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Lauri Vilmi

STUDIES IN THE MACROECONOMIC IMPLICATIONS OF FIRM ENTRY AND EXIT

UNIVERSITY OF OULU GRADUATE SCHOOL;
UNIVERSITY OF OULU,
OULU BUSINESS SCHOOL,
DEPARTMENT OF ECONOMICS

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Abstract

Standard macroeconomic models based on a representative firm ignore firm entry and exit. Therefore, these models miss a potentially significant channel of economic interactions through the firm dynamics. This doctoral thesis examines the role of firm dynamics in the economy through four essays.

The first essay examines the impact of monetary policy on firm entry. The essay finds that substantial inertia exists in the firm entry process. Based on the empirical evidence on firm dynamics, the second essay develops a real business cycle model in which firm entry is endogenous and default rates are stochastic. The essay studies how default shocks affect the economy. We concentrate on the stochastic properties of the model and show that the stochastic default rate is a potential explanation for the observed low correlation between labor productivity and hours worked. The third essay contributes to the previous literature by studying how endogenous exit rates affect business cycle dynamics in an economy subject to technology and money supply shocks. The fourth essay concentrates on the impact of exchange rate shocks on competition and import prices. The paper finds weak evidence that the changes in competition after a currency devaluation increase import prices. However, this effect occurs only in the long run (i.e., one year after the shock), and its magnitude varies greatly across countries.

Keywords: business cycles, firm defaults, firm dynamics, monetary policy

Vilmi, Lauri, Tutkimuksia yritysten markkinoilletulon ja markkinoilta poistumisen makrotaloudellisista vaikutuksista.
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Tiivistelmä

Tässä väitöskirjassa tutkitaan yritysten markkinoilletulon ja markkinoilta poistumisen vaikutuksia talouden dynamiikkaan. Väitöskirja koostuu neljästä erillisestä esseestä.

Ensimmäisessä esseessä tutkitaan rahapolitiikan vaikutusta yritysten markkinoilletuloon. Siinä löydetään yritysten syntymiseen liittyviä kustannuksia, jotka hidastavat koko talouden sopeutumista rahapoliittiseen sokkiin. Toisessa esseessä tutkitaan stokastisen yritysten markkinoilta poistumisen vaikutuksia makrotaloudellisiin muuttujiin. Havaitaan, että yritysten poistuminen markkinoilta on mahdollinen selitys aikaisemmassa kirjallisuudessa todettuun työn tuottavuuden ja tehtyjen työtuntien väliseen alhaiseen korrelaatioon. Kolmannessa esseessä endogenisoidaan yritysten poistuminen markkinoilta ja tutkitaan teknologian ja rahapolitiikan sokkien vaikutusta yritysten konkurssien määrään. Neljännessä esseessä puolestaan tutkitaan, miten valuuttakurssimuutokset vaikuttavat ulkomaisten yritysten markkinoilletuloon ja hinnoitteluun. Esseessä löydetään heikkoja todisteita siitä, että valuuttadevalvaation jälkeinen ulkomaisen kilpailun muutos nostaa tuontihintoja. Tämä vaikutus ilmenee kuitenkin vasta yli vuoden kuluttua sokista, ja sen suuruus vaihtelee suuresti maittain.

Asiasanat: markkinoilta poistuminen, rahapolitiikka, suhdannevaihtelut, yritysten markkinoilletulo

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Helsinki, January 2012 Lauri Vilmi

List of Original Essays

The dissertation includes an introductory chapter and four essays. Essay (IV) was co-authored with Marko Korhonen. Both authors were involved in planning, designing and executing the study. Vilmi's main responsibility was to write the theoretical model and the manuscript. Both authors performed the statistical analysis.

I Vilmi L (2011) Nominal and Real Rigidities and the Effects of Monetary Policy on Firm Entry. Manuscript.

II Vilmi L (2011) Firm Default Shocks and the Correlation between Labor Productivity and Hours Worked. Manuscript.

III Vilmi L (2011) The Effects of Endogenous Firm Exit on Business Cycle Dynamics and Optimal Fiscal Policy. Manuscript .

IV Korhonen M & Vilmi L (2011) Competition and Exchange Rate Pass-Through. Manuscript.

Contents

1 Introduction

1.1 Background

> *The principal and sufficient cause of cyclical fluctuations should rather be sought in the fact that in its very nature technical or commercial advance cannot maintain the same even progress as does, in our days, the increase in needs — especially owing to the organic phenomenon of increase of population — but is sometimes precipate, sometimes delayed. It is natural and at the same time economically justifiable that in the former case people seek to exploit the favourable situation as quickly as possible, and since the new discoveries, inventions, and other improvements nearly always require various kinds of preparatory work for their realization, there occurs the conversion of large masses of liquid into fixed capital which is an inevitable preliminary to every boom and indeed is probably the only fully characteristic sign, or at any rate one which cannot conceivably be absent.*
>
> *If, again, these technical improvements are already in operation and no others are available, or at any rate none which have been sufficiently tested or promise a profit in excess of the margin of risk attaching to all new enterprises, there will come a period of depression; people will not venture to the capital which is now being accumulated in such a fixed form, but will retain it as far as possible in a liquid, available form.*
>
> Wicksell (1935).

Wicksell (1935) pointed out that the generation of new discoveries or enterprises has a potentially important impact on business cycles. Economists started to pay attention to this issue just at the beginning of 2000's. This thesis examines how firm dynamics affect the overall economy. Firm dynamics, i.e. changes in the number of operating firms, includes both the entry of new firms and the exit of incumbent firms. The dynamics of entry and exit may, in turn, have important effects on the economy. This thesis explores how the entry and exit mechanisms contribute to improve our understanding of business cycle dynamics. Firm dynamics brings also new channels for monetary policy. Monetary policy affects the financing of firms, and especially investments in new

production lines, factories and firms. At the same time the tendency for firms to fail is among the most prominent features of recession, and firm defaults are likely to depend on the availability of finance. Bergin & Corsetti (2008) state that this extensive margin is widely under-appreciated but a potentially important mechanism for monetary policy. In the thesis I also examine this channel for monetary policy more closely.

Traditional business cycle and growth theories model the supply side of the economy via the behavior of a representative firm. Firms combine resources, usually capital and labor, to produce the final product with some exogenous productivity. Firms sell final goods in a competitive market and pay compensation to the owners of resources. Labor force earns wages and capital owners interest rate.

It is widely assumed that monetary policy is neutral in the long run. In the long run money has impact only on nominal prices but does not affect real variables. However, there is strong evidence that in the short run monetary disturbances have a signifact effect on real variables such as output and unemployment. Since the essays of *Of Interest* and *Of Money* by David Hume in 1752 these two incompatible effects of money have been at the center of monetary research. Friedman & Schwartz (1963) present evidence that money growth rate changes affect real economy. Later for example Christiano *et al.* (1999) provide more evidence for this by estimating the effects of monetary shocks by the identified vector auroregressive regression (VAR).

In the 1980s nominal price or wage rigidities became a standard explanation for the effects of monetary policy. According to these explanations money has real short-run effects because firms cannot adjust their prices and wages immediately. In the long-run firms are able to adjust their prices and money does not have any real effects. To model this effect Calvo (1983) introduces the staggered price setting for the firms. This sluggish response of price setting has become the foundation for the large body of modern macroeconomic models to account for the observed inertia in the price setting. To make firms set their prices optimally and to capture staggered price setting macroeconomic models such as nowadays widely used dynamic stochastic general equilibrium (DSGE) models assume monopolistic competition based on the preferences laid out by Dixit & Stiglitz (1977). This common feature of DSGE models generates persistent profits for firms. Permanent positive profits should induce more firms to enter the market. Standard models based on the representative firm ignore possible firm dynamics caused by positive profits, and assume a constant number of producers. Therefore, these models miss a potentially significant channel of economic interactions through the firm dynamics, which already Schumpeter (1934) stated:

the boom ends and the depression begins after the passage of the time which must elapse before the products of the new enterprises can appear on the market. And a new boom succeeds the depression when the process of resoption of the innovations is ended.

As Wicksell (1935) noticed firm entry is not frictionless but subject to different types of entry costs. Before engaging into the production process the entrants have to develop new goods and build up the production lines. The costs of starting production are not only research and development costs, but also costs due to government requirements and the regulation of entry. Djankov *et al.* (2002) provide cross country evidence for the costs of regulation. They find that already these official costs of entry are significant and time-consuming in most countries. They claim that official costs of entry process vary substantially across countries but correspond on average to about half a year's labor income. The entry is not only costly but takes time. According to their results, it takes on average 47 days to fulfill the official requirements for the entry. Thus, there seems to be inertia between investment decisions and the starting of production. Entry costs are potentially important for the dynamic responses of economies to different shocks. As Bilbiie *et al.* (2007) state "*the sluggish response of the number of producers generates a new and potentially important mechanism for real business cycle models*".

Export entry costs are used in the international trade literature to explain why some firms trade and some do not. Melitz (2003) shows that the exposure to trade will induce only the more productive firms to enter the export market. At the same time, the least productive firms cannot acquire finance for fixed costs and are forced to exit. Chaney (2008) models trade barriers as fixed costs, and shows that in the sectors with a low elasticity of substitution between goods the extensive margin, i.e. the entry of new exporters, is highly sensitive to trade barriers. Bernard & Jensen (2004) study empirically the factors that increase the probability of entry into exporting. They find that export entry costs affect significantly the export decision.

Dunne *et al.* (1988) present evidence for the firm entry and exit rates in the U.S. manufacturing industries. They find that entry and exit rates vary substantially and persistently across industries. Anyway, entry and exit are significant phenomena affecting large body of firms in every industry. During a five year period exit rate in the manufacturing industry is approximately 30 to 50 percent. The corresponding rate for the entry has the value of similar magnitude. Caballero (2007) summarizes literature on the job flows and finds similar evidence that gross job creation and destruction are large,

ongoing and persistent phenomena.[1] He also studies the behavior of job flows across business cycles and shows that job destruction exhibits sharp rises during recessions. Jacobson *et al.* (2008) provide evidence for the interaction between macroeconomic fluctuations and business defaults in Sweden over the period 1990-2002. They find that macroeconomic variables are important for explaining the time-varying likelihood of default. However, the quantitative magnitude of the effects of different macroeconomic variables seem to be sector specific. For example, output gap (i.e. business cycles) and the nominal interest rate (i.e. the stance of monetary policy) are important factors in the construction and real estate sectors in comparison with other industries. The nominal interest rate is very important for the financial service sector. Inflation and real exchange rate do not seem to affect significantly to the default rate but the real exchange rate depreciation decreases significantly the default risk in the manufacturing sector, which is the most export-oriented industry.

Firm entry and exit are important phenomena affecting the number of firms operating in the economy. How do these changes in the number of firms contribute to the economic development and business cycle dynamics? First, tougher competition decreases mark-ups and prices. The second impact comes from the positive effects which make final good production more efficient as the number of product varieties increase. This thesis concentrates mainly to examine the effects through the latter channel. This love for variety effect stems straight from the constant elasticity of scale production function in the final good production as in Dixit & Stiglitz (1977), and can be considered as a shortcut to model positive spillover effects across firms. Ethier (1982) uses similar production function to illustrate international returns to scale effects of intraindustry trade. Guiso & Schivardi (2011) provide evidence for the positive externalities for more firms. They observe that in Italy higher entrepreneurial incidence is connected to higher average productivity. They also find that higher productivity and positive externalities seem to be sectoral. Thus, positive externalities across firms are important factors generating clusters, i.e. areas with many entrepreneurs. Already Schumpeter (1934) highlighted the importance of spillover effects on the development of clusters. Marshall (1920) found three channels through which agglomeration affects the productivity: the opportunities to learn from other firms either because of knowledge spillovers or through the observation of other firms, bigger labor pool which increases the division of labor, and finally a greater variety of intermediate inputs may make production more effective.

[1] In our terminology we equate a firm or producer with the production line of individual variety. Therefore, we can think job destruction as a possible measure for the firm defaults.

Also Young (1928) argued that external economies of scale are important for the development. He states that larger markets generate new oppurtunities for the firms and ”the division of labour” and new advantages attach to it. The extent of American domestic market, unimpeded by trade barriers, may have caused the overwhelming development during the end of 19th century and in the 20th century. He finds that it is mainly new firms and product varieties which are the source of positive spillover effects:

> *When we look at the internal economies of a particular firm we envisage a condition of comparative stability. Year after year the firm, like its competitors, is manufacturing a particular product or group of products, or is confining itself to certain definite stages in the work of forwarding the products towards their final form. Its operations change in the sense that they are progressively adapted to an increasing output, but they are kept within definitely circumscribed bounds. Out beyond, in that obscurer field from which it derives its external economies, changes of another order are occurring. New products are appearing, firms are assuming new tasks, and new industries are coming into being. In short, change in this external field is qualitative as well as quantitative.*

In my thesis positive spillover effects stem from the generation of new product varieties. These product varieties are not just highly differentiated goods but new firms can even generate new industries. These totally new products can boost the economy of other industries, and hence generate spillover effects. This generation of varieties has an essential role in the economic development. In fact Young (1928) wrote:

> *Much has been said about industrial integration as a concomitant or a natural result of an increasing industrial output. It obviously is, under particular conditions, though I know of no satisfactory statement of just what those particular conditions are. But the opposed process, industrial differentiation, has been and remains the type of change characteristically associated with the growth of production. Notable as has been the increase in the complexity of the apparatus of living, as shown by the increase in the variety of goods offered in consumers' markets, the increase in the diversification of intermediate products and of industries manufacturing special products or groups of products has gone even further.*

And he continued to state that more varieties make economic production more efficient

This should be sufficiently obvious if we assume, as we must, that in most industries there are effective, though elastic, limits to the economical size of the individual firm. The output of the individual firm is generally a relatively small proportion of the aggregate output of an industry. The degree in which it can secure economies by making its own operations more roundabout is limited. But certain roundabout methods are fairly sure to become feasible and economical when their advantages can be spread over the output of the whole industry. These potential economies, then, are segregated and achieved by the operations of specialised undertakings which, taken together, constitute a new industry.

1.2 Related Literature

Hopenhayn (1992) presents the industry equilibrium model, where the processes for the entry and exit as well as for individual firms' output and employment are endogenously determined. Hopenhayn & Rogerson (1993) apply that model to a general equilibrium setting and study the consequences of a tax on job destruction. They find that in the economy with endogenous firm dynamics the tax has a sizable negative impact on total employment and average productivity.

In his seminal work, Melitz (2003) shows how exposure to trade induces only the more efficient firms to enter the export market and forces the least productive firms to exit. Bergin & Corsetti (2008), Bilbiie *et al.* (2007) and Lewis (2006) observe that firm entry is strongly procyclical. According to Lewis (2006), the correlation between output and net entry is as high as 0.71. Based on Melitz's international trade model, Bilbiie *et al.* (2007) build a real business cycle model consistent with the empirically observed procyclical number of producers and profits and countercyclical mark-ups. Their model performs at least as well as the benchmark model with respect to the implied second order properties of the key variables. Bergin & Corsetti (2008) show that firm entry alters the transmission of monetary policy innovations. In their model, stabilization policy has an additional role in regulating the optimal number of firms. Additionally, Bilbiie *et al.* (2008a) show that monetary policy affects firm entry by changing asset prices. This channel restores the Taylor principle in the presence of capital accumulation. Producer price inflation acts as a distortionary tax on profits, and distorts the allocation of resources to firm entry. Therefore, optimal monetary policy stabilizes individual product prices. Bilbiie *et al.* (2008b) show that the market economy in the model with

endogenous firm entry is efficient if and only if the consumption aggregator is of the constant elasticity of scale form. Lewis (2006) presents evidence based on estimated vector autoregressive models to suggest that firm entry reacts significantly to various shocks in the economy.

Most of the earlier literature on firm dynamics has concentrated on the dynamics of endogenous firm entry while assuming a constant exit rate. Despite the lack of theoretical DSGE models with endogenous firm exit, there is strong empirical evidence that firm exit rates vary over time. Jaimovich & Floetotto (2008) show that firm failures are strongly countercyclical but also vary substantially across industries. One of the few theoretical DSGE models that takes into account endogenous firm exit is Ghironi & Melitz (2005). In their paper, firms enter and exit the export market depending on macroeconomic conditions. The authors show that endogenous changes in firm exit alter the composition of the consumption basket. Thus, there exist endogenously persistent deviations from the purchasing power parity.

2 Summary of Essays

2.1 Essay 1: Nominal and Real Rigidities and the Effects of Monetary Policy on Firm Entry

The first essay examines the impact of monetary policy on firm entry. Bergin & Corsetti (2008) and Lewis (2006, 2009) find that expansionary monetary policy increases investments in the new firms. Previous papers do not estimate the exact model of firm entry but concentrate on studying the sign and magnitude of the response of firm entry. This essay aims to estimate the model with endogenous firm entry by matching theoretical impulse responses to an expansionary monetary policy shock with the corresponding empirically observed responses from vector autoregressive regressions. We contribute to the existing literature by studying what kind of features the model with endogenous firm entry must have to replicate empirically relevant impulse responses to monetary policy shocks. Especially, we concentrate on the effects of different nominal and real rigidities on the firm entry process.

Studying the effects of monetary policy on firm entry is an important and largely ignored topic in macroeconomic literature. As Bergin & Corsetti (2008) note,"*new startup firms are likely to be among the most sensitive to interest rate changes by policy makers*". Bilbiie *et al.* (2008a) study theoretically the interaction between monetary policy and firm entry and find that monetary policy directly affects asset prices because of a no-arbitrage condition. Bergin & Corsetti (2008) show that endogenous firm entry leads to a greater persistence in the effects of monetary policy shocks. They also notice that entry affects welfare. Thus, monetary policy has an additional role in regulating the number of entrants.

We find that the marginal cost of firms must depend on wages and interest rate to replicate observed positive response of firm entry to a shock. When firms utilize both capital and labor in their production and the wage expenses are paid in advance as in Christiano *et al.* (2005), profits and firm entry increase after expansionary monetary shocks, and investments in entrants increase. This essay has two main contributions. First, we show that it is possible to add endogenous firm entry to an otherwise standard DSGE model and obtain impulse responses to a monetary policy shock that fit well with the empirically observed responses. The response of firm entry peaks around one

year after the shock. After peaking, it returns slowly to its preshock level. Introducing firm dynamics into the model does not prevent the responses of other variables from replicating their empirically observed counterparts. We also find that the estimated parameter values do not change significantly when firm entry is added to the standard model. Our second major contribution is that we find substantial inertia in the firm entry process. This indicates that there exist remarkable congestion effects in the entry process; these costs raise the costs of entry with increasing number of entrants. The response of entry costs has an important role in the creation of new firms. When entry costs react strongly to expansionary monetary shocks (i.e., real wages are flexible), entry becomes more expensive and the response of new firms weakens.

2.2 Essay 2: Firm Default Shocks and the Correlation between Labor Productivity and Hours Worked

Based on the empirical evidence on the firm dynamics the second essay develops a real business cycle model in which firm entry is endogenous and default rates are stochastic. Then we study how default shocks affect the economy. We concentrate on the stochastic properties of the model and show that the stochastic default rate is a potential explanation for the observed low correlation between labor productivity and hours worked.

Kydland & Prescott (1982) demonstrate that real business cycle models can explain important facts about U.S. business cycles. These models are based on the assumption that shocks to aggregate productivity induce fluctuations in macroeconomic variables. The models also assume that prices are flexible. One of the main shortcomings of these models is that they are unable to explain some important facts about labor market fluctuations. The standard framework generates a volatility of hours worked that is too low relative to output and average labor productivity. In particular, it overstates the contemporaneous correlation between hours and productivity. The model even generates a correlation that is three times higher than the empirically observed value for the U.S. data.

The previous literature has offered several different explanations for the labor market puzzle. Hansen (1985) and Li (1999) treat worked hours as indivisible and study a more realistic treatment of unemployment and incomplete risk sharing. Kydland & Prescott (1982) assume nonseparable preferences between leisure in different time periods. These

extensions can explain the observed high volatility of hours worked, relative to output and labor productivity, but fail to replicate the low correlation between productivity and labor supply. Other studies aim to explain the puzzle by adding disturbances that affect labor supply more directly. Christiano & Eichenbaum (1992) add government spending shocks and Ambler & Paquet (1994) assume stochastic capital depreciation rate.

This essay presents an alternative explanation for the puzzle. We show that a time-varying, stochastic firm default rate can explain the low correlation. These default shocks correspond well with the empirical fact that firm default rates are highly volatile and far from constant. The stochastic firm default rate, or exit rate, can be thought of as a shortcut to the modelling of shocks affecting financing opportunities or the profitability of firms. For example, shocks to financial markets can both affect the probability of firms getting external finance and impact the default rate. Alternatively, the stochastic default rate can be thought of as a way to model time-varying economic shelf lives or technological obsolescence. The main contribution of the essay is that it shows that the empirically plausible volatility of default shocks predicts the observed correlation closely. Thus, the stochastic default rate is a possible candidate to explain the puzzle. The model with endogenous firm entry but a constant default rate alone generates higher volatility of labor supply, relative to output and labor productivity, and significantly decreases the correlation between productivity and hours worked. However, it is primarily default shocks that allow the model to perfectly predict the observed value of the correlation. Default shocks do not nevertheless explain the high observed volatility of the labor supply.

Our model, with endogenous firm entry and exogenous time-varying default rates, offers an additional possible explanation for the low correlation. In addition, it has some appealing advantages compared to the previous explanations. First, as Bilbiie *et al.* (2007, 2008a) discuss in detail, firm entry and the changes in the number of firms are potentially important empirical phenomena that are widely discarded in the standard macroeconomic discussions. We show that including this propagation mechanism in the model can partly explain the labor puzzle. The second appealing feature of our model is that including firm entry to the model does not lead to a significant deterioration of the predictions of the model in terms of other comovements. Third, in contrast to the explanation of the stochastic depreciation rate, the stochastic default rate also succeeds in generating an empirically good fit to the volatility of investments, relative to output. Finally, our model does not actually add a new shock to the model but divides the old concept of technology shock into two parts, i.e., the exogenous standard technology

shock and the endogenous response of productivity to the firm dynamics. Jaimovich & Floetotto (2008) provide evidence for this assumption by finding that the greater part, even 40 percent, of the variability in the total factor productivity is due to an endogenous mechanism embedded by the firm entry and exit.

2.3 Essay 3: The Effects of Endogenous Firm Exit on Business Cycle Dynamics and Optimal Fiscal Policy

This study extends the previous models with endogenous firm entry by presenting the model where both firm entry and exit are endogenous. The primary purpose is to study how endogenous exit rates affect business cycle dynamics in an economy subject to shocks to technology and money supply. In particular, we study the impact of shocks on labor productivity. A secondary purpose is to examine the role of fiscal policy in reducing the inefficient destruction of firms. When exit rates are endogenous, fiscal policy can affect firm defaults by an appropriate combination of subsidies and taxes. This policy effect does not exist in Bilbiie *et al.* (2008b), who show that a market economy is efficient when only firm entry is endogenous, so there is no role for fiscal policy. The introduction of endogenous firm exit, therefore, has implications also for the optimal design of fiscal policy.

This paper presents four main results. First, we show that negative technology shocks cause firms to default and, therefore, destroy part of the firm stock. This destruction implies a larger fall in household consumption, and households have to increase their labor supply to achieve even this lower consumption level. Thus, households' welfare is lower than in the case where changes in the number of firms are solely due to changes in firm entry. Second, we identify a new supply-side channel for monetary policy. As debt contracts are written in nominal terms, monetary shocks affect the rate of firm defaults. Monetary shocks therefore have real effects also when prices and wages are flexible. Third, we find that it is optimal for policy makers to affect exit rates. In our model, firm defaults exist partly due to a moral hazard problem between banks and firms. By subsidizing firms, policy makers can decrease the number of defaults, increase investments in the new firms and increase the number of firms producing in the economy. We find that the Ramsey optimal fiscal policy subsidizes firms and decreases the number of bankruptcies in the economy. Finally, we find that changes in the number of producing firms affect total factor productivity, which, in our model, is comparable to

aggregate labor productivity. Therefore, non-persistent shocks to technology or money supply have persistent effects on labor productivity. Endogenous firm dynamics can therefore explain part of the measured changes in total factor productivity (TFP). As a consequence, traditional models that ignore endogenous firm dynamics may misinterpret movements in TFP and labor productivity and overestimate the importance of persistent exogenous shocks.

2.4 Essay 4: Competition and Exchange Rate Pass-Through

The fourth essay studies the impact of exchange rate shocks on competition and import prices. Thus, we examine which fraction of the estimated pass-through rates corresponds to the change in markups due to the altered tightness of competition. Recent studies have examined the entry and exit of firms to foreign markets. They have observed that the expected future exchange rate affects the entry and exit decision.[2] The effects of exchange rate on competition and markups, however, have been largely ignored.

This paper develops a pricing-to-market model, where the average markup depends on the tightness of competition in the market. This effect is the key element for the derivation of our results. We assume that firms face a periodical fixed cost for their operations in the foreign market. Therefore, exchange rate changes affect the number of firms operating in the market, and also markups. Our model presents two consequences of the exchange rate depreciation. First, a fraction of foreign firms exit the domestic market because the fixed cost has increased more expensive in the terms of domestic currency. Second, foreign firms raise their prices. This is because of two reasons. First, as assumed also in the existing literature, depreciation increases marginal costs.[3] Second, fixed costs are higher and fewer foreign firms operate in the domestic market and, hence there is less competition and higher markups. The second effect is ignored in the previous literature. We estimate this effect and study how large fraction of total pass-through is due to the response of competition.

We test the implications of our model by estimating the impulse responses of competition and import prices to an exchange rate shock for 10 OECD countries. The empirical results support our theoretical model. We find that, in the long run, the competition decreases and prices increase after currency devaluation. We find a negative

[2] See, for example, Bernard & Jensen (2004).
[3] See, for example Campa & Goldberg (2005).

and statistically significant response of import volume as our model predicts. This response occurs only with a lag, which indicates that there is significant inertia in the entry and exit decisions of exporting firms. The changes in competition increase also import prices as our model predicts. However, this effect occurs only in the long run, one year after the shock, and its magnitude varies greatly across countries.

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