Figure 19: Left: Box plots for the average growth rates based on simulations for the technology policy with different values of μ. Right: The estimated Generalized Additive Model of the same data.

A Model setup and Parameter Setting

Table 1 shows the benchmark parametrization used for the simulations throughout the paper. Table 2 shows the set up of the model with respect to the number of agents used in the simulations. Note that for consumption goods firms Table 2 shows the initial number of firms as the actual number of firms varies over time due to endogenous firm exit and random firm entry. In addition to the number of agents, the table reports the general skill distribution of households and the general skill specific speeds of the adjustment of specific skills.

B Correlation Structure between the Business Cycle and other Macro Variables

Table 3 describes for some important macro economic time series the correlation with the time series of output. The time series are filtered by applying the HP filter with $\lambda = 1600$ and for the computation of the correlation coefficients we use the cyclical component of the HP filtered time series. The time units are quarters, i.e. we consider here leads and lags of at most four quarters.

C Statistical Analysis with Generalized Additive Models

Generalized Additive Models with penalized splines have been employed to evaluate the policy experiments statistically. There are basically three applications of GAMs in the paper:

1. In the policy experiments we considered variations of a policy intensity parameter μ within ranges between 0 and a maximum μ_{max}. Here, $\mu = 0$ represents the case in which no policy is applied. In order to show how a variation of μ changes the behavior of the model, we conducted simulations of the model in which we stepwise increased parameter μ. For each value of μ, we executed 48 batch runs and determined for each run the business cycle volatility and the average growth rate. As a result, we obtained 48 pairs of observations for business cycle volatility and growth for each value of μ. In order to measure the effect of μ on the two indicator variables, we estimated a GAM

Symbol	Name	Value
κ	Consumption adjustment	0.025
δ	Capital depreciation rate	0.01
χ^S	Service level expected demand	0.7
γ^C	Intensity of consumer choice	12.0
ρ	Discount rate	0.02
Δq^{inv}	Technological progress	0.05
T^{Ex}	Maximum deferral period	24
σ^V	Demand volatility	0.1
T^{LT}	Investment planning horizon	60
N^I	Number of steps in investment rule	40
N^I	Investment step size	0.2
σ_D^2	Expected variance	0.1
T^{Loan}	Debt repayment period	18
ω	Debt rescaling factor	0.50
r^c	ECB base rate	0.03
mr^c	ECB rate markdown deposit rate	0.1
d^f	Dividend payout ratio	0.70
$\bar{d}$	Threshold full dividends (firms)	0.5
α^b	Basel capital requirement	10.0
β^b	Min. cash reserve ratio	0.10
h^{FB}	Firm birth hazard rate	0.01
s^F	Initial equity for start ups	4.0
φ	Wage update	0.01
ψ	Wage reservation update	0.01
ϱ^{up}	Upper bound firing	0.1
γ^{gen}	Logit parameter general skills	0.5
u	Unemployment benefit pct	0.55
bs	Minimum level of benefits	0.33
T^G	Backward horizon for tax adjustment	72

Table 1: Parametrization of the model.

that is described by

$$g = g_0 + s(\mu). \tag{20}$$

In this expression, g is the response variable (business cycle volatility or growth rate) that is assumed to be distributed following some exponential family distribution, the policy intensity μ is the covariate of the statistical model and g_0 is a parametric intercept. The term $s(\mu)$ is an unknown smooth function that depends on covariate

Symbol	Name	Value
Agents		
	Households	1600
	Firms (initially)	80
	Investment good producers	1
	Banks	2
	Central Bank	1
	Government	1
General skill distribution		
$b_h^{gen} = 1$	Low-skilled workers	50%
$b_h^{gen} = 2$	High-skilled workers	50%
Specific skill adaptation speed		
$\chi(b_h^{gen} = 1)$	Speed for low-skilled workers	0.0125
$\chi(b_h^{gen} = 2)$	Speed for high-skilled workers	0.03703

Table 2: Set-up of the model.

μ. Figure 19 illustrates how the single observations for the growth rate under the technology policy are translated into predictions of the GAM.

2. For some variables such as aggregate output, it is of particular interest how the policy effect evolves over time. Therefore, one has to study the effect of μ on the evolution of time series data. In order to estimate this effect statistically, we set up a statistical model in which the policy effect is statistically co-explained by a second covariate, namely time t; to account for both explanatory variables, we specified a GAM, in which the smooth term jointly depends on t (in quarters) and μ. Technically speaking, since isotropic smooth terms of the sort of $s(t, \mu)$ are only good choices when covariates are on the same scale, which is not the case for μ and t, we opt for tensor product smooth terms to explain the joint effect of policy intensity and time (see Wood, 2006). The GAM is then described by

$$g = g_0 + te(t, \mu). \tag{21}$$

In Section **??**, we illustrated the evolution of policy effects with means of heat maps in which the color code indicates the strength of the policy effect estimated from the Spline model with time (at x axis) and the intensity parameter μ (at y axis) as predictor variables. The strength of the effect is thereby determined relative to to

	t-4	t-3	t-2	t-1	0	t+1	t+2	t+3	t+4
Output	0.337	0.492	0.639	0.841	1.000	0.841	0.639	0.492	0.337
Consumption	0.601	0.641	0.669	0.705	0.679	0.458	0.226	0.024	-0.191
Investments	-0.300	-0.204	-0.278	-0.292	0.178	0.349	0.281	0.244	0.371
Unemployment	-0.297	-0.453	-0.609	-0.810	-0.962	-0.801	-0.625	-0.485	-0.340
Vacancies	0.291	0.444	0.594	0.770	0.880	0.821	0.671	0.527	0.367
Firm Productivity	0.522	0.437	0.366	0.374	0.333	0.151	-0.025	-0.157	-0.240
Price	-0.540	-0.362	-0.144	0.068	0.267	0.464	0.631	0.731	0.768
Real Wage	0.693	0.725	0.736	0.738	0.691	0.471	0.232	0.018	-0.191
Total Credit	-0.327	-0.147	0.063	0.369	0.681	0.741	0.716	0.728	0.712
Firm Leverage Ratio	-0.445	-0.275	-0.065	0.234	0.546	0.651	0.674	0.711	0.717
Mark ups	-0.377	-0.515	-0.615	-0.739	-0.820	-0.686	-0.507	-0.347	-0.189

Table 3: Cross-correlations of the cyclical components of some important macro time series with the cyclical component of output, led k periods (other columns)

baseline scenario without policy. In particular, it is determined by

$$g^{eff} = \frac{g_0 + te(t,\mu)}{g_0 + te(t,\mu = 0)}. \tag{22}$$

The GAMs have been estimated with the statistic software R (R Core Team, 2014) using the function *gam()* from the mgcv package (see, e.g., Wood, 2011).