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## **ABSTRACT**

Intangible capital is an important factor of production in modern economies that is generally neglected in business cycle analyses. We demonstrate that intangible capital can have a substantial impact on business cycle dynamics, especially if the intangible is complementary with production capacity. We focus on customer capital: the capital embodied in the relationships a firm has with its customers. Introducing customer capital into a standard real business cycle model generates a volatile and countercyclical labor wedge, due to a mismeasured marginal product of labor. We also provide new evidence on cyclical variation in selling effort to discipline the exercise.

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# 1 Introduction

Intangible capital is an important factor of production in modern economies. It is rarely introduced in business cycle models, however, perhaps because it is assumed to have little impact on the short-run dynamics of macroeconomic variables, or viewed as too difficult to measure. In this paper, we present preliminary results showing that intangible capital can have a substantial impact on business cycle dynamics, and offer some new empirical evidence relating to our theory.

Specifically, we provide quantitative simulations showing that the labor wedge – the ratio of the marginal rate of substitution of households and the marginal product of labor of firms – can appear counter-cyclical and volatile in an economy where intangible capital is an important factor of production – especially if this intangible capital is a complement to production capacity. The cyclical behavior of the labor wedge has been highlighted as an important feature of the data that remains so far largely unexplained (Hall 1997, Mulligan 2002, Chari, Kehoe, and McGrattan 2005).

The prime example of intangible capital motivating our analysis is customer capital – the capital embodied in the relationships a firm has with its customers – which has a natural complementarity with production capacity: in order to make sales, a firm must both produce the goods and services, as well as attract the customers to sell them to.[1] It would appear an important form of intangible capital based on the substantial resources firms spend on customer acquisition and retention each year: marketing expenses have been estimated to amount to as much as 8 percent of GDP, with 11 percent of the workforce employed in sales-related occupations. As many customer relationships take the form of long-term repeat relationships, this spending can be viewed as investment into customer capital.

We consider a simple extension of the real business cycle model incorporating investment by firms in a long-lived customer base. In this setting, an expansion in firm sales requires an increase in the customer base, through an increase in selling effort. Be-

[1] Except perhaps at very high frequencies where inventories allow to disconnect sales from production for some goods.

cause selling effort represents investment into customer capital, it is volatile and contributes to a significant increase in aggregate labor. Sales and output rise only slowly, however, as customers accumulate over time. An economist faced with the evidence produced by the model would be puzzled by the small increase in output relative to labor, which implies a significant drop in the measured labor wedge. The wedge is not related to an inefficiency here, but rather reflects the measurement problems associated with intangible capital.

Our theory has implications for the cyclical properties of selling effort, and hence, we start by providing some new evidence on this. We then formalize and quantify these ideas in the context of a model.[2]

## 2 Cyclicality of Selling Effort

Is selling effort procyclical or countercyclical? Two alternative intuitions come to mind. On the one hand, if building a customer base is a form of investment, we might expect it to be procyclical, as investment tends to be. But on the other hand, if the business cycle is driven by fluctuations in demand, and if recessions are times when finding customers is harder, selling effort might be countercyclical.

One important piece of evidence on this issue is the cyclical behavior of advertising, known to be significantly procyclical.[3] Advertising represents only a subset of selling effort, however. With the aim of measuring a broader notion of selling effort, we turn to labor force surveys, which include information on occupations. Specifically, we use the basic monthly CPS over the period 1994-2010, the March CPS over the period 1968-2013,

[2]This work is related to Gourio and Rudanko (forthcoming) providing a more detailed model and evidence on customer capital, as well as a discussion of the literature. The most closely related works to the present paper include McGrattan and Prescott (2010) and McGrattan and Prescott (2014), who study the role of intangible capital in accounting for the behavior of productivity and hours in the 1990s, and the recent recession, respectively.

[3]There is no single perfect time series of advertising, but all the available series we are aware of are procyclical and volatile: (i) the McCann advertising series (see Hall 2013), (ii) aggregated advertising spending from Compustat, (iii) the Newspaper Association of America-produced estimates of newspaper advertising revenue, (iv) the Duke CFO survey of advertising and marketing spending plans, and (v) the advertising index and the magazine advertising data of the NBER macro history database.

and the American Community Survey over the period 2005-2011, all obtained through IPUMS.

Our primary interest is measuring the number of employees engaged in building new customer relationships (corresponding to investment into customer capital), which brings about the challenge of figuring out which occupations correspond to this activity. The BLS defines a group of "sales-related occupations" (SRO), but some of these jobs are likely to have more to do with serving existing customers than attracting new ones. Further, the BLS does not include in this category several occupations that clearly represent new customer acquisition, such as marketing managers and market researchers.[4]

For these reasons, we construct several categories of selling employment. The first one is the sales-related occupations category as defined by the BLS, which amounts to 10.7 percent of total employment. These workers are roughly average in terms of their wage, education (28 percent have a college education), and demographics. If we take out cashiers and clerks, who are likely to be less involved in customer acquisition, the share of employment for this category falls to 4.7 percent, but the average wage increases by 30 percent (37 percent of the remaining workers have a college education). This new category is mostly made up of different types of sales representatives, including those in financial services and real estate, and retail sales supervisors. The third category adds marketing managers and market researchers to the second category. Finally, the fourth category takes out retail sales supervisors from the third category.[5]

Having constructed these four groups, we measure their cyclical sensitivity by running simple regressions of the employment growth of each group $\Delta \log N_{it}$ on aggregate employment growth $\Delta \log N_t$:

$$\Delta \log N_{it} = \alpha_i + \beta_i \Delta \log N_t + \varepsilon_{it}.$$

[4]Clearly, many workers are engaged to some extent in customer acquisition. We focus on specific categories here in order to measure the cyclicality of this activity, but the overall scope of the activity likely exceeds the bounds of these specific categories.

[5]This category would appear a substitute for the cashiers and clerks category, based on our analysis of the patterns of switching job categories over time.

Table 1: Cyclicality of Sales Employment

| | CPS<br>1994q1-2010q4<br>Time-series | CPS March<br>1968-2013<br>Time-series | ACS<br>2005-2011<br>Cross-state |
|---|---|---|---|
| Sales-Related Occupations (SRO) | 1.09 | 1.10 | 0.53 |
| SRO - cashiers and clerks | 1.31 | 1.36 | 1.32 |
| SRO - cashiers and clerks + marketing | 1.21 | 1.04 | 1.28 |
| SRO - broad cashiers and clerks + marketing | 1.40 | 1.05 | 1.90 |

Notes: Regression coefficient of sales employment growth on aggregate employment growth.

Table 1 reports the results for the three data sets discussed. For the first column, we use annual growth rates calculated from quarterly data obtained by aggregating the basic monthly CPS files over the period 1994-2010, while for the second, we use annual growth rates from the March CPS files over the period 1968-2013. For the third column, we use cross-sectional data, running a cross-state regression during the Great Recession period. In this case, we construct the growth rate of employment in each state as the average employment level in 2009-2011 relative to the average employment level in 2005-2007.

The results show that employment in sales-related occupations is procyclical, and somewhat more variable than aggregate employment overall. When we focus on those categories thought to be more involved in customer acquisition (our second, third, and fourth categories), we find that in many cases there are larger sensitivities still. This is perhaps even more surprising given that these workers are more educated and earn higher incomes – qualities we would expect to be associated with less cyclical variation *ceteris paribus*. Figure 1 illustrates this pattern for the CPS 1994-2010 data, showing that the declines in sales employment during the 2001 and 2008 recessions were steeper than the declines of aggregate employment.

Overall, we conclude that selling effort appears to be procyclical and relatively volatile.

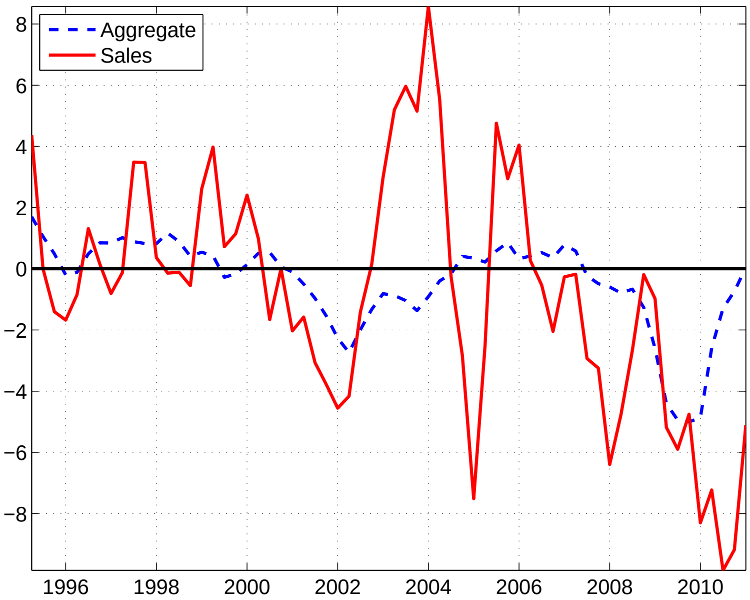


Figure 1: Annual Percentage Growth Rate of Aggregate and Sales Employment

# 3 Theory

Consider the following simple extension of the neoclassical business cycle model. Firms produce output $y_t$ using a standard Cobb-Douglas production technology: $y_t = k_t^{\alpha}(z_t n_{p,t})^{1-\alpha}$, where $k_t$ is capital, $n_{p,t}$ production labor, and $z_t$ productivity. Capital accumulates according to the law of motion $k_{t+1} = (1-\delta)k_t + x_t$, and the wage rate is $w_t$. To deliver this production output to the goods market, the firm must build a base of customers, which accumulates according to the law of motion

$$m_{t+1} = (1-\delta_m)\left(m_t + \xi n_{s,t}\right). \tag{1}$$

The customer base depreciates at the rate $\delta_m$ and grows as the firm employs sales labor to market and sell its production. (We use a broad interpretation of this sales labor, such that all labor engaged in customer acquisition activities is included.) For the sake of simplicity we assume a linear, labor-only technology for customer acquisition, with $\xi$

representing the productivity of sales activity.[6]

Given this, the firm problem reads as follows:

$$\max E_0 \sum_{t=0}^{\infty} M_{0,t} \left[ y_t - w_t(n_{p,t} + n_{s,t}) - x_t \right],$$
$$s.t.\ k_{t+1} = (1-\delta_k)k_t + x_t,$$
$$m_{t+1} = (1-\delta_m)\left(m_t + \xi n_{s,t}\right),$$
$$y_t = k_t^{\alpha}(z_t n_{p,t})^{1-\alpha},$$
$$y_t = m_t + \xi n_{s,t},$$

where $M_{0,t}$ is the stochastic discount factor, in equilibrium equal to the marginal rate of substitution of households. This firm problem differs from the standard one simply by adding the law of motion for the customer base together with the demand constraint that sales equal the size of the customer base $y_t = m_t + \xi n_{s,t}$, as well as the related choice of how much sales labor to hire.

We denote by $\mu_t$ the Lagrange multiplier on the demand constraint, so that the optimality condition for sales labor becomes

$$w_t = \xi E_t \sum_{j=0}^{\infty} (1-\delta_m)^j M_{t,t+j}\mu_{t+j}, \tag{2}$$

indicating that the firm hires sales labor up to a point where the marginal cost equals the present discounted value of the resulting customer capital.

The optimality condition for production labor becomes

$$w_t = (1-\alpha)\frac{y_t}{n_{p,t}}(1-\mu_t), \tag{3}$$

indicating that the firm hires production labor to a point where the marginal cost equals the marginal product, while taking into account the costs of customer capital required

[6]See Gourio and Rudanko (forthcoming) for a more detailed model of customer capital that this stylized model is a special case of.

to sell the additional output. Rearranging equation (3) shows that $\mu_t$ turns out to equal the markup the firm makes over the marginal costs of production.

And finally, the optimality condition for investment becomes

$$1 = E_{t-1}\left[M_{t-1,t}\left(1-\delta_k+\alpha\frac{y_t}{k_t}(1-\mu_t)\right)\right], \tag{4}$$

which similarly takes into account the costs of customer capital required to sell the additional output.

The household side of the model is standard: The household chooses how much labor to supply and how much to consume to maximize the expected present discounted value of flow utility, $U(c,n) = \log c - \frac{\gamma}{1+1/\varepsilon}n^{1+1/\varepsilon}$. The first order conditions imply that $w_t = \gamma c_t n_t^{1/\varepsilon}$ and $M_{t,t+j} = \beta^j c_t/c_{t+j}$.

In equilibrium, markets for goods and labor clear: $c_t + x_t = y_t$ and $n_t = n_{p,t} + n_{s,t}$.

# 4 Shock Propagation

We now turn to study the impact of intangible capital on shock propagation in the model. For the sake of brevity, we focus on shocks to productivity $z_t$.

To parameterize the model, we first adopt values for the standard parameters from the business cycle literature, setting $\alpha = 0.3$, $\delta_k = 0.025$, $\beta = 0.995$, $\varepsilon = 4$, on a quarterly basis, and set $\gamma = 4.19$ to target a steady-state wedge of 0.4. We then follow the approach of Gourio and Rudanko (forthcoming) in parameterizing $\delta_m$ and $\xi$. We set $\delta_m = 0.05$ based on available evidence on customer turnover rates, and $\xi = 0.72$ to target a steady-state share of labor in sales of 15 percent. As discussed above, according to the BLS classification, sales-related occupations account for 11 percent of employment, but also employees outside this category are likely to be involved in customer acquisition to a degree.

Turning to the results, Figure 2 displays the responses of output, labor, sales labor, and the labor wedge in the model to a persistent one percent increase in productivity $z$.

We measure the labor wedge as

$$\tau = 1 + \frac{\frac{U_n(c,n)}{U_c(c,n)}}{(1-\alpha)\frac{y}{n}}, \tag{5}$$

following Shimer (2009).

The figure compares the customer capital model to the standard real business cycle (RBC) model, the limit of the customer capital model when $\xi \to \infty$. As the first panel illustrates, customer capital generates a hump-shaped output response. When productivity increases, firms seek to take advantage of this by expanding production, but the expansion is constrained by the customer base. To build up the customer base, firms increase sales labor in response to the shock, and as a result aggregate labor increases more than in the RBC model. As a consequence, the response of measured productivity in our model is also hump-shaped, and markedly different from $z$. The final panel depicts the labor wedge, which is constant in the RBC model but counter-cyclical and volatile in the customer capital model.

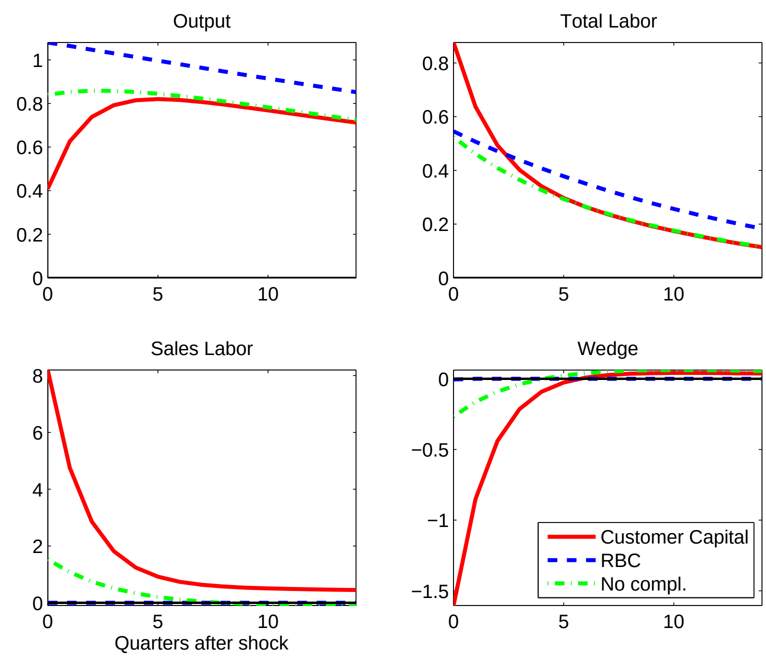


Figure 2: Impulse Responses to Positive Productivity Shock, in Percentage Terms

To understand the behavior of the labor wedge in the customer capital model, note

Table 2: Business Cycle Statistics

| | Volatilities | | | | Correlations | | | |
|---|---|---|---|---|---|---|---|---|
| | $y$ | $n$ | $n_s$ | $\tau$ | $(n, y)$ | $(n_s, y)$ | $(n_s, n)$ | $(\tau, n)$ |
| Data | 1.12 | 0.92 | 2.31 | 1.62 | 0.94 | 0.27 | 0.37 | -0.89 |
| Models: | | | | | | | | |
| RBC | 0.90 | 0.46 | – | – | 0.98 | – | – | – |
| Customer Capital | 0.74 | 0.77 | 6.81 | 1.36 | 0.60 | 0.34 | 0.95 | -0.92 |
| No complementarity | 0.94 | 0.54 | 1.49 | 0.27 | 0.94 | 0.72 | 0.90 | -0.79 |

Notes: Both empirical (1994-2010) and model-simulated time series are HP(1600)-filtered.

that the labor wedge calculation assumes a standard Cobb-Douglas aggregate production function, where the marginal product of labor can be measured using the average product $y/n$ (see equation (5)). This expression is misspecified in our model. Our model can be thought of as a two-sector model (production and sales) with perfect complementarity between sectors, where the output of the sales sector (the new customer relationships) is not counted in GDP. As a result, the average product of labor – calculated as $y/n$ – does not correspond to the marginal.[7]

To illustrate the role of the complementarity, Figure 2 compares these responses to a variant of the customer capital model relaxing the complementarity. In this model $m$ represents an intangible capital which enters into production as: $y = (k^\alpha (zn_p)^{1-\alpha})^\omega (m + \xi n_s)^{1-\omega}$.[8] The expression for the marginal product continues to be misspecified in this setting as well, but as the figure shows, the quantitative impact on model dynamics is clearly weaker.

A potential resolution to the measurement problem is to use consistent measures of labor and output in the expression for the marginal product: if we only include pro-

[7]Our model generates a wedge on the labor demand side. Karabarbounis (forthcoming) has recently argued in favor of a wedge on the labor supply side instead, but his approach requires treating average per-period wages as allocative.

[8]This technology is closer to what McGrattan and Prescott (2014) use for the production of tangibles, but they emphasize shocks to intangible rather than tangible production, with intangible capital a non-rival input in the production of tangibles and intangibles.

duction output in the numerator, then we should only include production labor in the denominator. Returns to labor are equated across production and sales activities in this economy, and in the model without complementarity one can indeed use $y/n_p$ as an exact measure of the marginal product of labor. In the customer capital model (with complementarity) this is not the case, however, as seen in equation (3).

Finally, note that simply making it costly for firms to attract customers is not enough to get the effects of customer capital highlighted here. In a model where the customer base depreciates fully from one period to the next ($\delta_m = 1$), sales labor is always proportional to output and the model dynamics are very similar to the standard RBC model.

To quantify the magnitude of these effects, we produce business cycle moments and compare them to US data in Table 2. For each model, we set the volatility of $z$ so that the Solow residual in the model has the same volatility as in the data. The first row recapitulates well-known stylized moments of US business cycles. Relative to this evidence, the RBC model underestimates the volatility of employment and the labor wedge, while the customer capital model generates significantly more volatility in both. The volatility of sales labor in the model appears high relative to the data, however.

# 5 Concluding Remarks

Intangible capital is typically omitted in business cycle analysis, and our preliminary results suggest that this may be an important omission. Clearly, more work remains to be done on developing the evidence, and the theory will likely need to be adjusted accordingly. Our simple model for example predicts a volatility for selling effort that is high relative to our data. How would this – and other results – change if the model was extended to allow firms to use prices as an alternative means of attracting customers? How would imperfect competition, an intensive margin of demand, or endogenous separations of customers affect these results? These questions remain for future research.

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