A Post–Keynesian Policy Model

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Abstract: This paper discusses a Post–Keynesian policy model of income, production, and trade. The one–country, one–sector model features Kaleckian investment demand, Kaldorian productivity and a labor market module based on a wage–price spiral. The model is first presented for a closed economy with exogenous real wages; second, for a closed economy with endogenous real wages; third, for an economy open to trade with endogenous real wages. Simulations of a variety of macroeconomic shocks to two different baseline calibrations (one profit–led, one wage–led) show key characteristics of the model. Monte Carlo exercises of coefficients over reasonable parameter ranges shed some light on lingering questions about the effectiveness of wage policies in closed and open economies.

1 Introduction

This paper attempts to further our understanding of a Post–Keynesian macroeconomic model of the real side by (1) endogenizing wages and prices in a framework similar to those in Naastepad (2006) and Rada and Taylor (2006), and (2) investigating model sensitivity to different parameter regimes using Monte Carlo analysis. The latter is aimed at the debate in Post–Keynesian research regarding the nature of the demand regime as either profit–led or wage–led, and consequences therefrom for distributive policies.

The discussion rests on two strands of literature. First, the Neo–Kaleckian literature on interactions between the rate of capacity utilization and the distribution of income, see Rowthorn (1982), Dutt (1984), Taylor (1985), Bhaduri and Marglin (1990), Lavoie (1995). In a nutshell, growth must be wage–led in the 'stagnationist' Kaleckian model, and can be profit–led in the 'exhilirationist' version, if the positive response of investment demand to profitability outweighs the negative response of consumption demand, via the the multiplier. The distribution of income is fully determined by the degree of monopoly, and a shock to the mark–up leads to a decrease in rates of profit and utilization—the paradox of costs—if demand is wage–led, and to an increase in rates of profit and utilization if demand is profit–led. Second, a cornerstone of Kaldorian growth models is the Kaldor–Verdoorn law, see Kaldor (1978), Thirlwall (1983) as well as contributions in McCombie et al. (2003). In a nutshell, the Kaldor–Verdoorn law determines labor productivity growth as a function of demand growth. Naastepad (2006) and Rada and Taylor (2006) employ productivity rules of the Kaldor–Verdoorn type to endogenize productivity in models with Kaleckian investment. In these models, nominal wage rate and prices remain exogenous. The wage share then must fall over an expansion, unless it is assumed that real wage growth matches productivity growth.

How does such a Kalecki–Kaldor model behave with endogenous nominal wages and endogenous prices? How does trade affect such a model? These are the two questions posed, and in the following sections I

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present a Kalecki–Kaldor model of a closed economy, then include a wage curve and mark–up equation, and lastly open the economy to trade.

Before taking off, though, a couple of comments on scope and methodology are in order. First, both the Kaleckian and Kaldorian models are called *growth* models. However, there is some controversy about the rate of capacity utilization as a long run adjusting variable. Similarly, the Kaldor–Verdoorn law in a demand–driven context might be better suited to the short run. Here, the model(s) presented will be interpreted in the short run, and, correspondingly, the capital stock is taken as fixed. Second, the model combines goods and labor market, but does not take financial stock variables into consideration. That is not to deny their importance, but for the sake of simplicity. Obviously, applicability of the model to current events is then limited, but the paper is mainly theoretical, rather than empirical. Third, the model is static, and therefore cannot be compared to cyclical models, which can describe short run dynamics and long run growth around an unstable equilibrium with stationary state variables. (The seminal reference here is Goodwin (1967), and, i.e., Barbosa-Filho and Taylor (2007) present a recent example. This literature informs our discussion, but clearly has a different scope.) Lastly, the model is presented in growth rates, which simplifies analysis, and enables detailed comparative static exercises.

2 A Kalecki–Kaldor model of a closed economy

The model of this section is a closed economy version of Naastepad (2006) and Rada and Taylor (2006), Section 7. The focus of the former is to introduce a real wage effect on productivity, arguing that firms substitute away from labor with rising costs for the latter, thus inducing technical change. The result is that effectice demand can turn wage–led, and wage restraint can lead to stagnation as well as a slowdown in productivity growth. The focus of the latter (with regard to this model) is to discuss the implications of shocks and policies for employment generation. In both papers, real wage growth is exogenous. An exogenous real wage implies a rising profit share, unless it is assumed that real wage growth matches that of labor productivity. In the model of the next section real wage growth is endogenous, but it might be helpful to review this model as is.

The model—closed economy, one sector, no government—can be summarized in the following five relationships:

$$\hat{I} = \hat{I}_0 - \rho\hat{\psi} + \beta\hat{u} \text{ with } \rho = (\psi/\pi)\alpha \tag{2.1}$$

$$\hat{s} = -\sigma\hat{\psi} = -(s_\pi - s_\psi)(\psi/s)\hat{\psi} \tag{2.2}$$

$$\hat{\xi} = \hat{\xi}_0 + \delta\hat{V} \tag{2.3}$$

$$\hat{V} = \hat{I} - \hat{s} \tag{2.4}$$

$$\hat{L} = \hat{V} - \hat{\xi}, \tag{2.5}$$

where *hats* denote growth rates. I is investment, I_0 represents autonomous investment or 'animal spirits', ψ represents real unit labor costs—the wage share—and V real GDP. $0 < \alpha < 1$ is the elasticity of investment demand with respect to the profit share, and $0 < \beta < 1$ the elasticity of investment demand with respect to aggregate demand. In levels, the function can be written as $I = I_0(1-\psi)^\alpha u^\beta$, so that the function is a Kaleckian investment function with profit share and the rate of capacity utilization as independent arguments, in order to allow for profit–led demand (Bhaduri and Marglin (1990)). In other words, the standard Kaleckian investment function implies that the paradox of costs always applies, whereas the version in $\pi = (1-\psi)$ and $u = V/K$ with $\hat{K} = 0$ in the short run used here does not.

s is the aggregate saving propensity, and follows from the accounting identity that saving out of wage income plus saving out of profit income sum to total saving. $\sigma > 0$ is the elasticity of saving with respect to the wage share, so that the saving propensity always falls with a redistribution of income towards wage earners.

ξ is average labor productivity, and is determined by a Kaldor–Verdoorn Law. Kaldor based his insight on the pioneering work of Verdoorn (1949), and expounded on it in Kaldor (1978). He argued that labor productivity increases with the expansion of manufacturing as (1) manufacturing allows for the exploitation of increasing returns (Young (1928), Arrow (1962)), and (2) labor from less productive sectors with diminishing returns is transferred to modern activities. The literature on the topic is extensive, and generally finds strong support for a positive link between demand growth and productivity growth. $0 < \delta < 1$ is the Kaldor–Verdoorn elasticity.

Value added V is determined from the demand side, and employment L follows given a *changing* labor input coefficient $1/\xi$. Strictly speaking, only I and ξ are determined by behavioral functions. Closure assumptions—output is demand–determined and labor supply does not constrain the economy—complete the model.

2.1 Steady state

The two equations of the model in productivity growth/demand growth–space are

$$\hat{\xi}_{ED} = \frac{\hat{\omega}(\sigma-\rho) + \hat{I}_0}{\sigma-\rho} - \frac{1-\beta}{\sigma-\rho}\hat{V}, \text{ and} \tag{2.6}$$

$$\hat{\xi}_P = \hat{\xi}_0 + \delta\hat{V}, \tag{2.7}$$

where $\hat{\xi}_{ED}$ is the *effective demand*–curve, and $\hat{\xi}_P$ represents a Kaldor–Verdoorn *productivity* schedule. Demand is profit–led if $\sigma - \rho < 0$, i.e. if the (leakage) elasticity of saving is smaller than the (injection) elasticity of investment, both with respect to real unit labor costs. The steady state solutions

$$\hat{\xi}^* = \frac{\delta\hat{I}_0 + (1-\beta)\hat{\xi}_0 + (\sigma-\rho)\delta\hat{\omega}}{1-\beta+(\sigma-\rho)\delta}, \text{ and} \tag{2.8}$$

$$\hat{V}^* = \frac{\hat{I}_0 + (\sigma-\rho)(\hat{\omega} - \hat{\xi}_0)}{1-\beta+(\sigma-\rho)\delta} \tag{2.9}$$

show that growth, as typical for models with this structure (Thirlwall (1979), McCombie and Thirlwall (2004)), depends on trend growth rates, here of investment $\hat{I}_0$, productivity $\hat{\xi}_0$, and of real wages $\hat{w}_0$, and the relevant elasticities.

The steady state is economically meaningful if $1 - \beta + (\sigma-\rho)\delta > 0$, meaning either

$$\delta > -\frac{1-\beta}{\sigma-\rho} \text{ if demand is wage–led, } (\sigma-\rho > 0, \textbf{WL}), \text{ or} \tag{2.10}$$

$$\delta < -\frac{1-\beta}{\sigma-\rho} \text{ if demand is profit–led, } (\sigma-\rho < 0, \textbf{PL}). \tag{2.11}$$

Since the model is static, it is not straighforward to talk about stability. The equivalent to the condition above in the one–dimensional Keynesian model is seen as a stability condition, since output adjustment is presumed to be fast. However, without explicit distributive dynamics stability can not be formally established. For the remainder of the paper, I will use the steady state's denominator—the two curves's slopes—to exclude configurations that are meaningless. Hence, assuming the appropriate trend growth rates the steady state exists, and is is always economically meaningful, if demand is wage–led, $\sigma - \rho > 0$. Additionally, the steady state is economically meaningful if the demand growth schedule cuts the productivity growth schedule from below, and demand is profit–led, $\sigma - \rho < 0$.

2.2 Induced technical change

If productivity growth speeds up with higher real wage growth, the productivity rule is

$$\hat{\xi} = \hat{\xi}_0 + \gamma\hat{\omega} + \delta\hat{V}, \tag{2.12}$$

and the steady state becomes

$$\hat{\xi}^* = \frac{\delta\hat{I}_0 + (1-\beta)\hat{\xi}_0 + ((1-\beta)\gamma + (\sigma-\rho)\delta)\hat{\omega}}{1-\beta+(\sigma-\rho)\delta} \tag{2.13}$$

$$\hat{x}^* = \frac{\hat{I}_0 + (\sigma-\rho)((1-\gamma)\hat{\omega} - \hat{\xi}_0)}{1-\beta+(\sigma-\rho)\delta} \tag{2.14}$$

meaning $\gamma > 1$ reverses the sign of real wage growth on steady state output growth, given the demand regime $\sigma - \rho$. For the remainder of this paper, I will stick to a Kaldor–Verdoorn productivity rule without induced technical change, primarily because it does save some complexity.

3 A Kalecki–Kaldor model of a closed economy with wage and price setting

The model is the same as above plus wage curve and mark–up price:

$$\hat{w} = \hat{w}_0 + w_1(\hat{L} - n) \tag{3.1}$$

$$\hat{Q} = \hat{q}_0 + q_1(\hat{w} - \hat{\xi}), \tag{3.2}$$

where w is the nominal wage, and Q the price, marked–up on nominal unit labor cost. The wage curve (Blanchflower and Oswald (1990, 1995))implies that the wage level w rises with the rate of employment, L/N, given bargaining strength of workers summarized in the elasticity $w_1 > 0$. n represents the growth rate of the labor force N.

3.1 Price, real wage and distribution

Let us start with a couple of comments on the price Q. First, it is labelled such because further below I introduce the price P of output, which differs from the price Q of value added in an open economy. Second, Q rises with nominal unit labor costs $w/\xi = wL/V$, given the mark–up elasticity $0 < q_1 < 1$. As elaborated on a little furter below, the equation for Q implies an endogenous mark–up. The standard formulation, i.e. $Q = (1+\tau)w/\xi$, with a fixed mark–up, fixes the profit share at $\pi = \tau/(1+\tau)$, which would defeat the purpose of determining the distribution of income endogenously. First, though, let us have a closer look at inflation and the real wage. Inflation can be derived from the mark–up equation, which, after substituting the wage curve and the Kaldor–Verdoorn relationship, becomes

$$\hat{Q} = \overline{\eta} + q_1\psi_1\hat{V}, \tag{3.3}$$

with the parameters

$$\begin{aligned} \overline{\eta} &= \hat{q}_0 + q_1\overline{q}, \\ \overline{q} &= \hat{w}_0 - (1+w_1)\hat{\xi}_0 - w_1 n, \text{ and} \\ \psi_1 &= w_1 - (1+w_1)\delta. \end{aligned}$$

and partials

$$\frac{\partial\hat{Q}}{\partial\hat{q}_0} > 0,\ \frac{\partial\hat{Q}}{\partial\hat{w}_0} > 0,\ \frac{\partial\hat{Q}}{\partial\hat{\xi}_0} < 0,\ \frac{\partial\hat{Q}}{\partial n} < 0.$$

The parameter ψ_1 deserves close attention. Since $0 < q_1 < 1$, the sign of $\partial\hat{Q}/\partial\hat{V} = q_1\psi_1$ varies with ψ_1. Prices rise with activity ($\psi_1 > 0$) if $w_1/(1+w_1) > \delta$, and vice versa. Pricing behavior depends on bargaining power of workers (w_1) and the strength of productivity gains (δ); the implicit assumption is that the firms do not have sufficient pricing power in product markets to retain earnings generated due to unit cost savings.

The real wage is $\hat{\omega} = \hat{w} - \hat{Q}$, which becomes

$$\begin{aligned} \hat{\omega} &= \overline{w} + (w_1(1-\delta) - q_1\psi_1)\hat{V}, \text{ with} \\ \overline{w} &= \hat{w}_0 - w_1(\hat{\xi}_0 + n) - \overline{\eta}. \end{aligned} \tag{3.4}$$

If $\psi_1 < 0$, $\partial\hat{\omega}/\partial\hat{V} > 0$, but the total effect will not be much larger than $w_1(1-\delta)\hat{V}$, since both q_1 and ψ_1 are likely to be small. On the other hand, if $\psi_1 > 0$, $\partial\hat{\omega}/\partial\hat{V} > 0$ as well, since $w_1 > -\frac{\delta q_1}{(1-q_1)(1-\delta)}$. Pro–cyclical real wages are build into the model, but prices can be (weakly) counter–cyclical.

Next, the distributive curve $\hat{\psi} = \hat{w} - \hat{Q} - \hat{\xi}$ is

$$\begin{aligned} \hat{\psi} &= \overline{\psi} + (1-q_1)\psi_1\hat{V}, \text{ with} \\ \overline{\psi} &= -\hat{q}_0 + (1-q_1)\overline{q}. \end{aligned} \tag{3.5}$$

$\partial\hat{\psi}/\partial\hat{V} > 0$ if $\psi_1 > 0$, and distributive adjustment exhibits a profit squeeze (**PS**), since real unit labor costs rise with activity; whereas $\partial\hat{\psi}/\partial\hat{V} < 0$ if $\psi_1 < 0$, and distributive adjustment exhibits 'forced saving' (**FS**), since productivity growth outruns real wage growth, and the profit share rises. Such forced saving in combination with the Kaleckian demand specification is not equivalent to macroeconomic adjustment with forced saving under full employment. The latter implies that at or near full employment the cycle turns following price increases, which diminish real wealth and in turn consumption as asset holders desire to replenish their savings. In this case the economy still operates below full capacity, and forced saving refers to a rising profit share due to productivity growth in excess of real wage growth.

Now, let us consider the mark–up τ mentioned above. The price equation Q implies that τ is endogenous. Since $Q = (1+\tau)w/\xi$ at any point in time must hold, $\tau = q_0(w/\xi)^{q_1-1} - 1$, and log–differentiation gives

$$\hat{\tau} = \frac{1}{\pi}\left[\hat{q}_0 - (1-q_1)\overline{q} - (1-q_1)\psi_1\hat{V}\right], \tag{3.6}$$

which implies that $\partial\hat{\tau}/\partial\hat{V} > 0$ if $\psi < 0$, and vice versa. Since $\psi = 1/(1+\tau)$, $\hat{\psi} = -\pi\hat{\tau}$, and the two approaches are identical. To summarize, a profit squeeze, i.e. $\psi_1 > 0$ and a higher wage share over the course of an expansion, coincides with a counter–cyclical mark–up, and a (weakly) pro–cyclical price. Forced saving, i.e. $\psi_1 < 0$ and a higher profit share over the course of an expansion, coincides with a pro–cyclical mark–up, and a (weakly) counter–cyclical price. To emphasize: Despite a rising mark–up τ, price Q falls with an increase of demand, because the decrease of per unit nominal costs due to strong productivity are large, i.e. $\hat{w} - \hat{\xi} > -\pi\hat{\tau}$, or $\psi_1 > (1-q_1)\psi_1$.

3.2 Steady state

The two equations in $\hat{\psi} = \hat{\omega} - \hat{\xi}$ and $\hat{V}$ are

$$\hat{\psi}_{ED} = \frac{\hat{I}_0}{\rho-\sigma} - \frac{1-\beta}{\rho-\sigma}\hat{V} \tag{3.7}$$

$$\hat{\psi}_D = \overline{\psi} + (1-q_1)\psi_1\hat{V}, \tag{3.8}$$

where, as above, $\rho - \sigma$ determines the demand regime, subscripts stand for ED = *effective demand*, D = *Distribution* and, if $\rho-\sigma > 0(<0)$, demand will be profit–led, **PL**, (wage–led, **WL**). The steady state is

$$\hat{\psi}^* = \frac{(1-\beta)\overline{\psi} + \psi_1\hat{I}_0}{1-\beta+(\rho-\sigma)\psi_1} \tag{3.9}$$

$$\hat{V}^* = \frac{\hat{I}_0 - (\rho-\sigma)\overline{\psi}}{1-\beta+(\rho-\sigma)\psi_1} \tag{3.10}$$

and for the model to make sense

$$\psi_1 > -\frac{1-\beta}{\rho-\sigma}, \text{ if } \rho-\sigma > 0, \textbf{PL}, \text{ and} \tag{3.11}$$

$$\psi_1 < -\frac{1-\beta}{\rho-\sigma}, \text{ if } \rho-\sigma < 0, \textbf{WL}. \tag{3.12}$$

The condition above is violated if (1) $\psi_1 > 0$, (PS), and $\rho - \sigma < 0$, (WL), *and* $\psi_1 > \frac{1-\beta}{\sigma-\rho}$, meaning the demand curve cuts the distributive curve from above, or (2) if $\psi_1 < 0$, (FS), and $\rho-\sigma > 0$, (PL), *and* $\psi_1 < -\frac{1-\beta}{\rho-\sigma}$, meaning the demand curve cuts the distributive curve from below. When would this occur? In both cases the slope of the demand growth schedule is *small*. The slope of the demand growth schedule decreases as β approaches 1 from below. The Keynesian stability condition, however, requires that $s-\beta > 0$, which means that β cannot become very large.

4 A Kalecki–Kaldor model of an *open* economy with wage and price setting

Opening the economy to trade requires several changes: Price P of total supply X and price Q of value added $V = (1-f)X$ differ, since the former includes imports, valued at eP_f; in all of the following, $P_f = 1$ for brevity. Real consumption is nominal after–saving income $(1-s)QV$ deflated by the 'CPI' P, which means that the price ratio Q/P enters the multiplier. Assuming that all trade passes through domestic firms (or distributors), the multiplier includes as well the import propensity. The demand curve has to reflect these changes.

4.1 Prices, again

The price of domestic content Q, the price of foreign content eP_f, and the price of total supply P now differ. e is the domestic currency price of one unit of foreign currency; in all of the following, $P_f = 1$ for brevity. P averages Q and e, weighted by the import propensity f. The wage curve and Q are as above, but the profit rate becomes $r = (1-\psi)(Q/P)u$. Growth rates of prices can be summarized as follows:

$$\begin{aligned}\hat{Q} &= \hat{q}_0 + q_1(\hat{w} - \hat{\xi}) \\ \hat{w} &= \hat{w}_0 + w_1(\hat{V} - \hat{\xi} - n) \\ \hat{P} &= (1-f)\hat{Q} + f\hat{e} \qquad (4.1) \\ \hat{r} &= \hat{u} - (\psi/\pi)\hat{\psi} + \hat{Q} - \hat{P}. \qquad (4.2)\end{aligned}$$

$\hat{Q}$ is as above, and $\hat{P}$ follows therefrom:

$$\hat{P} = (1-f)\overline{\eta} + f\hat{e} + (1-f)q_1\psi_1\hat{V} \qquad (4.3)$$

with $\overline{\eta} = \hat{q}_0 + q_1\overline{q}$ as above, and partials

$$\frac{\partial \hat{P}}{\partial \hat{q}_0} > 0,\ \frac{\partial \hat{P}}{\partial \hat{w}_0} > 0,\ \frac{\partial \hat{P}}{\partial \hat{\xi}_0} < 0,\ \frac{\partial \hat{P}}{\partial n} < 0,\ \frac{\partial \hat{P}}{\partial \hat{e}} > 0.$$

The sign of $\partial\hat{P}/\partial\hat{V} = (1-f)q_1\psi_1$ depends on ψ_1. Like in the previous section, price and mark–up behavior and distributive adjustment hinge on the relative magnitude of the bargaining elasticity w_1 and the Kaldor–Verdoorn elasticity δ. P reflects that, depending on the share of domestic content in total supply, $(1-f)$.

4.2 Exports, imports and the multiplier

Export- and import functions can be written as

$$\begin{aligned}\hat{M} &= \hat{f} + \hat{X} = \hat{\phi}_0 - \phi_1(\hat{e} - \hat{P}) + \hat{X} \qquad (4.4) \\ \hat{E} &= \hat{\epsilon} + \hat{X}_f = \hat{\epsilon}_0 + \epsilon_1(\hat{e} - \hat{P}) + \hat{X}_f, \qquad (4.5)\end{aligned}$$

where income elasticities of import and export demand are assumed unitary, for simplicity, but price elasticitities of import and export demand are $-\phi_1$ and ϵ_1. The only trade shocks considered further below are shocks to the nominal exchange rate, so that the trend demand growth rates $\hat{\phi}_0 = 0, \hat{\epsilon}_0 = 0$ for brevity.

With total supply $X = C + I + E$, value added $V = (1-f)X$ and real consumption $C = (1-s)QV/P$, the multiplier becomes $m = \frac{(1-f)}{1-(1-f)(1-s)Q/P}$ and its growth rate is

$$\hat{m} = m_Q(\hat{Q} - \hat{P}) + m_\psi\hat{\psi} - m_f\hat{f}, \qquad (4.6)$$

where the elasticities (at unitary base year prices) are

$$\begin{aligned}m_f &= f(1-f)^{-2}m > 0, \\ m_Q &= -m_P = (1-s)m > 0, \text{ and} \\ m_\psi &= sm\sigma = m(s_\pi - s_\psi)\psi > 0.\end{aligned}$$

After substituting the growth rate of the import propensity f, $\hat{f} = -\phi_1(\hat{e} - \hat{P})$, the growth rate of the multiplier becomes

$$\hat{m} = m_Q\hat{Q} + m_\psi\hat{\psi} + m_f\phi_1\hat{e} - (m_Q + m_f\phi_1)\hat{P}. \tag{4.7}$$

The multiplier increases with value added prices Q, since it implies a rise in real income QV/P, and increases with ψ, since wage earners have a higher propensity to consume. The multiplier *decreases* with supply price P, since it implies a fall in real income, and decreases in the import propensity f. Since f is a decreasing function of e/P, a nominal devaluation decreases imports, and increases the multiplier, whereas domestic price increases increase imports, hence decrease the multiplier. The introduction of import costs brings prices to the fore! Next to the wage share ψ, prices Q and P as well as the nominal exchange rate e impact the multiplier. The open economy results can differ starkly from the closed economy results. To see how, we have to consider effective demand.

4.3 Effective demand and steady state

The effective demand curve now includes external demand, $\hat{V} = \hat{m} + \chi\hat{I} + (1-\chi)\hat{E}$ with $\chi = mI/V$ the multiplier adjusted share of investment in GDP. After some algebra the effective demand schedule can be written as

$$\hat{V} = \frac{\lambda(\overline{\eta} - \hat{e}) + \chi\hat{I}_0 + (1-\chi)\hat{X}_f}{1 - \lambda q_1\psi_1 - \chi\beta} + \frac{m_\psi - \chi\rho}{1 - \lambda q_1\psi_1 - \chi\beta}\hat{\psi} \tag{4.8}$$

where

$$\lambda = f m_Q - (1-f)\left[m_f\phi_1 + (1-\chi)\epsilon_1\right].$$

λ can be interpreted as a Marshall–Lerner condition. A nominal devaluation $\hat{e} > 0$ is expansionary if $\lambda < 0$, meaning the sum of the (weighted) import and export price elasticities ϕ_1 and ϵ_1 has to be larger than the elasticity of the multiplier with respect to value added price Q,

$$(1-f)(m_f\phi_1 + (1-\chi)\epsilon_1) > f m_Q.$$

However, trade effects shift the ED–curve as well through inflation and productivity trends. If the economy is fairly open and flexible, and the elasticities are large, $\lambda < 0$, and vice versa. If $\lambda < 0 \Rightarrow \frac{\partial\hat{V}}{\partial\hat{q}_0} < 0; \frac{\partial\hat{V}}{\partial\hat{w}_0} < 0; \frac{\partial\hat{V}}{\partial\hat{\xi}_0} > 0; \frac{\partial\hat{V}}{\partial\hat{n}} > 0$, and vice versa. 'Reflation' and wage policies are difficult in an open economy. Essentially, if the economy responds strongly to changes in external competitiveness, i.e. the specific Marshall–Lerner condition is satisfied, and $\lambda < 0$, wage policies have contractionary effects that emphasize—if profit–led—or limit and possibly reverse—if wage–led—the endogenous effects of distributional changes on demand.

To gauge the total effect, let us consider the steady state:

$$\hat{V}^* = \frac{\chi\hat{I}_0 + (1-\chi)\hat{X}_f + \lambda(\overline{\eta} - \hat{e}) - (\chi\rho - m_\psi)\overline{\psi}}{1 - \chi\beta + (\chi\rho - m_\psi - \lambda q_1)\psi_1} \tag{4.9}$$

$$\hat{\psi}^* = \frac{(1 - \lambda q_1\psi_1 - \chi\beta)\overline{\psi} + \lambda(\overline{\eta} - \hat{e})\psi_1}{1 - \chi\beta + (\chi\rho - m_\psi - \lambda q_1)\psi_1}. \tag{4.10}$$

For the model to be economically meaningful,

$$\psi_1 > -\frac{1-\lambda q_1\psi_1 - \chi\beta}{\chi\rho - m_\psi}, \text{ if } \chi\rho > m_\psi, \textbf{PL}, \text{ and} \tag{4.11}$$

$$\psi_1 < -\frac{1-\lambda q_1\psi_1 - \chi\beta}{\chi\rho - m_\psi}, \text{ if } \chi\rho < m_\psi, \textbf{WL}. \tag{4.12}$$

What is the steady state demand growth rate response to a shock? Note that the expression for $\hat{V}^*$ includes $\overline{\eta}$ and $\overline{\psi}$, both of which are functions of trend growth rates. Recall from above $\overline{\eta} = \hat{q}_0 + q_1\overline{q}$, and $\overline{\psi} = -\hat{q}_0 + (1-q_1)\overline{q}$ where $\overline{q} = (\hat{w}_0 - (1+w_1)\hat{\xi}_0 - w_1 n)$, so that writing $\theta = (m_\psi - \chi\rho)$ and simplifying $\lambda(\overline{\eta} - \hat{e}) + (m_\psi - \chi\rho)\overline{\psi}$ gives

$$[\lambda - \theta]\,\hat{q}_0 + [\lambda q_1 + (1-q_1)\theta]\,\overline{q} - \lambda\hat{e}. \tag{4.13}$$

The sign of the response of $\hat{V}^*$ to shocks to $\hat{q}_0$ depends on $\lambda - \theta$, and to $\hat{w}_0, \hat{\xi}_0, n$ on the q_1–weighted average of λ and θ. The following section takes a closer look at this condition, based on the arguably most interesting question what effect a policy induced shock to $\hat{w}_0$ would have.

4.4 Wage policy

With $\lambda < 0$, the demand curve $\hat{\psi}_{ED}$ shifts left (contracts) with $\hat{q}_0 > 0, \hat{w}_0 > 0$ and shifts right (expands) with $\hat{e} > 0, \hat{\xi}_0 > 0, \hat{n} > 0$. But how does the steady state demand growth rate respond to an increase in the nominal wage rate? Profit– and wage–led demand regimes have to be considered separately:

1. $\lambda < 0$ and $\theta = (m_\psi - \chi\rho) < 0$, (**PL**):
   $\partial\hat{V}^*/\partial\hat{w}_0 > 0$ if $(\chi\rho - m_\psi)/\lambda > q_1/(1-q_1)$;
   Since $q_1/(1-q_1) > 0$, steady state demand growth with profit–led demand and $\lambda < 0$ always responds negatively to wage policies.

2. $\lambda < 0$ and $\theta = (m_\psi - \chi\rho) > 0$, (**WL**):
   $\partial\hat{V}^*/\partial\hat{w}_0 > 0$ if $(\chi\rho - m_\psi)/\lambda > q_1/(1-q_1)$;
   This condition is satisfied, if $m_\psi \gg \chi\rho$, and/or λ is *small*, and/or q_1 is *small*, which implies that $\hat{\psi}_{ED}$ has to be fairly steep!

With $\lambda > 0$, $\hat{\psi}_{ED}$ shifts right (expands) with $\hat{q}_0 > 0, \hat{w}_0 > 0$ and shifts left (contracts) with $\hat{e} > 0, \hat{\xi}_0 > 0, \hat{n} > 0$. How does steady state demand growth rate respond to an increase in the nominal wage rate?

1. $\lambda > 0$ and $\theta = (m_\psi - \chi\rho) < 0$, (**PL**):
   $\partial\hat{V}^*/\partial\hat{w}_0 > 0$ if $q_1/(1-q_1) > (\chi\rho - m_\psi)/\lambda$;
   This condition is satisfied, if $q_1 \gg 0$, and/or $\lambda \gg 0$, and/or $\chi\rho - m_\psi$ is *small*. In other words, the demand curve has to be fairly steep.

2. $\lambda > 0$ and $\theta = (m_\psi - \chi\rho) > 0$, (**WL**):
   $\partial\hat{V}^*/\partial\hat{w}_0 > 0$ if $q_1/(1-q_1) > (\chi\rho - m_\psi)/\lambda$;
   This condition is always satisfied, since $q_1/(1-q_1) > 0$, and $(\chi\rho - m_\psi)/\lambda < 0$. If demand is wage–led and the economy is relatively closed to trade, wage policies are effective in spurring demand.

Wage policy can be successful, in the sense that it improves economic performance, if demand is strongly wage–led and λ is small, if negative, or if demand is only weakly profit–led, and λ is large, if positive. Wage policy cannot be successful, if $\lambda < 0$ and demand is profit–led, and is always successful, if $\lambda > 0$ and demand is wage–led.

5 Calibration(s) and simulation(s)

How do these many and possibly small shifts in parameter regimes impact overall model results? This question is taken up further below in this section. First, though, a note about methodology. The model above has been presented and discussed in growth rates, because it enabled a straightforward analysis of steady states, composite elasticities and the impact of shocks. The expressions in growth rates were derived by log–differentiating equations in *level*. Near the steady state, the linearized version describes the model's behavior reasonably well; calibrating and simulating the model in *levels* is approximately equivalent as long as the shocks considered are not large. This is easy to verify, given the slew of data simulation exercises provide: Log–differentiation is an approximation to the real proportional changes of endogenous variables; the two approaches are approximately equal, and over– or underestimation of a variable's proportional change in the linearized model rises with the size of the shock.

5.1 Calibration(s)

It is common practice to use a base year data set and elasticity values to calibrate a variety of parameters. For an illustrative example, let's have a look at the investment function. Suppose one can deduce a reasonable prior from available econometric evidence for the two elasticities, α and β. Investment I and the rate of capacity utilization $u = V/K$ are given from the base year data, allowing to solve for I_0. Thus, the key to calibration is to recognize that for each equation the base year value of the endogenous variable is known, hence the relationship can be used to determine one parameter.

It might be necessary to calibrate two parameters in a single relationship. For example, the gross macroeconomic propensity to save is a function of a distributive variable. Both the aggregate propensity s and the wage share ψ are known from the base year data, leaving two parameters, s_π and s_ψ, to be determined. Setting $s_\pi - s_\psi = s'$, with $0 < s' < 1$ gives the second degree of freedom, in effect defining how much larger the propensity to save out of profit income is than the propensity to save out of wage income.

Obviously, such a calibration exercise leaves considerable leeway to the modeler to determine the particular manifestation of functions. Point estimates for elasticity values simply do not converge, however often data sets, methods and procedures are updated and extended, and using elasticities from other studies is prone with difficulties, depending on the underlying model, its assumptions, as well as the data set used. For that reason, one can go a step further and randomize the procedure outlined in preceding paragraphs. Principally, for each equation elasticities are drawn from a uniform probability distribution with suitable boundaries and fitted to the base year data by calculating the appropriate intercepts. Specifically, mean and variance for the uniform probability distributions of a randomized parameter p can be written as

$$E[p] = \frac{[(1-x)m + (1+x)m]}{2} = m, \text{ and} \tag{5.1}$$

$$Var[p] = \frac{[(1+x)m - (1-x)m]^2}{12} = \frac{1}{3}(xm)^2, \tag{5.2}$$

where $x > 0$ indicates the range of the distribution. The means m are chosen given prior evidence discussed below. The standard deviation is $\sqrt{Var[p]} = \sqrt{1/3}(xm)$, and the ratio of the deviation x from mean m to the standard deviation is constant at $\sqrt{3} = 1.73$. However wide the distributions are chosen to be around m, the dispersion xm represents roughly $\frac{7}{4}$ times a standard deviation.

How to chose x? It would be desirable to limit dispersion, for a number of reasons. First, in the best of all worlds, the point estimates discussed below serve as an acceptable prior for the set of means m, around which 'true' parameters might fall with a limited degree of uncertainty. Second, increasing dispersion washes out discernible results by flattening the resulting distributions. Third, in Monte Carlo exercises I shift the means m, while maintaining x, in order to assess model sensitivity to possible changes to the prior. However, as will be seen in the next paragraphs, substantial uncertainty might require larger dispersion for at least some elasticities. I set $x = 0.3$ for most. Let us briefly look at a particular parameter. Suppose that for α, the cost elasticity of investment, $m = 0.40$, so that the lower bound of $E[\alpha]$ is equal to $\alpha^L = 0.70(0.40) = 0.28$, and the upper bound is $\alpha^H = 1.30(0.40) = 0.52$. Further, variance $Var[\alpha] = 0.0048$, standard deviation $\sqrt{Var[\alpha]} = 0.069$, and the aforementioned ratio $\frac{0.12}{0.069} = 1.73$.

How to chose the means m for all relevant parameters? Clearly, this is an area fraught with difficulties, so the preliminary disclaimer includes that I will try to outline weaknesses where possible, and that all of the following should be viewed as a first attempt. Importantly, this paper emphasizes the theoretical analysis of the model above rather than the specific empirical results.

A number of studies have investigated the links between demand and distribution. The main difficulty in comparing and applying any of these results is that some rest on cyclical models of a macroeconomy, and some are single equation regressions. Barbosa-Filho and Taylor (2007) estimate a structural Goodwin model, finding a steep and profit–led demand curve. Similarly, Proano (2008) finds negative feedback from unit labor costs to economic activity for the US, EU–area, and selected large EU economies. Naastepad (2006) finds a significant impact of distributive changes on investment. Rada and Taylor (2006) suggest similar numbers. Gordon (1996) finds a significant relation between distribution and demand, and the US to be profit–led. Hein and Vogel (2008) discuss literature of single–equation estimations that often commend demand in developed economies to be wage–led. More open economies on the one hand and the United States on the other hand appear more often to be profit–led. Their own estimations confirm that empirical evidence on the nature of the demand regime is often conflicting and depends on model and estimation priors. Here, I will assume that the distributive elasticity of investment (α) is positive and significant, meaning that higher unit labor costs lead to lower investment. Naastepad (2006) estimates $\alpha = 0.39$ for the Netherlands, which could arguably be higher for the US. Proano (2008) (and related literature) do not estimate separate investment functions, but instead an IS–curve for capacity utilization that depends on a distributive variable. Their estimates can be read as confirmation of that general range, leading me to adopt $\alpha = 0.40$.

The slope of the distributive curve is not less controversial. Here, too, the devil is in the detail. For example, Storm and Naastepad (2007) find that the profit share is pro–cyclical. Indeed, a glance at a plot of the (US) business cycle together with corporate profits relative to GDP strongly suggests a pro–cyclical profit share. However, in a *cyclical* model the profit share can rise over the early part of an expansion. With strong bargaining and the appropriate institutions, the wage share (profit share) will catch up (fall behind) and rise (fall) in the later stage of the cycle. Barbosa-Filho and Taylor (2007) find such a relationship. It would be consistent with a fairly flat overall distributive curve. Other dynamic models, such as Proano (2008), Flaschel et al. (2007), and Flaschel and Krolzig (2006), estimate wage–price spirals and find (1) the responsiveness of wages to pressure in the labor market to be quite strong, but (2) the mark–up elasticity to be much weaker—which would imply a high w_1 here, and possibly a profit squeeze. According to Proano (2008), the employment elasticity of wages $w_1 = 0.94$, and the mark–up elasticity $q_1 = 0.05$ in the US. The trouble is that the story does not transfer well into a static model. Since w_1 near unity steers the calibration towards a profit–squeeze, and q_1 near 0 can exclude the possibility of a positive impact of wage policies if $\lambda > 0$ and demand is profit–led, I adopt $w_1 = 0.75$ and $q_1 = 0.20$ for the prior, with $x = .5$ for q_1.

The aggregate savings propensity is determined in the SAM's flows of funds, as is the wage share ψ, leaving the two class behavioral parameters s_π and s_ψ to be calibrated. s_π and s_ψ should be disaggregated as wage–receiving households versus capitalist profit–receiving households. Conceptually, this fits in a standard framework, because all valued added, including profits, is distributed to households who own shares, even though that would occur outside the scope of the model. It is less straightforward, however, when it comes to real world data. A substantial part of macroeconomic savings remains within corporations, purportedly to finance investment (Eichner and Kregel (1975), Kalecki (1937)). Moreover, a substantial part of wage income is rather akin to profit income, as recent research has shown, see Gordon and Dew-Becker (2008) and Piketty and Saez (2003, 2006). Here, I will be content with estimates discussed elsewhere. Naastepad (2006) estimates $s_w = 0.14$, and $s_\pi = 0.49$ for Netherlands, so that the difference turns out to be about 0.35. In the US, the difference *could* be higher. The average (net) saving propensity has been near 0 for a while (and has only recently started to rise), but high(er) income households are unlikely to save as little. I am assuming $s_\pi - s_\psi = 0.30$ for the prior.

Next, the demand elasticity β is less controversial, and its mean is set at 0.5. The Kaldor–Verdoorn coefficient δ is usually found to be in the range between 0.30 and 0.60, and I set $E[\delta] = 0.45$. See Rowthorn (1975, 1979) and Thirlwall (1980, 1983, 1986), as well as the contributions collected in McCombie et al. (2003) for discussion and estimates. The price elasticities ϵ_1 and ϕ_1 of exports and imports have frequently been subject to empirical testing. For the US, it has been argued that $\phi_1 > 1 > \epsilon_1$, leading to balance of payments problems, see Blecker (1998). Either way, at this level of aggregation price elasticities of trade are likely not too far from unity. However, since λ would not turn positive with trade elasticities near unity, I allow arbitrarily low bounds, drawing ϵ_1 and ϕ_1 from $[0.20, 1.00]$. I will use these bounds only in the following section, where the focus is to highlight how the model works.

How do these estimates figure in the theoretical model laid out above? Let's first examine the slope of the effective demand curve. Recall the relevant coefficient on $\hat{\psi}$, reproduced here for the reader's convenience. Using means of the prior for all behavioral parameters except α and $s_\pi - s_\psi$, and evaluating at the base year data gives[1]

$$\frac{\partial \hat{V}}{\partial \hat{\psi}} = \frac{m_\psi - \chi\rho}{1 - \lambda q_1 \psi_1 - \chi\beta} \Rightarrow \frac{\partial \hat{V}}{\partial \hat{\psi}} > 0 \text{ if } \frac{2.13}{1.43}(s_\pi - s_\psi) > \alpha, \tag{5.3}$$

meaning demand is wage–led, if $1.48(s_\pi - s_\psi) > \alpha$. It is important to see that this back–of–the–envelope calculation depends on the base year data. Different initial conditions can lead to different demand regimes. Based on elasticities previously discussed, the base year data with $\alpha = 0.40$ and $(s_\pi - s_\psi) = 0.30$ would render demand wage–led, which could, with only slight changes, swing the other way. The distributive regime, on the other hand, is easier to eye–ball. With $w_1 = 0.90$ and $\xi_1 = 0.40$, $\psi_1 > 0$. Note, however, that if $w_1 < 1$ and $\xi_1 > 0.50$, distributive adjustment works against wage income recipients.

What does it take for λ to change sign? Given the base year data, $\lambda > 0$ if $0.36 > 0.37\epsilon_1 + 0.58\phi_1$. It is easy to see that both trade elasticities have to be significantly smaller than unity for λ to be positive, and for the effective demand curve to shift right (expand) in response to, i.e., wage policy or a nominal appreciation.

[1] The base year is derived from NIPA-tables, Bureau of Economic Analysis (BEA) data for the US economy, in Billion current US dollars, 2007:Q2.

5.2 Simulations

This section reports illustrative simulation results. As will become clear, it does not take large changes in underlying elasticities to generate sign changes of crucial partial derivatives. Table 1 summarizes six different calibrations, which were chosen based on their characteristics in order to show how different parameter regimes influence simulation results. The top part of the table reports the elasticities drawn from uniform probability distributions with bounds indicated in square brackets. The bottom part reports the most important composite parameters. Row 11 shows θ, which determines the demand regime. The difference shown in row 13 determines whether $\partial\hat{V}/\partial\hat{q}_0 > 0$, row 14 whether $\partial\hat{V}/\partial\hat{w}_0 > 0$. Row 18 is the slope of the effective demand curve, and its inverse is the slope of $\hat{\psi}_{ED}$. Row 19 reports the slope of the distributive curve, $\hat{\psi}_D$.

Before we dive into the simulations, recall from the previous section that the trade elasticities ϵ_1 and ϕ_1 have been set with an unrealistically low bound of 0.20. In the three calibrations (2, 3 and 4) with a positive λ, the sum of the trade elasticities is less than 0.63. The US economy, with an import share in production of roughly 20 per cent, appears open enough to require these *very low* trade elasticities for λ to turn positive. Since this section is supposed to illustrate the model's working, rather than carry a lot of empirical validity, I stick with these low trade elasticities.

A few more general observations are worth making: The upper part Table 1 makes it clear that it does not take large changes of elasticities to generate very different model behavior. As an example, compare the first and second calibration (column 2 and 3). Both are profit–led, but the third shows a profit squeeze and the second forced saving. Importantly, λ has the same sign, row 14 changes signs. Demand growth in the model calibrated with no.2 responds negatively to a wage shock, whereas demand growth in the model calibrated with no.3 responds positively to a wage shock. The difference between the trade elasticities (row 5 and 6) is *not* large. Similarly, read along rows 1 through 8, the variability of any given elasticity from calibration to calibration is not large, but in combination small changes switch the model from profit–led (no.1–no.3) to wage–led (no.4–no.6), and from profit squeeze (no.1 and no.3) to forced saving (no.2 and no.4–6).

Tables 2 and 3 summarize simulation results; Table 2 for model responses to a demand shock, here 5 per cent to autonomous investment I_0, and Table 3 for model responses to a distributive shock, here 5 per cent to the intercept term in the wage curve, w_0. Let us briefly look at Table 2, before focusing on the main question, namely the effectiveness of wage policies. Column 1 in Table 2 reports simulation results with a profit–led/profit squeeze (PS/PL) calibration with $\lambda < 0$—a capital owner's dream, except for the relatively strong bargaining ability of workers. Column 4 in Table 2 reports simulation results with a calibration more friendly to workers, since demand is wage–led and λ is positive, meaning wage policies are always successful—the threat of international competition is an empty threat. Still, productivity gains are so strong that not capitalists but workers are squeezed during the upturn. And that is the main difference! The wage falls by four tenth of one per cent with forced saving, and rises by six one–hundredth of one per cent in simulation 1; propensity to save and multiplier change with the distribution of income. Investment rises slightly stronger with forced saving, since real unit labor costs continue to fall. The headline numbers, however, do not show significant differences.

Now let us move to Table 3 and simulation results in response to a wage shock. The real wage rises across the board, and with it the wage share rises; investment falls with the increase in real unit labor costs. The profit rate r falls—the increase in the wage share, or the decrease in the mark–up, is too large to allow the paradox of costs to play itself out. Put differently, consumption does not respond sufficiently strong to the increase in real wages to have a larger effect on profits than the combined negative effect of reduced investment and a lower mark–up. Essentially, growth of GDP, where positive, is *too small.* The point though is, that the sign of GDP growth varies, depending on the sign of row 14 in Table 1. Simulations 2 and 6 can be drawn on to highlight subtle differences. Simulation 2 is profit–led/profit–squeeze with $\lambda > 0$ *and* $\lambda q_1 + (1 - q_1)\theta > 0$. The upward shift of the distributive curve coincides with a *rightward* shift of the demand curve—and the shift is large enough to counter the *contractionary* move along $\hat{\psi}_{ED}$. Simulation 6, on the other hand, is wage–led/forced saving with $\lambda < 0$ *and* $\lambda q_1 + (1 - q_1)\theta < 0$. The upward shift of the distributive curve coincides with a *leftward* shift of the demand curve—and the shift is large enough to counter the *expansionary* move along $\hat{\psi}_{ED}$. Simulation 5 is as well wage–led/forced saving, but shows very different results: With $\lambda < 0$ *but* $\lambda q_1 + (1 - q_1)\theta > 0$, the *leftward* shift of the demand curve is not large enough to counter the *expansionary* move along $\hat{\psi}_{ED}$.

Figure 1 and 2 highlight the issue. In Figure 1, $\hat{\psi}^1_D$ represents a distributive curve with for forced saving, and $\hat{\psi}^1_{ED}$ a wage-led demand curve. All trend growth rates are assumed to be zero, so that the two curves cross at the origin, point A. A shock to $\hat{w}_0 > 0$ shifts the distributive curve upwards, and, if $\lambda < 0$, shifts (contracts) the demand curve leftward. Whether the new steady state demand growth rate is smaller (point B) or larger (point C) than zerio, depends on the relative size of λ and the slope of the demand curve. In Figure 2, $\hat{\psi}^1_D$ represents a distributive curve with a profit squeeze, and $\hat{\psi}^1_{ED}$ a profit-led demand curve. With trend growth rates assumed to be zero the two curves cross at the origin, point A. The wage policy shifts the distributive curve upwards, and, if $\lambda > 0$, shifts the demand curve outward. Again, whether the new steady state demand growth rate is smaller (point B) or larger (point C), depends on the relative size of λ and the slope of the demand curve.

6 Monte Carlo

How do a large number of calibrations look on average? How successful can wage policy be on average? These questions can be approached with Monte Carlo simulations. A Monte Carlo exercise is, simply put, a repeated evaluation of a function with at least one random variable or parameter. The resulting set can be analyzed graphically either by plotting a histogram, or smoothing the corners of a histogram through a Kernel Density Estimation (KDE) procedure. KDE generates a continuous probability function, which can be integrated to evaluate probability mass below and above zero. With a normal Kernel the density function is

$$f[X] = \frac{1}{hn} \sum_{i}^{n} \sqrt{2\pi} \exp^{-\frac{1}{2}\left(\frac{X - p_i}{h}\right)^2}, \tag{6.1}$$

where p_i are the i elements of the distribution generated by n draws of the expression under consideration, i.e. the slope coefficient of effective demand growth. h represents the bandwidth—the bin width for the histogram—which determines the smoothness of the resulting distribution. It is well known that (1) the choice of the particular Kernel has only marginal effect on shape and location of resulting distributions, and that (2) the smoothing parameter h tends to be best chosen subjectively, despite rules of thumb. The bandwidth applied here is 'approximately Silverman.' See Silverman (1986) for the original discussion, and Greene (2007), pages 414–416, for a standard introduction.

For the following exercises, the trade elasticities are re–set to a more realistic range. Means are now set to 0.7, which is arguably still low—but large enough to render λ negative in *all* 500 iterations. The question will be whether λ is large enough relative to the slope of a wage–led demand curve to make wage policies *always* have negative effects on growth.

First, let us look at the slope of effective demand and distributive curve. The key question is how sensitive the key links between demand and distribution (the partial derivatives of the log–differentiated demand and distributive functions, $\partial\hat{V}/\partial\hat{\psi}$ and $\partial\hat{\psi}/\partial\hat{V}$) are to carefully defined changes in parameter regime. Thus, using the previously discussed calibration input set as a benchmark, means m of relevant parameters are shifted, reduced form coefficients drawn and calculated n–times, and resulting distributions compared. From previous sections it is clear that changes of either α or the savings differential $s_\pi - s_\psi$ have the opposite effect. Similarly, w_1 and δ have opposite effects on the slope coefficient of the distributive curve. To save space, I focus on one parameter for either function, namely the cost elasticity of investment α and the bargaining elasticity w_1.

Figures 3 and 4 show the resulting distributions. Figure 3 confirms that for a Kaleckian economy will tend to be wage–led. The slope of the distributive curve centers closely around zero. A decrease in the bargaining elasticity has a strongly negative effect, whereas a further increase in w_1 rather flattens than shifts the distribution.

It is straightforward to extend the procedure discussed in the previous section to investigate full model responses to shocks. First, define bounds of key parameters to calibrate the full model n times. Second, shock the model as in the examples discussed in detail above. Third, calculate n sets of results. Fourth, shift bounds of key parameters exactly as in the previous section. Rinse and repeat for the rest. Such exercises obviously furnish large output data sets—the sample size n times the number of equations times the number of different calibration input sets. Some judgement is required on which are the relevant statistics to consider. Given that the discussion is focused on $\hat{\psi}$ and $\hat{V}$, I will stick to demand growth in response to a distributive shock.

The exercise is geared to highlight interaction between wage policies and demand. The model with n different calibrations is subjected to a positive nominal wage shock. Subsequently, probability densities of the response of growth of value added are estimated. The different calibrations are based on the same changes to distributions parameters are drawn from as above. Shifting the mean of distribution of the cost elasticity of investment α varies the character of the demand regime. Subsequently, growth of value added in response to exogenous growth of nominal wages is calculated. In other words, the simulation considers a cross effect, that is, (1) from a distributive shock (the wage curve intercept w_0) via different demand calibrations to GDP.

Figure 5 shows results, at least on the face of it counterintuitive, given that above simulations have shown that demand, based on the prior distribution, tends to be wage–led. In other words, a positive shock to the nominal wage does not deliver an expansion of demand, even if demand tends to be wage–led. Similarly, in the previous section, an upward shift of the distributive curve along a positively sloped demand curve is outweighed by a leftward shift of that demand curve—λ can be quite important.

7 Conclusions

The focus of this paper is an investigation of a small, but comprehensive Post–Keynesian model of the real side, with particular emphasis on calibration and the impact thereof on model behavior. Endogenous prices and wages turn out to be crucial for model outcomes. Specifically, shocks to a price or the wage rate shift not only the distributive curve, but as well the demand curve. The sign and size of the shift depends on the base year data, particularly the multiplier, as well as the trade elasticities, but tends to be adverse from the perspective of wage income recipients. Whether this adverse effect outweighs the positive impact of redistribution under a wage–led demand regime depends on elasticities and slopes, and can easily go either way.

These price effects appear only in the open economy version of the model. Distinguishing between a mark–up on domestic variable cost—labor—and the supply price of output, which includes import costs, brings the price ratio of Q and P in the multiplier and therewith the demand curve. In Naastepad (2006) and Rada and Taylor (2006), worker's disadvantage of opening the economy to trade comes with the increasing likelihood of of a profit–led demand regime, since exports increase with competitiveness as proxied by relative unit labor costs. Here, worker's disadvantage of opening the economy to trade works through a different channel—but globalization does work as a disciplining device.

Bibliography

Arrow, K. J. (1962). The Economic Implications of Learning by Doing. *The Review of Economic Studies*, 29(3):155–173.

Barbosa-Filho, N. H. and Taylor, L. (2007). Distributive and Demand Cycles in the US-Economy - A Structuralist Goodwin Model. *Metroeconomica*, 57:389–411.

Bhaduri, A. and Marglin, S. (1990). Unemployment and the Real Wage: The Economic Basis for Contesting Political Ideologies. *Cambridge Journal of Economics*, 14(4):375–393.

Blanchflower, D. G. and Oswald, A. J. (1990). The wage curve. *The Scandinavian Journal of Economics*, 92(2):215–235.

Blanchflower, D. G. and Oswald, A. J. (1995). An introduction to the wage curve. *The Journal of Economic Perspectives*, 9(3):153–167.

Blecker, R. A. (1998). International Competitiveness, Relative Wages and the Balance of Payments Constraint. *Journal of Post-Keynesian Economics*, 20:495–526.

Dutt, A. K. (1984). Stagnation, Income Distribution and Monopoly Power. *Cambridge Journal of Economics*, 8(1):25–40.

Eichner, A. S. and Kregel, J. A. (1975). An Essay on Post-Keynesian Theory: A New Paradigm in Economics. *Journal of Economic Literature*, 13(4).

Flaschel, P., Kauermann, G., and Semmler, W. (2007). Testing Wage and Price Phillips Curves for the United States. *Metroeconomica*, 58:550–581.

Flaschel, P. and Krolzig, H.-M. (2006). Wage–price Phillips Curves and Macroeconomic Stability: Basic Structural Form, Estimation and Analysis. In Chiarella, C., Flaschel, P., Franke, R., and Semmler, W., editors, *Quantitative and Empirical Analysis of Nonlinear Dynamic Macromodels*. Elsevier, Amsterdam.

Goodwin, R. M. (1967). A Growth Cycle. In *Socialism, Capitalism, and Growth*. Cambridge University Press.

Gordon, D. M. (1996). Growth, Distribution and the Rules of the Game: Social Structuralist Macro Foundations for a Democratic Economic Policy. In Epstein, G. A. and Gintis, H. M., editors, *Macroeconomic Policy after the Conservative Era: Studies in Investment, Saving and Finance*, chapter 12, pages 335–383. Cambridge University Press.

Gordon, R. J. and Dew-Becker, I. (2008). Controversies about the Rise of American Inequality: A Survey . *National Bureau of Economic Research, NBER Working Papers*, 13982.

Greene, W. H. (2007). *Econometric Analysis*. Prentice Hall, 6th edition.

Hein, E. and Vogel, L. (2008). Distribution and Growth Reconsidered: Empirical Results for Six OECD Countries. *Cambridge Journal of Economics*, 32:479–511.

Kaldor, N. (1978). Causes of the Slow Rate of Growth of the United Kingdom. In *Further Essays on Economic Theory*, London. Duckworth.

Kalecki, M. (1937). The Principle of Increasing Risk. *Economica*, 4(16):440–447.

Lavoie, M. (1995). The Kaleckian model of growth and distribution and its neo-Ricardian and neo-Marxian critiques. *Cambridge Journal of Economics*, 19:789–818.

McCombie, J. S. L., Pugno, M., and Soro, B. (2003). *Productivity Growth and Economic Performance: Essays on Verdoorn's Law*. Palgrave Macmillan, Basingstoke, Hampshire.

McCombie, J. S. L. and Thirlwall, A. P. (2004). *Essays on Balance of Payments Constrained Growth: Theory and Evidence*. Routledge studies in development economics. Routledge, London.

Naastepad, C. W. M. (2006). Technology, Demand and Distribution: A Cumulative Growth Model with an Application to the Dutch Productivity Growth Slowdown. *Cambridge Journal of Economics*, 30(3):403–434.

Piketty, T. and Saez, E. (2003). Income inequality in the united states, 1913-1998. *The Quarterly Journal of Economics*, 118(1):1–39.

Piketty, T. and Saez, E. (2006). The evolution of top incomes: A historical and international perspective. *The American Economic Review*, 96(2):200–205.

Proano, C. R. (2008). Gradual Wage-Price Adjustments and Keynesian Macrodynamics: Evidence from the U.S. and Major European Countries. *CEM Working Paper 146*.

Rada, C. and Taylor, L. (2006). Empty Sources of Growth and Accounting, and Empirical Replacements a la Kaldor and Goodwin with some Beef. *Structural Change and Economic Dynamics*, 17(4):486–500.

Rowthorn, R. E. (1975). What Remains of Kaldor's Law? *The Economic Journal*, 85(337):10–19.

Rowthorn, R. E. (1979). A Note on Verdoorn's Law. *The Economic Journal*, 89(353):131–133.

Rowthorn, R. E. (1982). Demand, Real Wages and Economic Growth. *Studi Economici*, 18:3–53.

Silverman, B. (1986). *Density Estimations for Statistics and Data Analysis*. Chapman & Hall.

Storm, S. and Naastepad, C. W. M. (2007). It is high time to ditch the NAIRU. *Journal of Post Keynesian Economics*, 29:531–554.

Taylor, L. (1985). A Stagnationist Model of Economic Growth. *Cambridge Journal of Economics*, 9:383–403.

Thirlwall, A. (1979). The balance of payments constraint as an explanation of international growth rate differences. *Banca Nazionale del Lavoro Quarterly Review*, 128:45–53.

Thirlwall, A. (1983). A Plain Man's Guide to Kaldor's Growth Laws. *Journal of Post Keynesian Economics*, 5(3):345–358.

Thirlwall, A. P. (1980). Rowthorn's Interpretation of Verdoorn's Law. *The Economic Journal*, 90:386–388.

Thirlwall, A. P. (1986). A general model of growth and development on kaldorian lines. *Oxford Economic Papers*, 38:199–219.

Verdoorn, P. (1949). Fattori che Regolano lo Sviluppo della Produttiva del Lavoro. *L'industria*, 1:3–10.

Young, A. A. (1928). Increasing Returns and Economic Progress. *The Economic Journal*, 38(152):527–542.

	Six calibrations		**1**	**2**	**3**	**4**	**5**	**6**
	Random seed #		13	452	437	34	42	32
	Elasticities							
1	$s_\pi - s_\psi$	[.21,.39]	0.23	0.33	0.25	0.36	0.37	0.24
2	α	[.28,.52]	0.47	0.52	0.52	0.40	0.40	0.32
3	β	[.35,.65]	0.40	0.50	0.58	0.38	0.51	0.52
4	δ	[.32,.59]	0.37	0.54	0.32	0.50	0.51	0.54
5	ϕ_1	[.20,1.00]	0.56	0.25	0.23	0.22	0.74	0.67
6	ϵ_1	[.20,1.00]	0.55	0.21	0.40	0.30	0.84	0.74
7	w_1	[.53,.98]	0.61	0.67	0.77	0.68	0.56	0.73
8	q_1	[.10,.30]	0.18	0.22	0.19	0.28	0.28	0.19
	Parameters							
9	m_ψ		0.35	0.51	0.38	0.56	0.58	0.37
10	$\chi\rho$		0.49	0.54	0.54	0.42	0.42	0.33
11	$\theta = m_\psi - \chi\rho$		-0.14	-0.03	-0.16	0.14	0.16	0.04
12	λ		-0.15	0.15	0.09	0.13	-0.36	-0.28
13	$\lambda - \theta$		-0.01	0.18	0.24	-0.01	-0.52	-0.32
14	$\lambda q_1 + (1 - q_1)\theta$		-0.14	0.01	-0.11	0.13	0.02	-0.02
15	$\lambda q_1 \psi_1$		0.00	-0.01	0.00	-0.01	0.02	0.01
16	$\chi\beta$		0.22	0.27	0.32	0.21	0.28	0.28
17	$1 - \lambda q_1 \psi_1 - \chi\beta$		0.78	0.74	0.68	0.80	0.70	0.71
18	$\theta[1 - \lambda q_1 \psi_1 - \chi\beta]^{-1}$		-0.18	-0.04	-0.23	0.17	0.23	0.06
19	ψ_1		0.02	-0.23	0.20	-0.17	-0.23	-0.20

Table 1: These six different calibrations are used for the illustrative simulations. The top part of the table reports the elasticities drawn from uniform probability distributions with bounds indicated in square brackets. The bottom part reports the most important composite parameters. Row 11 shows θ, which determines the demand regime. The difference shown in row 14 determines whether demand growth responds positively to a wage shock. Row 18 is the slope of the effective demand curve, its inverse is the slope of $\hat{\psi}_{ED}$. Row 19 reports the slope of the distributive curve, $\hat{\psi}_D$.

	Simulations	1	2	3	4	5	6
	Random seed #	13	452	437	34	42	32
	Shock:						
	5% increase in I[0]						
1	Investment	6.42	7.66	6.73	6.69	7.58	7.51
2	Exports	-0.01	0.03	-0.05	0.04	0.17	0.09
3	Imports	3.55	3.78	3.99	3.38	3.69	3.83
4	Output	3.55	3.82	3.96	3.41	3.83	3.91
5	GDP	3.55	3.83	3.95	3.42	3.87	3.92
6	Employment	2.23	1.76	2.67	1.68	1.89	1.80
7	Productivity	1.29	2.03	1.25	1.71	1.94	2.09
8	Multiplier	0.02	-0.37	0.27	-0.26	-0.35	-0.23
9	Propensity to save	-0.04	0.74	-0.53	0.50	0.80	0.51
10	Wage Share	0.06	-0.65	0.63	-0.41	-0.63	-0.61
11	Real (consumption) wage	1.35	1.33	1.92	1.26	1.25	1.43
12	Real (product) wage	1.35	1.36	1.89	1.29	1.29	1.46
13	Inflation (P)	0.01	-0.15	0.12	-0.13	-0.20	-0.12
14	Inflation (Q)	0.01	-0.19	0.15	-0.16	-0.25	-0.14
15	Profit rate	3.43	5.08	2.75	4.19	5.07	5.10

Table 2: Summary of simulation results – Model responses to a 5 per cent shock to autonomous investment I_0.

	Simulations	1	2	3	4	5	6
	Random seed #	13	452	437	34	42	32
	Shock:						
	5% increase in w[0]						
1	Investment	-4.08	-3.86	-4.35	-2.41	-2.72	-2.63
2	Exports	-0.40	-0.18	-0.29	-0.32	-0.93	-0.56
3	Imports	-0.45	0.28	-0.63	1.10	1.10	0.44
4	Output	-0.85	0.06	-0.80	0.86	0.28	-0.06
5	GDP	-0.95	0.01	-0.84	0.80	0.09	-0.18
6	Employment	-0.60	0.00	-0.57	0.40	0.04	-0.08
7	Productivity	-0.35	0.00	-0.27	0.40	0.04	-0.10
8	Multiplier	1.51	2.26	1.73	2.30	2.03	1.54
9	Propensity to save	-3.17	-4.33	-3.28	-4.26	-4.53	-3.37
10	Wage Share	4.05	3.85	3.90	3.47	3.56	4.07
11	Real (consumption) wage	3.89	4.11	3.82	4.19	3.92	4.18
12	Real (product) wage	3.72	3.90	3.65	3.94	3.66	4.00
13	Inflation (P)	0.72	0.90	0.73	1.09	1.11	0.76
14	Inflation (Q)	0.89	1.10	0.89	1.34	1.37	0.93
15	Profit rate	-8.42	-7.12	-8.02	-5.61	-6.45	-7.72

Table 3: Summary of simulation results – Model responses to a 5 per cent shock to the wage curve intercept w_0.

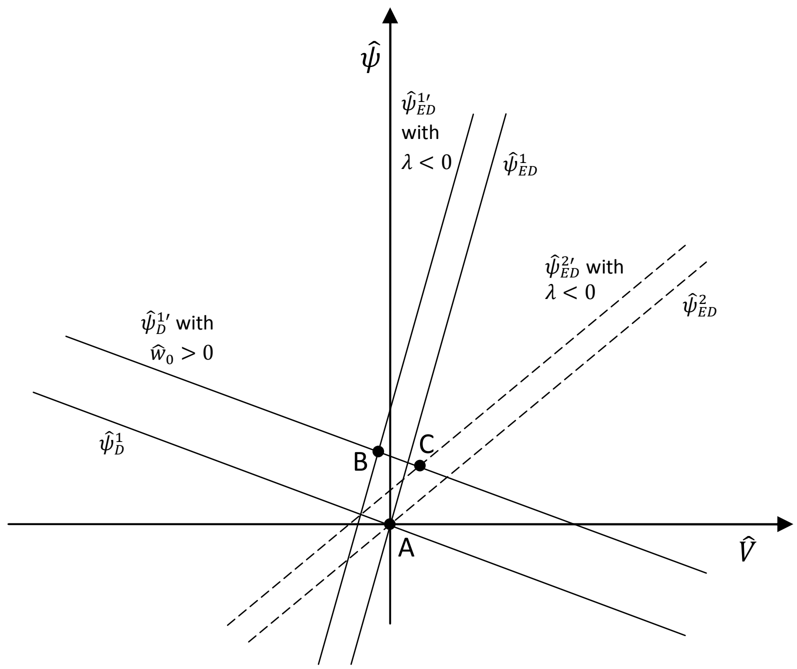

Figure 1: $\hat{\psi}_D^1$ represents a distributive curve with for forced saving, and $\hat{\psi}_{ED}^1$ a wage-led demand curve. All trend growth rates are assumed to be zero, so that the two curves cross at the origin, point A. A shock to $\hat{w}_0 > 0$ shifts the distributive curve upwards, and, if $\lambda < 0$, shifts the demand curve leftward. Whether the new steady state demand growth rate is smaller (point B) or larger (point C), depends on the relative size of λ and the slope of the demand curve.

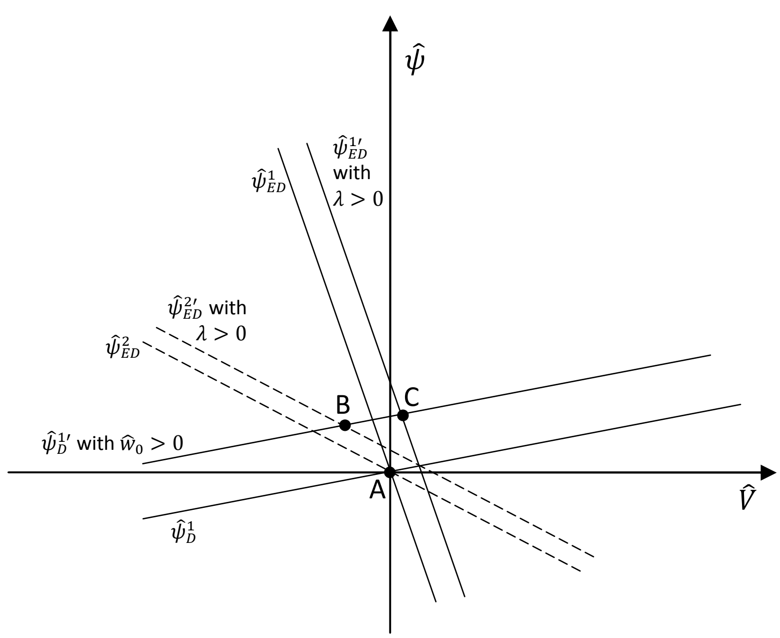

Figure 2: In this figure, $\hat{\psi}_D^1$ represents a distributive curve with a profit squeeze, and $\hat{\psi}_{ED}^1$ a profit-led demand curve. All trend growth rates are assumed to be zero, so that the two curves cross at the origin, point A. A shock to $\hat{w}_0 > 0$ shifts the distributive curve upwards, and, if $\lambda > 0$, shifts the demand curve outward. Whether the new steady state demand growth rate is smaller (point B) or larger (point C), depends on the relative size of λ and the slope of the demand curve.

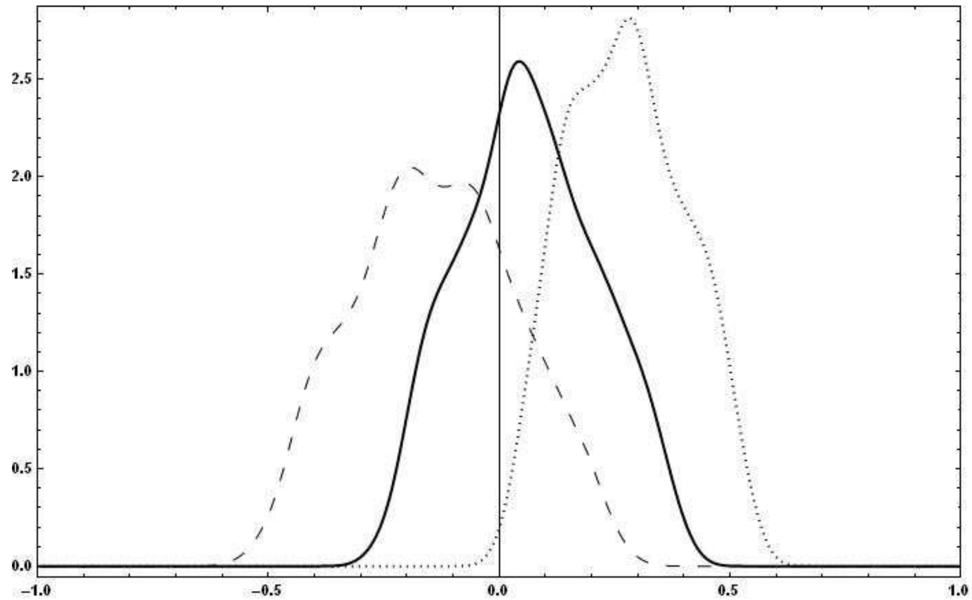

Figure 3: The probability distributions show repeated calculations of the slope of the (log-differentiated) effective demand curve, with α drawn from *different* uniform probability distributions: The black line shows the prior, as reported in Table 1. The dotted line shows a downward shift of α to [.18,.33], and the dashed line an upward shift of α to [.38, .7]. Bounds of all other elasticities are unchanged from the prior, see Table 1.

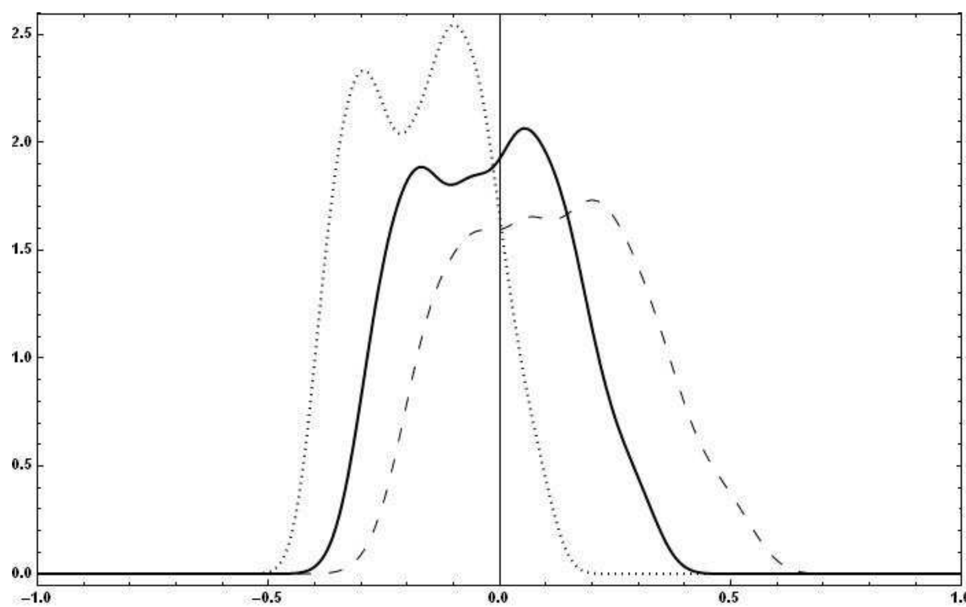

Figure 4: The probability distributions show repeated calculations of the slope of the (log-differentiated) distributive curve, with w_1 drawn from *different* uniform probability distributions: The black line shows the prior, as reported in Table 1. The dotted line shows a downward shift of w_1 to [.34,.64], and the dashed line an upward shift of w_1 to [.7, 1.3]. Bounds of all other elasticities are unchanged from the prior, see Table 1.

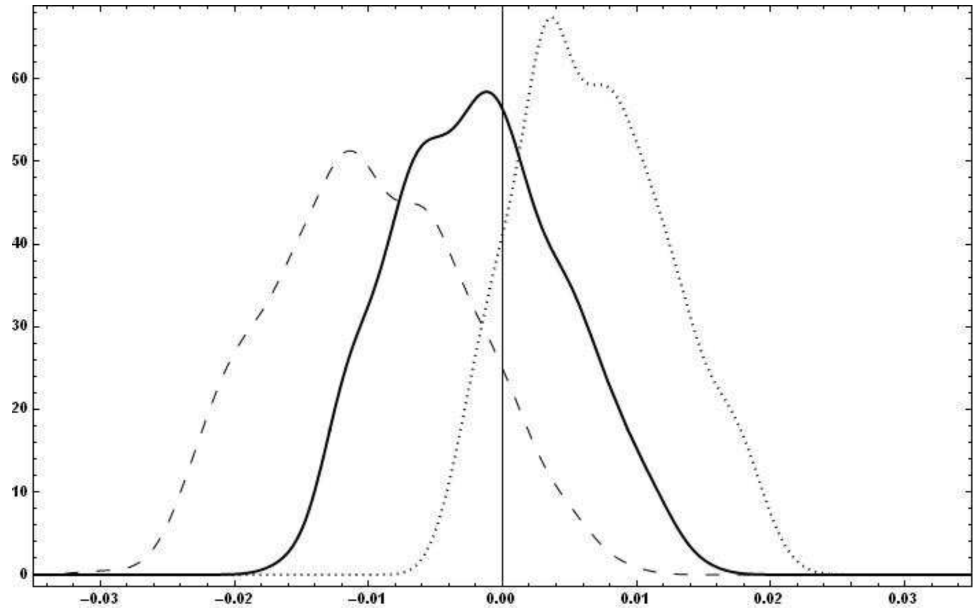

Figure 5: The probability distributions show repeated simulations of the model's response of GDP growth ($\widehat{V}$) to "wage policy," introduced with $\widehat{w}_0$=5%. The horizontal axis shows absolute numbers; growth varies between -3% and 2.5%, roughly. The black line shows model responses under the calibration prior, as reported in Table 1. Dotted line and dashed line represent model responses to the same shock, with calibrations changed as in Figure 3. The dotted line corresponds to a downward shift of α to [.18,.33], and the dashed line to a upward shift of α to [.38, .7].