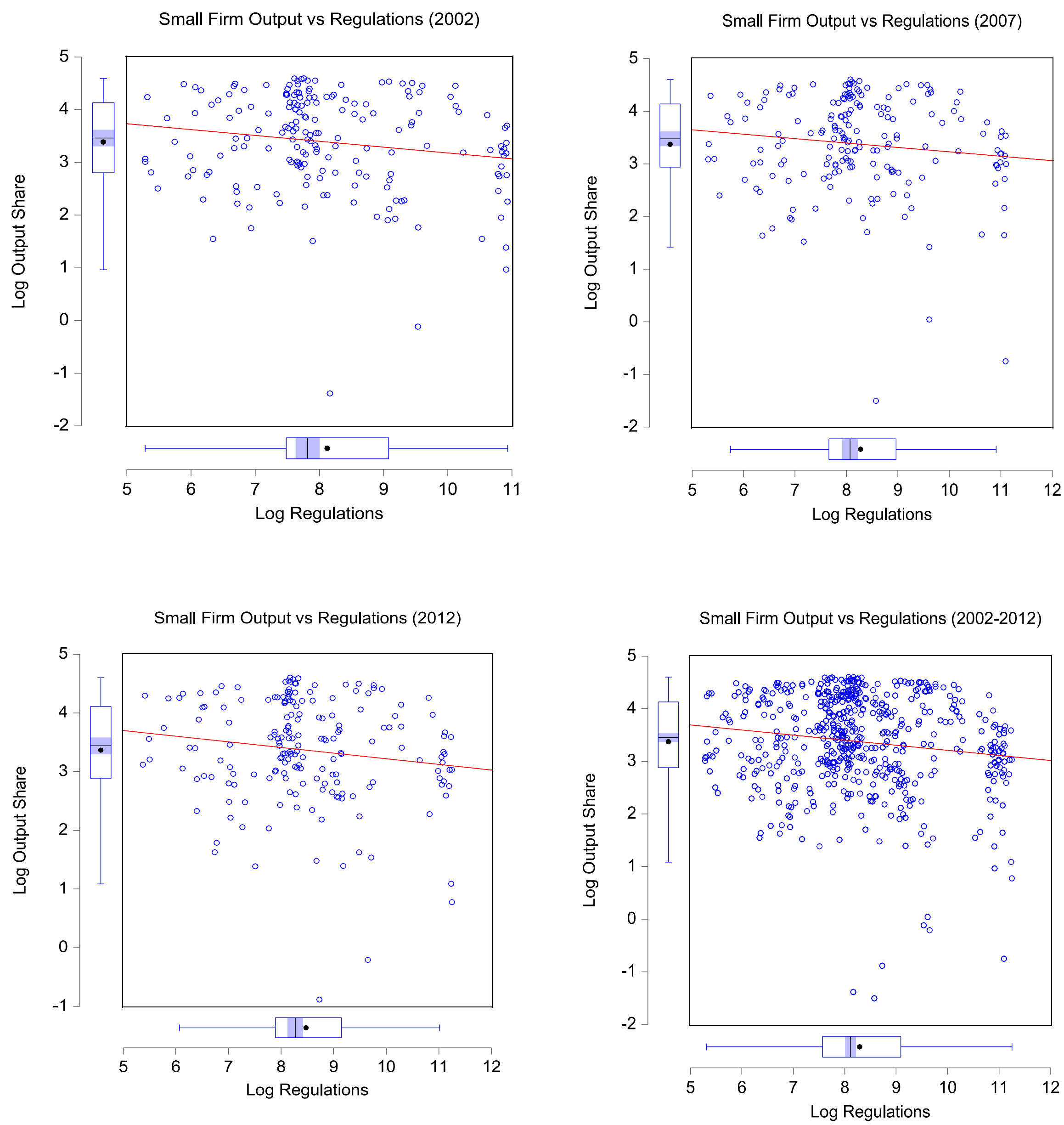
Notes: Small business output shares derived from Census Bureau's SUSB dataset. Data only available for Economic Census years (2002, 2007, 2012).

Figure 4 – Small Firm Industry Employment Shares versus Industry Regulation



Notes: 1) In each plot, the vertical axis is the natural log of the share of total 5-digit NAICS industry employment by small firms in a given year, while the horizontal axis is the natural log of regulatory restrictions.
2) The box and whisker plot adjacent to each axis reveal the distribution of the data plotted along said axis. The box spans the inner quartile range (IQR) (*i.e.* first through third quartile or middle 50% of sample data), while the vertical line and point within each box represent the median and mean of the data respectively. The whisker and staples span the range of data within 1.5IQR below the first and above the third quartile.

Figure 5 – Small Firm Industry Output Shares versus Industry Regulation



Notes: 1) In each plot, the vertical axis is the natural log of the share of total 5-digit NAICS industry output produced by small firms in a given year, while the horizontal axis is the natural log of regulatory restrictions.
2) The box and whisker plot adjacent to each axis reveal the distribution of the data plotted along said axis. The box spans the inner quartile range (IQR) (*i.e.* first through third quartile or middle 50% of sample data), while the vertical line and point within each box represent the median and mean of the data respectively. The whisker and staples span the range of data within 1.5IQR below the first and above the third quartile.