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Learning-by-doing, organizational capital and optimal marku variations

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ABSTRACT

We characterize optimal markup variations in an otherwise standard Ramsey model augmented with learning-by-doing mechanism to firms' technology. In our setup, firms learn from their production experience and accumulate an intangible organizational capital stock which raises their future productivity. Two main results emerge from our study. First, optimal Ramsey allocation features procyclical markup variations. Second, the level of markup is inversely related to the degree of learning. Both of these results stem from a common source - the dynamic link between the current level of production and the future levels of productivity. A change in markup not only changes demand and the level of production in the current period, it also affects the stock of organizational capital and productivity in the future. So, by changing markups procyclically, the Ramsey planner can essentially dampen the cyclical effects of a persistent productivity shock. With a higher learning rate the future productivity gain from a marginal fall in markup is larger and hence our model predicts that optimal markup should be lower for a higher rate of learning.

1. Introduction

A growing number of studies analyze the importance of markup variations for welfare and macroeconomic dynamics.[1] Also, there is a sizable empirical literature which studies the cyclical behavior of markups.[2] However, there has been little work on developing the implications of markup variations for optimal macroeconomic policy. Some recent studies find that markup fluctuations have important implications for macroeconomic policy.[3] This paper contributes to this new strand of literature by taking a normative stand and addressing the question - how should markup vary over the business cycle. To this end, we augment a standard imperfectly competitive Ramsey model by embedding learning-by-doing (LBD) mechanism to firms' technology, and study the canonical Ramsey problem of optimal policy design. We show that the presence of LBD and organizational capital creates a link between current level of production and future levels of productivity and cost, which essentially gives rise to a theory of time varying endogenous markup. Also, our analysis shows that organizational capital has direct impacts on the demand side of the economy

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[1] See e.g., Davis and Huang (2011), Jaimovich and Floetotto (2008), Monacelli and Perotti (2008), Gali, Gertler, and López-salido (2007), Rotemberg and Woodford (1991), and the citations therein.

[2] For a sample of papers studying cyclical behavior of markups, see, e.g. Jaimovich (2007), Banerjee and Russell (2004), Kollmann (1997), Bils (1987), Nekarda and Ramey (2013), Johri (2001), Haskel, Martin, and Small (1995), Morrison (1994) . Interestingly, no consensus has been reached on whether markups are pro- or countercyclical. The first four studies suggest that markups are countercyclical, while the work by Nekarda et al. suggests that they are procyclical conditional on a technology shock but acyclical conditional on demand shocks; the last three studies likewise suggest pro-cyclicality of mark ups.

[3] For example, Faia (2012) show that including markups as a target variable in an operational monetary policy rule improves welfare compared to the ones which do not react to markups.

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which further strengthen the learning by doing mechanism. Two main results emerge from our analysis of the Ramsey problem. First, optimal markup is procyclical – it falls during recession and rises during boom. Second, the size of the markups and the rate of learning are inversely related - the higher the rate of learning the lower the optimal markup.

There is an extensive empirical literature[4] documenting the pervasive influence of learning-by-doing in productive activities. The main lesson from this literature is that agents and organizations appear to become more productive as they gain experience at producing a particular product or service. Also, the very same idea is implicitly contained in the sizeable empirical industrial organization literature on estimating learning curves at the industry or firm level. A second strand of literature explores the macroeconomic implications of LBD mechanism and especially its ability to resolve discrepancies between existing models and data.[5] Finally, some recent studies, e.g. Martin and Rogers (2000), Johri and Talukdar (2011), Conesa and Domínguez (2013), and Talukdar (2014), investigate the implications of LBD for optimal macroeconomic policy issues. In particular, Talukdar (2014) study the impact of LBD on optimal inflation and labor income tax dynamics, Martin and Rogers (2000) analyses the optimal fiscal stabilization policy in presence of learning by doing, while Johri and Talukdar (2011), and Conesa and Domínguez (2013) investigate the impact of intangible capital on optimal capital income taxation. Our paper brings together this final strand of literature and the literature studying the importance of endogenous markup variations for macroeconomic dynamics.

In order to model the learning-by-doing effect into production technology, we closely follow the work of Cooper and Johri (2002) and assume that firms learn from their production experience and accumulate production related knowledge in the form of an intangible capital - commonly known as organizational capital (OC). More specifically, higher production in any period by a firm leads to the accumulation of organizational capital by the firm. This accumulation of organizational knowledge not only increases firms productivity in the next period, it also contributes to the stock of organizational capital in all future periods. This link between current level production and future levels of productivity makes the pricing decision dynamic with firms endogeneizing the effect of their pricing decision today on productivity tomorrow. The presence of this dynamic link in production environment gives rise to a theory of endogenous markup determination at the firm level. The monopolistically competitive firms maximize their lifetime profits by essentially choosing their level of markups and thereby controlling how much they wish to learn and accumulate organizational capital for the future. This very feature of the model is the key in delivering the main results of our paper.

The economic intuition for the optimality of pro-cyclical markup variations is rather straightforward. As the firms face downward sloping demand curves for their products, the size of their price (markups) and the demand for their products are inversely related. Also, because of the LBD effect, there is a direct link between the current level of production and the future level productivity. Therefore, the Ramsey planner can use markup variations as a way of altering future productivity and thereby minimizing the welfare-reducing cyclical impacts of the productivity shocks. For example, if the economy is hit by a negative and persistent productivity shock, a reduction in markup can generate higher demand and production. And the higher the level of current production, the higher the level of future productivity due to the larger future stocks of organizational capital. Conversely, when the economy experiences a positive productivity shock, a current raise in markup will ultimately cause a downward movement in future level of productivity. Therefore, by pro-cyclical variations in markups, the Ramsey planner is partly able to mitigate the welfare-reducing cyclical effects of exogenous productivity shocks. The reason for the inverse relationship between the learning rate and the optimal markup is that a higher (lower) learning rate causes a stronger (weaker) link between the current level of production and the future level of productivity. That is, with a higher learning rate, a given reduction in markup can result in a larger gain in future productivity and profit. Therefore, the Ramsey optimality implies that the higher the learning rate, the lower the optimal markup. Our numerical results show that the net markup approaches to zero as the learning rate crosses the 25% mark.

Finally, we show that learning by doing mechanism is strengthen further by the feedback effects from the demand side of the economy. Since LBD increases productivity, it can affect household's income by raising both profits and labor earnings. In particular, our quantitative results show that the higher the learning rate, the higher are the profits, and the net labor earnings. Moreover, the higher the household income, the higher is the optimal level of consumption. And, a higher demand for consumption goods implies higher production by the intermediate goods firms which also means larger stocks of organizational capital available for all the future periods.

The structure of the paper is as follows. Section 2 describes the economic environment, discuses about the sources of the main findings, and defines the equilibriums. Section 3 discusses about parameterizations and functional forms of our model. Section 4 establishes our central results by analyzing the dynamic properties of the Ramsey allocations and Section 5 presents some concluding remarks.

2. The model

The model economy consists of households, firms, and the government. The production environment consists of two sectors: intermediate goods and final goods. The main innovation in our model is that we embed a learning-by-doing mechanism to intermediate firms' production technology. This feature of our model gives rise to a time-varying mark-up which depends on the value of the LBD parameters. What follows is a description of the consumers problem, the production structure of the economy, the government and the resource frontier, and the definition of equilibrium in our model.

[4] A partial list of studies include Bahk and Gort (1993), Irwin and Klenow (1994), Jarmin (1994), Benkard (2000), Thornton and Thompson (2001), and Atkeson and Kehoe (2005). In particular, Atkeson and Kehoe (2005) model learning-by-doing mechanism and estimate the size of organizational capital for the US manufacturing sector and find that it has a value of roughly 66% of physical capital.

[5] See, for example, Cooper and Johri (2002), Chang, Gomes, and Schorfheide (2002), Samaniego (2006), Johri and Lahiri (2008), Gunn and Johri (2011)