Department of Economics

Essays in Economic Policy

Lorenzo Ciari

Thesis submitted for assessment with a view to obtaining the degree of Doctor of Economics of the European University Institute

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CONTENTS

1 ENTRY DECISIONS AFTER DEREGULATION: DOES INCUMBENTS' MARKET POWER MATTER? 1
1.1 Introduction and motivation . . . 2
1.2 The Italian banking sector: from the 1936 law to the liberalization . . . 6
1.2.1 The banking sector after deregulation . . . 7
1.3 The empirical model and specification issues . . . 9
1.3.1 Identification . . . 12
1.4 Data sample and descriptive statistics . . . 14
1.4.1 The definition of entry: entry through branching and entry by acquisition . . . 15
1.4.2 Measuring market power . . . 15
1.4.3 The instruments: the characteristics of the banking market structure in 1936 . . . 16
1.4.4 Control Variables . . . 16
1.4.4.1 Market level variables . . . 17
1.4.4.2 Bank level variables . . . 17
1.5 Main results . . . 18
1.6 Interaction analysis . . . 23
1.7 Conclusion . . . 29
APPENDICES
A. Appendix . . . 30

2 MEASURING THE DETERRENCE PROPERTIES OF COMPETITION POLICY: THE COMPETITION POLICY INDEXES 38
A. Introduction . . . 39
B. What makes competition policy work? . . . 40
C. The structure of the Competition Policy Indexes . . . 44
D. The construction and composition of the low-level indices . . . 45
Independence of the competition authorities . . . 46
Separation of powers . . . 47
Quality of the law . . . 48
Powers during investigations . . . 50
Sanctions and damages written on the books . . . 51

Ciari, Lorenzo (2011), Essays in Economic Policy
European University Institute
DOI: 10.2870/31694

Resources . . . 53
Actually imposed sanctions and cases . . . 54
Rationale behind the subjective weights . . . 55
E. The construction of the medium level indexes . . . 56
F. The construction of the high-level indexes . . . 57
G. Data . . . 57
Missing data . . . 58
The EU . . . 59
H. Robustness of the indexes . . . 59
I. Results . . . 61
J. Comparisons with other similar indicators . . . 65
K. Conclusions . . . 67
L. Tables and figures . . . 69
APPENDICES
A. Appendix . . . 82

3 COMPETITION POLICY AND PRODUCTIVITY GROWTH: AN EMPIRICAL ASSESSMENT 85
A. Introduction . . . 86
B. Theoretical Background and Literature Review . . . 89
C. Econometric Specification . . . 95
Identification . . . 97
D. Data Sample and Descriptive Statistics . . . 100
Measuring the Quality of Competition Policy: The CPIs . . . 101
Main Variables . . . 105
Instruments for Policy . . . 108
Descriptive Analysis . . . 110
E. The Results . . . 110
The Basic Model . . . 111
Instrumental Variables . . . 114
Non-Linearities . . . 115
Extensions and Robustness Checks . . . 118
Where does Identification comes from? . . . 121
F. Conclusions . . . 123
G. Figures and Tables . . . 133

Ciari, Lorenzo (2011), Essays in Economic Policy
European University Institute DOI: 10.2870/31694

APPENDICES

A. The Indexes 145
B. The TFP Measures 151
C. The Assumptions on the Error Terms 154

Ciari, Lorenzo (2011), Essays in Economic Policy
European University Institute DOI: 10.2870/31694

CHAPTER 1

ENTRY DECISIONS AFTER DEREGULATION: DOES INCUMBENTS' MARKET POWER MATTER?*

Lorenzo Ciari and Riccardo De Bonis

Abstract

This paper investigates the role of incumbents' market power in shaping the entry decisions of Italian banks after branching liberalization in 1990. Using a unique dataset on 260 banks, we find that entry over the 1990-1995 period was targeted towards markets that were more competitive to begin with, i.e. where banking spreads were smaller. The results confirm the entry deterrent role of market power in the short-run and show a long run effect of regulation that survives after the removal of administrative barriers. The capacity of market power to discourage entry is confirmed in instrumental variables specifications, where we use the characteristics of the local banking markets in 1936, a proxy for tightness of banking regulation, to identify an exogenous source of variation in the spreads.

Keywords: deregulation, banking, barriers to entry, market power
JEL classification:L1, L5, G28

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European University Institute
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1.1 Introduction and motivation

During the 1980s and the 1990s, most European countries and the US have implemented regulatory reforms that affected the banking sector, aimed at removing restrictions to banking business and activities. In the US, the reforms started in the 1970s and culminated in the Riegle-Neal Act of 1994, which allowed nationwide acquisitions of banks across states (Jayaratne and Strahan, 1997). In Europe, the elimination of restrictions to banks' activities started after the approval of the Single Market Program, that required the integration of national financial markets. The implementation of the First and the Second Coordination Banking Directives in the early 1990s allowed European banks to branch freely in each national market and across member states. At the same time, privatization started in many countries.[1]

With the removal of administrative barriers to branching, banks increased the size of their networks, expanding the scope of their activity within their own markets and entering new markets. The study of banks' expansion strategies became a relevant research field both from a management and an industrial organization perspective. The management literature focused essentially on the existing nexus between banks' organization and strategic decisions,[2] while the industrial organization literature focused on the identification and quantification of existing barriers to entry that survived after deregulation. Such barriers are known to be pervasive in the banking industry, as documented by Vives (2001).[3]

In this paper, we investigate the role played by incumbents' market power in shaping the entry decisions of banks after the removal of branching restrictions. We look at how "initial" conditions in terms of competition intensity shape the short run adjustments of

[1] An excellent survey of the organization of the European banking market on the eve of the launch of the monetary union is De Bandt and Davis (2000).

[2] In particular, the emphasis has been placed on testing the hypothesis related to the impact of differences in functional skills, resources and organizational attributes possessed by the entrant and the entry timing decision. A review of this literature can be found in Fuentelsaz and Gomez (2001) and Fuentelsaz et al. (2002).

[3] The empirical literature on entry barriers faced by banks after deregulation is vast. We have identified four main strands of this literature: the first examines how asymmetric information between incumbents and entrants shapes entry decision. The second analyzes the link between market structure and entry (Amel and Liang, 1997; Calcagnini, De Bonis and Hester, 2001 and 2002; Adams and Amel, 2007); the third looks at the importance of entry deterrence and first mover advantages (Pita Barros, 1995 and Berger and Dick (2007)). The fourth looks at the importance of distance as a factor shaping entry and the competitive interaction among banks (Felici and Pagnini, 2008 and Degryse and Ongena, 2005).

 DOI: 10.2870/31694

markets towards the new free-entry equilibrium. By "initial" we refer to the period that immediately precedes deregulation. We test the market power-entry relationship looking at the Italian experience, which is particularly suitable for two reasons. First, Italian local markets appeared extremely segmented in terms of market structure and competitive interaction at the outset of deregulation. Second, as shown in Guiso et al. (2004a), these heterogenous "initial" conditions can in large part be attributed to the regulatory framework introduced in the 1930s, which imposed different entry restrictions across local Italian markets (De Cecco (1968)). The existence of such differences can be exploited as an identification approach that allows to isolate an exogenous source of variation in local competition at the inception of the deregulatory process.

From a theoretical point of view, the relationship between incumbents' market power and entry is ambiguous (Cotterill and Haller 1992, Amel and Liang 1997). We try to discriminate between two views. On one hand, markets which have been heavily regulated and insulated from entry should be more profitable and attract relatively more entry. Those should be the markets in which there are higher profit margins to erode and where the incumbents might be relatively inefficient, insofar as entry (or the entry threat) represents one of the main drivers of efficiency.[4] On the other hand, the market power held by incumbents might signal the existence of significant barriers to entry. We believe these barriers to be of two kinds: informational and strategic.

Informational asymmetries between entrants and incumbents as an entry barrier have been thoroughly analyzed in theory. Dell'Ariccia et al. (1999) and Dell'Ariccia(2001) show that incentives to entry in credit markets can be dampened by an adverse selection problem due to the incumbents' superior information about borrowers' creditworthiness.[5] The adverse selection problem is a structural feature of the banking industry: heterogenous degrees of market power held by the incumbents in local markets might

[4]Empirical evidence of the entry efficiency nexus can be found in Jayaratne and Strahan (1997) or Claessens et al. (2001) for the banking sector or Aghion et al. (2009) in general .

[5]The role of asymmetric information as a barrier to entry has been empirically confirmed, although indirectly. For example, Shaffer (1998) and Bofondi and Gobbi(2003) show that the loan default rates experienced by the entrants is higher than those of the incumbents. Also, Gobbi and Lotti (2004) show, looking at the Italian experience after deregulation, that entry through branching is less likely than *de novo* entry (the creation of a new bank). The authors attribute this finding to the fact that asymmetric information plays a less relevant role for *de novo* entrants, which have in general a higher knowledge of the local business community.

 DOI: 10.2870/31694

reflect different intensity of the informational asymmetry.[6] In the context we study, the asymmetric information channel matters also insofar as entry regulation has contributed to the acquisition of informational rents for incumbents. Indeed, restrictions to entry might have increased the ability of banks to collect a long time series of information about the creditworthiness of customers, the more so in more tightly regulated markets.[7]

The second channel through which a regulatory regime that favors the creation of dominant positions might discourage entry is related to the strategic interaction between incumbents and future entrants. The higher margins granted by the regulation to the incumbents translate into greater resources to engage in entry deterrence or to credibly threat to do it. This is the so-called deep-pocket argument, dating back to Telser (1966) and Benoit (1984). Financially stronger incumbents are in the position to engage in predatory strategies, or in entry deterring strategies that are financially costly in the short run, but profitable in the long run, as they discourage entry or they actually force new competitors to leave the market.[8] Moreover, the effectiveness of entry deterrent strategies in an oligopolistic setting relies on the incumbents' ability to coordinate. Being largely protected from the threat of entry during the long-lasting regulated period, in a market which was formally organized as a cartel until the mid 1970s and where competition was banned because of its perceived detrimental impact on financial stability, incumbents were in the position to develop tacit or explicit coordination mechanisms (Scherer and Ross, 1990, and Vives, 1991). Such collusive devices might well survive after deregulation, especially where the incentives to deter entry are higher and the market structure helps to sustain them.

We test the nature of the market power-entry relationship by estimating a simple

[6]Demand side factors such as the size of non-financial firms in the relevant market, institutional quality or the scope for non-lending related activities for banks might determine the relevance of the adverse selection problem.

[7]The idea that we explore is that in presence of restrictions to entry, the ability of a bank to engage in a long lasting relationship with his clients is increased. When the regulatory regime allows entry, borrowers might more easily shift from one bank to another, thus disrupting the quality and depth of information that each incumbent has on a given firm. This, in turn, reduces the informational advantage that incumbents have on average over entrants.

[8]There is a wide literature that examines the role played the financial strength of market participants on industry outcomes and entry. A recent contribution is the one by Cestone et al. (2009), who study how the financial strength of business groups shapes entry decision of French firms both in the manufacturing and in the service industry. Our paper is related to their work, although we look at market power and regulation as a source of financial strength while they look at incumbents' access to business group deep pockets.

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model of the probability of entry on a panel of 99 local Italian markets. Our dependent variable is the opening of at least one new branch over the years 1990-1995 in a province in which a bank was not operating at the beginning of the sample period. We estimate how the probability of entry over the years that follow the removal of administrative barriers is influenced by the market power held by the incumbents at the outset of the deregulation. We measure market power in local markets using the spread between loan rates (computed from single loan contracts) and the average deposit rate in the province, correcting the spread for the riskiness of local borrowers, as well as for other factors unrelated to market power. Given the potential endogeneity of our measure of market power, we also use the characteristics of the banking sector in the 1930s, a proxy for the strength of regulation in local markets, as instruments for the market power held by incumbents at the inception of deregulation.[9]

Our results suggest that market power acts as an entry deterrent mechanism in the years that follow the lifting of administrative barriers, at least in the short-run. In other words the econometric exercises are in favor of the second view we presented earlier. Indeed, the probability of entry is significantly lower in those markets where incumbents enjoy higher rents associated with the long lasting regulation approved in the 1930s. This result bears important policy implications, insofar as the removal of entry barriers was conceived to promote the convergence of local markets towards a competitive equilibrium, pushing new competitors towards areas where the rents enjoyed by the incumbents were higher. The entry deterrent effect of market power is amplified in our instrumental variables specification. Finally, we perform an interaction analysis in which we look at how the market power-entry relationship changes according to banks' and local markets' characteristics. The results suggest that both informational asymmetries and strategic barriers are in place.

The paper is organized as follows. Section 2 describes the institutional features of the Italian banking sector, from the regulation of the 1930s to the complete removal of branching restrictions in the 1990s. Section 3 presents the empirical model, while Section 4 describes the variables employed and the relative data sources. Section 5 presents the main empirical results, while section 6 illustrates the interaction analysis. Section 7

[9]The use of regulation as potential instrumental variable for different proxies of competition intensity is widespread. See, for example Aghion et al. 2005 .

 DOI: 10.2870/31694

concludes. The Appendix contains some robustness checks.

1.2 The Italian banking sector: from the 1936 law to the liberalization

The regulation of the Italian banking sector was introduced in 1936, after the financial crisis that hit the US and Europe in the early 1930s. The law imposed restrictions to the ability of different types of credit institutions to open new branches and to extend loans. An area of competence was assigned to each bank on the basis of its presence on the Italian territory in 1936, and the ability of each bank to grow and operate was limited to that area. The regulation established a differential treatment for the different existing credit institutions, in terms of their potential expansion. Indeed, while national banks were allowed to branch only in the main cities and in areas of particular economic relevance, cooperative banks and local commercial banks were allowed to branch in the entire territory of the province in which they were located in 1936. Finally, savings banks, public institutions controlled by local governments, were allowed to branch within the entire territory of the region.[10]

The main effect of the regulation was to freeze the structure of the Italian banking market for the next fifty years. However, the ability of different credit institutions to grow was affected in a very different way: while local banks' offices grew by 138% on average, big national banks' office grew by 70% on average. This heterogeneity cannot be attributed to different conditions in the demand for the services, as local and national banks differed in their legal status but not in their functions. As a consequence of the institutional framework introduced in 1936, the Italian local markets developed over the next fifty years very different market structures. In areas where local banks, and in particular savings banks, were prevalent for reasons mainly related to the colonial heritage of the country, markets grew less concentrated relative to areas where big national banks were the main market players.

Deregulation started in the late 1980s, triggered by the initiatives taken at the EU level to create a single market. In particular, European Directives asked for the creation of uni-

[10]We use the term regulation relating both to the legal rules introduced in the 1930s in the aftermath of the financial crisis and to the policy adopted by the government and the central bank towards the banking sector until the 1980s. Such policy was consistently inspired by the need to restrict competition between banks, with significantly more space to expand granted to local and in particular savings banks. An interesting description of the Italian banking regulation can be found in Polsi (2001) and in Conti and La Francesca (2000)

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versal banks, credit institutions that should be free to branch across states once they had obtained a license in their home country. Branching restrictions were entirely removed in Italy in 1990.[11] In 1993, a new Banking code was approved, which incorporated the Second Coordination Banking Directive and completely reorganized the sector.

1.2.1 The banking sector after deregulation

Following liberalization, branches increased rapidly, raising from around 15,600 in 1989 to 23,400 in 1995. International comparisons of banking structures show that in a short time Italy reached about the median in European rankings of indicators of banking capacity. Figure 1 plots the evolution of the number of branches between 1987 and 1998: the pattern is fairly stable in the years that precede the liberalization. In 1990, with the complete removal of administrative barriers, the number of branches starts growing and keeps growing at positive rates over the following years.

In Figure 2 we plot the growth rates of the number of opened branches: the growth rate is close to zero in 1988 and 1989, while it goes to 10 % in 1991 and remains very high in the following years. A stabilization in the growth rate is observed starting from 1995. A careful look at the data, however, reveals that only a small fraction of opened branches is represented by entry into new geographic markets. Indeed, more than 90% of the new branches that were opened over the 1990-1995 period were opened by incumbents, that is by banks that were already operating in the local market before the liberalization. This preliminary observation suggests the existence of significant barriers to entry.

We investigate the role of incumbents' market power in shaping the entry behavior of banks. Table 1 presents simple correlation statistics between entry into new geographic markets over the years 1990-1995 and a set of proxies of the market power held by incumbents at the outset of liberalization. We correlate the decision of a bank to open at least one branch in a local market (province) where it was not operating in 1989 with different measures of market concentration (CR4 and the Hefindahl-Hirschman index), the average interest rate on loans in the province, and a measure of the spread between loans and deposits rates. These market power proxies are averages of the 1987-1989 period.

[11] An anticipation of liberalization took place in the 1980s, when the Bank of Italy authorized the opening of new branches throughout the country. The Bank of Italy decided which banks could open branches in a given area, still in according to the principles of a "regulated" expansion of the banks' networks. Such regulatory approach was abandoned in 1990.

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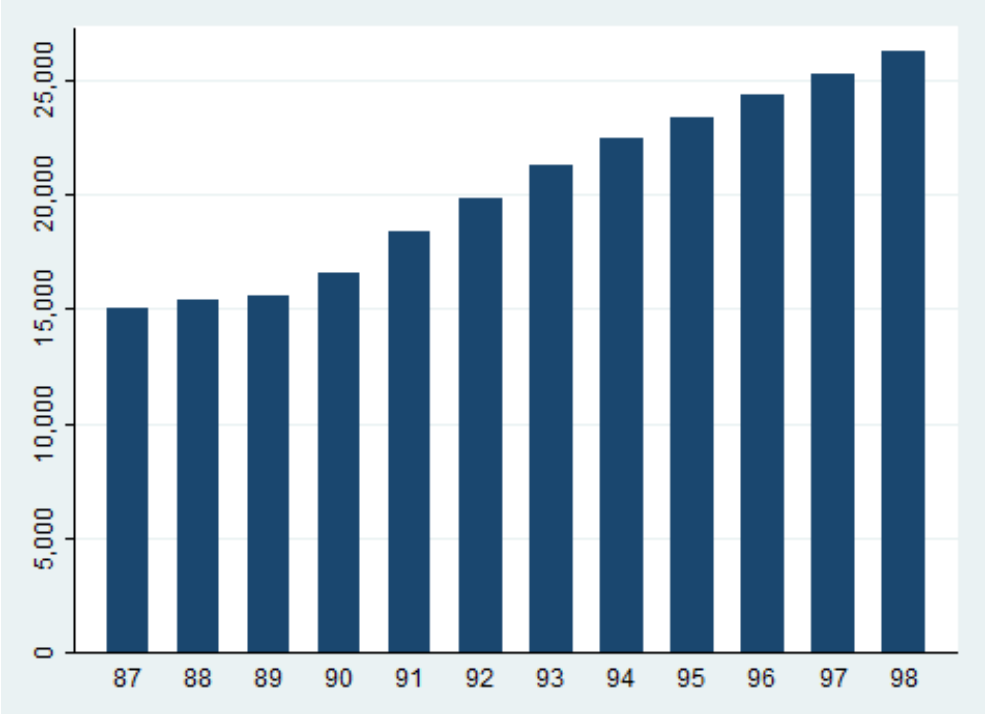
Figure 1.1: Evolution of the number of branches



The figure plots the total number of branches of Italian banks over the period 1987-1998.
Source: Bank of Italy

The table shows a negative and significant correlation between the decision to enter a new geographic market and all proxies of incumbents' market power, which are significantly correlated among each other. This data suggests that entry was lower in more concentrated markets, where prices and spreads were higher. Such finding is merely descriptive, but it clearly points to the necessity of a closer investigation, since branching deregulation was expected to spur entry in those markets where instead it appears to be a less significant phenomenon, at least in the five years that followed deregulation. A confirmation comes from a simple count of the entry episodes matched with different spread levels. We segment our provinces' sample into low (first quartile), medium (second and third quartile) and high (fourth quartile) spread provinces: the entry episodes are 130 in low spread provinces, 230 in medium spread provinces, and only 64 in high spread provinces.

The increase in the number of branches came hand in hand with privatization and a consolidation waves through mergers and acquisitions. In 1990 public sector banks -

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Table 1.1: Market power and entry: correlation pattern

	entry	**CR4**	**herf**	**avint**	**spread**
entry	1				
CR4	-0.0307*	1			
herf	-0.0485*	0.4383*	1		
avint	-0.0521*	0.3205*	0.4389*	1	
spread	-0.0285*	0.1834*	0.2023*	0.5107*	1

*$p < 0.01$

banks of national interest, credit institutes of public law, and saving banks - were the dominant banking institutions in Italy, accounting for a market share of approximately 70%. In the years that followed the liberalization, the State and the local governments, through the foundations (juridical entities of public law), still maintained the control of their banks in most of the cases. The privatization of large Italian banks took place only from 1993 onwards (Farabullini and Hester, 2005), while the foundations substantially diminished their ownership of public sector banks only after 1995. The liberalization and the privatizations triggered a major consolidation of the banking sector. Mainly because of mergers and acquisitions, there was a substantial decrease in the number of banks operating in the Italian territory, from 1,193 in 1989 to 1,023 in 1995.[12]

1.3 The empirical model and specification issues

We estimate a model for the probability of entry by branching into local markets over the period that goes from 1990 to 1995. Our analysis concentrates on the short run market adjustment following deregulation. The choice of the 1990-1995 period has two main motivations. First, we want to capture the potential extra effect on entry decisions of the new discipline of the banking sector introduced in 1993 with the new Banking Code, after the full liberalization of branching in 1990. Second, limiting our sample to 1995, we can analyze the post deregulation branching behavior of banks before the consolidation process and privatizations begin to unfold their effects. Moreover, as we have seen before, in 1995 there was a stabilization in the growth rate of branches. Following the existing

[12]The number of mergers involving Italian banks increased substantially at the beginning of the 1990s. However, the market shares of banks involved in acquisitions became particularly high beginning from the the second half of the 1990s and continued to grow in the new millennium.

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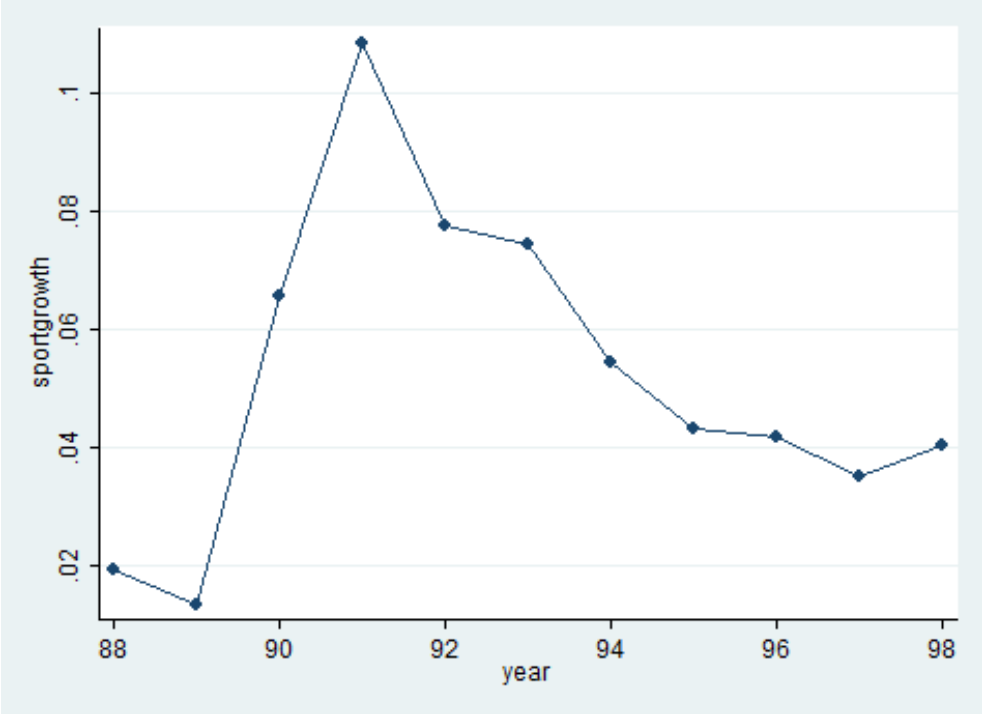
Figure 1.2: Evolution of the growth rate of branches



The figure plots the growth rate in the number of branches of Italian banks over the period 1987-1998. Source: Bank of Italy

literature and the indications of the Bank of Italy,[13] we define a local market as a province, a juridical entity analogous to the US metropolitan statistical areas. We pool the episodes of entry over the reference period and check how the probability that a bank opens a branch in a province in which it was not operating before 1990 is affected by the pre-liberalization market and banks' characteristics. The explanatory variables thus capture the conditions under which the banks develop their strategic entry decision.[14]

We define the set of potential entrants as the set of banks that were operating at the end of the sample period (1995). In this way, we exclude from our analysis the very few entry episodes involving banks that cease to exist over the reference period. For each bank included in the sample, we consider the subset of provinces in which the bank was not

[13]The Bank of Italy was the Italian competition authority for the banking sector until 2006. The power to decide on competition issues was then passed to the Italian competition authority.

[14]Using pre-deregulation variables to explain post-deregulation entry behaviours, we limit the potential endogeneity bias associated with the simultaneous determination of the banks' decision to enter new markets and market outcomes.

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operating in 1989. In modeling the entry decision of banks, it should be recognized that when banks design their networks, they take into account both their own and competitors network choices. However, given the difficulty of estimating such a complex model, we follow Pita Barros (1995) and Fuentelsaz and Gomez (2001) and adopt a partial equilibrium model in which we assume that banks take independent decisions in relation to their presence in each of the different geographical markets. In the appendix we present results of specifications in which we attempt to control for the interrelation between the entry decisions.

We assume that a bank expands the scope of its operation as long as the expected stream of profits guarantee survival in the long run. The decision to enter a new geographic market can be modeled as a function of the difference between the expected revenues associated with entry and the cost of entry. Expected profits depend on both demand and supply side factors, as well as on the characteristics of the entrant, while the cost of entry is a function of the extent of entry barriers faced by the entrant.[15]

Let Y_{ij} be a dichotomous dependent variable defined as:

$$Y_{ij} = \begin{cases} 1 & \textit{if bank i originally not operating in province j} \\ & \textit{enters province j over the reference period (90-95)} \\ \\ 0 & \textit{otherwise} \end{cases}$$

In the main specification, we use a **probit** probability model.[16] This implies that the probability that a bank i, initially not operating in market j, decides to enter in that market, is given by:

$$Pr(Y_{ij} = 1) = \int_{-\infty}^{X_i\beta + Z_j\omega + W_{ij}\gamma} \phi(t)\, dt = \Phi(X_i\beta + Z_j\omega + W_{ij}\gamma)$$

[15]Amel and Liang (1997) model entry by a firm into a market as a positive function of the difference between the firms' expected profits and entry-forestalling profits. Entry-forestalling profits represent that level of profits below which no firm will choose to enter, and they are a function of entry barriers and characteristics of the market. Expected profits can be characterized as a function of pre-entry profits, entry barriers, market concentration, and other market characteristics.

[16]We tested the robustness of our results to the choice of different functional form. In particular, we exploited the panel dimension of our dataset to estimate a conditional fixed effect logit model that eliminates the bias resulting from bank level heterogeneity that is invariant across markets. See the results in the Appendix.

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where the X_i are bank level characteristics that affect the entry decision, Z_j are characteristics of the target market, and W_{ij} are characteristics that link the single bank and the target market. The banks' characteristics are size and geographic scope of operation, as well as indicators of efficiency and profitability. The link between a potential entrant and each target market is represented by the geographical distance between a bank's headquarters and each of the Italian provinces. The target market characteristics are the size of the market, its potential growth and a measure of the scope of entry, represented by the initial density of branches in a province. Finally, our main variable of interest is a proxy for the intensity of market power held by the incumbents at the outset of deregulation, represented by the spread of loan rates over deposit rates. Although the use of spread measures as proxies for market power is quite common in the empirical banking literature, the possibility to achieve a correct interpretation of such measures is subject to a set of "identification" issues, to which we turn in the next section.[17]

1.3.1 Identification

Our main empirical challenge consists in finding an identification strategy that allows to interpret the results we obtain as evidence of a causal link between incumbents' market (monopoly) power and the entry decisions of banks. There are two distinct issues to face in this context. The first issue is that the observed spread between the loan and the deposit rates might capture characteristics of the marketplace that have nothing to do with market power. The main concern is that observed spreads might be correlated with the riskiness of local borrowers or with any features of banks that impact on their operating costs. For example, spreads may vary across markets because of existing differentials in the cost of collecting information. The second issue is that, even if we believe that the proposed strategy correctly identifies market power, there exist many potential sources of the incumbents' dominant position. For example, banks might enjoy market power through a collusive agreement that restrains competition, or because of their superior efficiency vis-á-vis potential entrants. The policy implications that we may derive from our study

[17] Another widely used measure in the empirical banking literature to proxy for the intensity of competition in a market is the degree of concentration of the industry. However, the use of concentration indexes as proxies for competition has been widely criticized from a theoretical point of view, as concentration may actually be the outcome of a fierce competitive fight in which less efficient firms are kicked out of the market. On this issue see Berger and Hannan (1989) and (1992), and Jackson (1992).

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would change in the two cases. As a consequence, only if we can say something about the source of incumbents' market power we can also say something about its relationship with entry decisions.

Our preliminary identification effort consists in using a measure of the spread that does not simply capture the difference between loan and deposit rates. Starting from individual loan contracts, we use a refined measure that represents the residual part of the spread that is explained neither by the riskiness of local borrowers, nor by a set of banks' characteristics that might affect their marginal cost, as will be thoroughly explained in the next section. Moreover, in the estimated equations, we insert many controls to proxy for factors that might impact on the spread and that are not related to the monopoly power held by incumbents.

The main identification approach consists however in the use of instrumental variables. The history of Italian banking regulation suggests using the characteristics of the banking sector in the 1930s as instruments for the spread observed in the late 1980s. The regulation of the banking sector approved in the 1930s had differing impacts across Italian credit institutions. As a consequence, the Italian provinces developed different competitive conditions during the following fifty years. The fact that local banks, and among them savings banks, were granted a greater possibility to expand than national banks, had the consequence of allowing more entry and more competition in those areas where local, and in particular savings banks were prevalent at the time of the regulation.[18] The different tightness of regulation was motivated by political and historical reasons, and it was largely exogenous with respect to the economic performance of the markets. The use of the characteristics of the banking sector in the 1930s as instruments for the competitive conditions at the outset of deregulation has been suggested by Guiso et al. (2004a, 2004b). The exogeneity of the differential treatment of the regulation is based on the following arguments: first, the number and composition of banks in 1936 was not linked to any characteristics of the region that affected the ability of banks to expand or the profitability

[18] As we already mentioned in the introduction, the banking market was formally organized as a cartel until the mid 1970s. The spirit of the regulatory regime was to protect the banking market from competition, which was deemed dangerous for financial stability. During the 1980s, the cartel was formally abandoned and banks were let formally free to compete on prices and on other dimensions of their business. However, local markets differ substantially in terms of their market structure, and this is in large part attributable to the regulation. The idea we explore and test looking at the data is that the cartel was perpetuated in those markets where few banks had the ability and the incentives to keep the collusive agreement.

 DOI: 10.2870/31694

of a local market; second, the regulation produced a differential impact on the various areas of the country mainly for "exogenous" reasons related to the political support that the different credit institutions guaranteed to the fascist regime. Finally, the regulation was kept for so many years for reasons that have nothing to do with the economic performance of the regions.

Instrumental variables isolate that part of the loan deposit rate spread that is explained by the regulatory regime introduced in 1936. This allows us to interpret the observed spread-entry relationship as one due to market power, since the channel through which the regulation affects the spread is the protection from competitive pressures. Moreover, the instrumental variables approach allows us to address our second identification concern, ruling out the "efficiency" source for the observed market power entry relationship. Indeed, the local markets which were more protected by the regulation from the entry threat are unlikely to be the markets where incumbents are more efficient fifty years later. This argument relies on the widely documented nexus between entry and efficiency.[19]

As a refinement of our identification approach, we perform an interaction analysis aimed at shedding light on the channels through which monopoly power affects entry behavior. The existence of strategic and informative barriers suggests an heterogenous effect of market power on entry, depending on the characteristics of the entrant, of the local markets and on the mode of entry. We postpone the discussion of these interactions to a later section of the paper, after presenting the data employed for the analysis and the results of our main specification.

1.4 Data sample and descriptive statistics

In the following sections we describe the main variables used in our regressions. We begin with the dependent variables, the entry measures. We then move to the description of the proxy for market power and of the instruments. We conclude by describing the control variables employed in the different specifications proposed. Table 2 provides

[19] A relevant contribution is Aghion et al. (2004), who show how the policy reforms in the United Kingdom that changed entry conditions by opening up the U.K. economy during the 1980s have led to faster total factor productivity growth of domestic incumbent firms and thus to faster aggregate productivity growth. For similar evidence related to the banking sector, see Jayratne and Strahan (1998) and Sturm and Barry (2004).

 DOI: 10.2870/31694

summary statistics.

1.4.1 The definition of entry: entry through branching and entry by acquisition

In order to construct the entry measures we employ Bank of Italy statistics that records the annual number of branches that each bank has in each province. The dependent variables are measures of entry in local banking markets. We distinguish two types of entry: entry through branching and entry by acquisition. Entry through branching **(entry**) occurs whenever a bank opens, between 1990 and 1995, at least one branch in a province in which it was not operating in 1989, at the outset of deregulation. This is our main dependent variable. However, as part of our identification approach, we also use entry by acquisition as dependent variable. Entry by acquisition **(entryacq**) occurs when a bank enters a province through the acquisition of another bank.

1.4.2 Measuring market power

Our main independent variable is a measure of the extent of monopoly power in local banking markets in the period immediately preceding deregulation **(marketpower**). We proxy market power in a local market by using the spread between the loan rate applied to firms and the average deposit rate in the province. The spread is calculated from data on individual loans extended by a bank in a province. In order to control for firms' and banks' characteristics that might have effects on the spread which are not related to market power, the spread is regressed on indicators that capture the riskiness of local borrowers and the efficiency of banks. The borrower characteristics controls are: the firms' returns on sales, their leverage (as proxy for financial fragility), their size (measured by log assets) and their Z-score (a measure of the financial distress status of a firm), which is likely to capture important information that banks use to assess the riskiness of their borrowers. The bank characteristics included are size, profitability, ownership structure as well as the ratio of non performing loans over total loans (the source is Bilbank, a commercial database). The residual part of the spread that is not explained by lenders and borrowers' characteristics, which is assumed to measure the banks' market power, is captured by a full set of provincial dummies. The employed measure of local market

 DOI: 10.2870/31694

power is then a normalized version of the coefficient attached to each province.[20]

1.4.3 The instruments: the characteristics of the banking market structure in 1936

Our measure of market power - the spread - though controlling for many factors other than market power that might have an influence on it, might still suffer form an endogeneity bias, in the sense that it might capture market level characteristics other than the intensity of competition. The history of Italian banking regulation provides valid instruments for our analysis, as discussed in the previous identification section. We use some statistics on the banking structure in 1936 as instruments for the spread observed in the late 1980s. As we have seen, the regulation gave a greater possibility to expand to local banks and among them to savings banks. As a consequence, in local markets where this type of bank was prevalent in 1936 there was more entry in the following fifty years and this explains a substantial part of the spread differentials in the late 1980s, as we will show later. More specifically, the instrumental variables used in our specifications are the following: the fraction of banks' branches owned by local banks in each province in 1936, the number of savings banks per 1000 inhabitants in the region in 1936, and the number of banks offices per 1000 inhabitants in each province in 1936. We take our measure of market power, as well as the instrumental variables, from Guiso et. al (2004a).

1.4.4 Control Variables

The control variables can be divided into three categories: variables that capture characteristics of the target market of the potential entrants, variables that measure characteristics of the potential entrants that might affect the entry decision, and variables that link the market of origin of a potential entrant with the target market.

[20]The variables used to construct the index of market power refer mostly to the years that precede deregulation, in particular to 1985. Data on interest rates refer to 1991, when deregulation had not yet begun to unfold its effects, as demonstrated in Angelini and Cetorelli (2003), who show that interest rates remain basically unchanged until 1992.

 DOI: 10.2870/31694

1.4.4.1 Market level variables

All market level variables refer to a period that precedes the lifting of the regulatory barriers to entry, as we want to capture the initial conditions faced by the entrants when the regulatory barriers were lifted. The size of the market, capturing the potential demand for loans, is proxied by the total loans granted in the province **(loans)**, while the potential for market growth is measured through the growth rate of loans **(loansgrowth**), as well as by the growth rate of value added in the province **(vagrowth)**. The supply side characteristics included in the study are the concentration of the loan market in the province, and the branch density in the province. The concentration in the loan is measured through the Herfindahl-Hirschman index **(herf)**, while branch density **(scopeofentry)** is measured as the ratio between the number of branches in the province and the surface of the province itself. Finally, we use a dummy to identify the local markets located in the South of Italy **(south)**, to proxy for potential institutional and development factors driving the entry decisions. All the market level variable are averages of the years 1987-1989. In our interaction analysis, we exploit two variables proxying the size of non-financial firms operating in the province and the size of non loan-related activities of the banking sector in each province. The size of non-financial firms is measured through the average number of employees per firm operating in each province in 1991 **(empl)**, while the size of non loan-related activities **(securities)** is captured by the securities held by banks on behalf of the customers in a given province (it is an average for 1990 and 1991).

1.4.4.2 Bank level variables

The bank level characteristics are constructed from the data on the number and location of branches of a given bank and from balance sheets. The variable **(size**) measures the number of branches by a given bank at the beginning of the reference period. The variable **(scope**) measures the number of provinces in which the bank operates[21]. The variable **(sizeloans)** measures the total amount of loans extended by a bank. We measure the financial soundness of a bank by the variable **(badloans**), that is the ratio of bad loans to the total amount of loans extended by a bank. The bank balance sheet statistics

[21] In the main specifications, the variable used is a dummy variable that separate single-province banks from banks operating in more than one province. The variable, which shows to be highly significant in all regressions, has been so constructed to avoid problems of collinearity with other size variables.

 DOI: 10.2870/31694

are taken from Bilbank. A final variable included in our specifications is the distance between the market of origin in which potential entrants operate, and the target market. Distance can be measured across different dimensions (on this subject see Alessandrini, Presbitero and Zazzaro, 2009). Given the nature of control that distance has in this work, we controlled exclusively for the geographical distance between a bank's headquarters and the center of each province**(distance**).

Table 1.2: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
entry	0.021	0.143	0	1	20164
entryacq	0.004	0.064	0	1	20164
marketpower	1.722	0.747	0	3.628	20164
loans	1760.506	3492.381	100.529	27649.279	20164
loansgrowth	0.156	0.056	-0.006	0.355	20164
scope	0.711	0.453	0	1	20164
scopeofentry	0.287	0.182	0.036	1.282	20164
avvagrowth	0.091	0.01	0.058	0.11	20164
herf	0.095	0.049	0.029	0.263	20164
empl	34048.701	31902.655	5044	236115	20164
securities	2710.855	7251.355	34.89	62263.844	20164
size	47.412	88.052	0	1250	20164
sizeloans	777.886	2017.002	0	17004.975	20069
badloans	0.001	0	0	0.006	19974
distance	25.556	26.856	0	146.599	20164

1.5 Main results

In this section we present the main results of our work. Table 3 shows the results of the principal specification. The dependent variable is a dummy variable that records entry by branching in local markets over the period 1990-1995. We employ bank level data in which each observation corresponds to a bank-province pair. In column (1) we report the estimates for our baseline specification, consisting of a probit model. Both the firm level and market level variables play a significant role in shaping banks' short run geographic diversification decisions. The **size** of a bank and its **scope** of operation have a positive and significant effect on the probability of entry. The positive effect of size is consistent with the view that resource constraints play a crucial role in shaping entry de-

DOI: 10.2870/31694

cisions (Cotterill and Haller, 1992; Ingham and Thompson, 1994): size can be seen as a proxy for slack resources available within a firm, and the availability of such resources facilitates the overcoming of entry barriers, especially in a context in which it might be difficult to access external funds (Felici and Pagnini, 2008). Also the market level controls show in general the expected sign and significance: the size of the market, as well as past value added growth in the province, exert a positive role in attracting new entrants. These measures correctly capture the growth potential of the market, as suggested in the literature (Amel and Liang, 1997; Pita Barros,1995). Also, a greater density of branches per inhabitants, measured by the variable **scopeofentry**, reduces the likelihood of entry by banks, although the coefficient is not significant. The other variable that enters significantly in our model is the distance between a potential entrant's headquarters and the target market. Felici and Pagnini (2008) stress different sources of distance-related entry barriers. First, the role of reputation in attracting customers is crucial in banking as in many other commercial sectors. A bank has accumulated over the years reputational capital that can be invested when entering a new market; however, this reputation effect dissipates with distance. Second, it is well known (Dell'Ariccia et al., 1999 and Dell'Ariccia, 2001) that asymmetric information represents a major entry barrier in banking. Potential entrants face adverse selection problems being uninformed about the quality of potential borrowers, over which the incumbents possess an informational advantage. For a potential entrant, the cost of collecting information about local borrowers is likely to be reduced if the market is located close to where the entrant already operates. We will return to this point in our interaction analysis.

We now turn to our main variable of interest, i.e. **market power**. As we can see, the degree of market power held by the incumbents, as measured by the spread between loan and interest rates at the outset of liberalization, exerts a negative effect on the probability of entry. The effect is significant at 5% level of confidence, and remains significant in the richer specification proposed in column (2), which extends the baseline model. We include a different measure of a bank's size, that is the total amount of loans extended by a bank in the period immediately proceeding deregulation (**sizeloans**); the variable **loansgrowth** measuring the average observed growth of the total amount of loans extended in a province, and the **south** dummy variable, capturing potentially important institutional differences between northern and southern regions of the country. The results in this sec-

 DOI: 10.2870/31694

ond specification confirm that bank's size is positively correlated with the probability of entry into a new geographic market, and that the potential growth of the credit market, as proxied both by value added growth in the province and by the growth rate of the amount of loans extended in the province, exerts a positive effect on the probability of entry. The variable **south** does not play a significant role.

The proxy for market power included in column (1) and column (2) of Table 2 is the spread between the loan and deposit rates for each province. As we have seen in Section 3, the observed spread between loan and deposit rates might capture characteristics of the banking market unrelated to the intensity of incumbents' monopoly power.

To refine our identification strategy, we use an instrumental variables approach, as described in section 3. We use the characteristics of the banking sector in 1936 as instruments for the spread between loan and deposit rates. Column (3) presents the results of a 2SLS estimation (assuming a linear probability model). This specification confirms the validity of our main finding: market power acts as an entry deterrent mechanism. Indeed, the probability of entry is lower in those markets where entry regulation was tighter. At the bottom of column (3) we report statistics that are useful to test the validity of our IV strategy: the Hansen J-statistic, the GMM counterpart of the Sargan statistic, shows that we cannot reject the null of no correlation between the instruments and the error term in our equation. The F-test of excluded instruments shows that the instruments are jointly significant in explaining the endogenous measure of market power, which is supported also by the Anderson canonical correlation, which seems to exclude a weak-instruments problem in our model. In column (4) we present the result of an non linear instrumental variable probit model (see Cameron and Trivedi, 2005 for a detailed description of the model). The results appear qualitatively similar to the previous models and confirm that market power exerts a negative effect on entry.

In summary, the results contained in Table 3 illustrate that the probability of entry is significantly reduced in markets where incumbents have been protected for many years from the threat of entry. In order to give a sense of the magnitude of the estimated effect, we run several simulations. We compare the suggested magnitude of the market power effect on entry of the specification presented in column (1) and column (3), respectively the simple probit and the instrumental variable probit models. The simple probit model predicts that going from the most competitive province in Italy (Ravenna) to the least

 DOI: 10.2870/31694

Table 1.3: Market Power and entry: main results

	(1) probit	(2) probit	(3) 2sls	(4) ivprobit
marketpower	-0.00232**	-0.00270**	-0.0132**	-0.00609*
	(0.00110)	(0.00117)	(0.00604)	(0.00369)
size	0.0714***		0.271***	0.0717***
	(0.00737)		(0.0258)	(0.00740)
sizeloans		0.00306***		
		(0.000320)		
scope (d)	0.00849***	0.00840***	0.00438**	0.00856***
	(0.00150)	(0.00143)	(0.00213)	(0.00149)
scopeofentry	-0.00285	-0.00313	-0.0161	-0.00784
	(0.00315)	(0.00295)	(0.0108)	(0.00586)
distance	-0.438***	-0.458***	-0.357***	-0.426***
	(0.0482)	(0.0467)	(0.0516)	(0.0434)
loans	0.00109***	0.00108***	0.00285***	0.00109***
	(0.000246)	(0.000220)	(0.000821)	(0.000132)
vagrowth	0.177**	0.157**	0.341**	0.232**
	(0.0785)	(0.0740)	(0.161)	(0.0905)
loansgrowth		0.0303**		
		(0.0154)		
south (d)		0.00178		
		(0.00222)		
Observations	20164	20069	20164	20164
Hansen J stat.			0.212	
F-square first			6.86**	
Anderson CC			1806***	

Marginal effects; Cluster robust standard errors in parentheses
(d) for discrete change of dummy variable from 0 to 1
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

DOI: 10.2870/31694

competitive one (Catanzaro), the probability of entry drops by 52%, holding constant all other variable included in the model. The instrumental variable probit, in which we address the potential endogeneity of our spread measure, the probability falls even more, by 82%.

In Table 4 we test the robustness of our main finding using market-level data (i.e. aggregated statistics). The dependent variable has been changed into the total number of entry episodes recorded in a province between 1990 and 1995. In column (1) we report the result of an OLS specification. We find a negative and significant effect of market power on entry. This finding is confirmed in column(2), where we show the results of 2SLS estimation. Again, as in the context of bank-level data, the magnitude of the estimated effect increases significantly when we account for the endogeneity of market power using the characteristics of the banking sector in 1936 as instruments. Finally, the results are confirmed in column(3) where we estimate a model *á la Poisson*.

Table 1.4: Market Power and entry: aggregate market data

	(1) Ols	(2) 2sls	(3) Poisson
marketpower	-1.296***	-3.789***	-0.903**
	(0.377)	(1.281)	(0.361)
scopeofentry	-0.517	-4.075*	-1.194
	(1.142)	(2.345)	(0.998)
loans	0.000498***	0.000500***	0.000223***
	(0.000168)	(0.000160)	(0.0000529)
loansgrowth	11.07*	11.05*	7.726
	(5.585)	(6.117)	(4.826)
vagrowth	49.24**	84.00**	39.85*
	(23.20)	(34.51)	(23.59)
south (d)			-1.924***
			(0.471)
Observations	95	95	95

Marginal effects; Robust standard errors in parentheses
(d) for discrete change of dummy variable from 0 to 1
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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1.6 Interaction analysis

The results presented in the previous section illustrate that the regulation approved in 1936, shaping the competitive framework for the successive 50 years, impacted the entry behavior of banks in the aftermath of deregulation. Indeed, in markets which have been more protected from the entry threat, incumbents enjoy greater market power, and this acts as an entry deterrent mechanism. This evidence bears important policy implications, as it suggests that liberalization policies might not quickly deliver the expected benefit of increased competition just where it is more necessary.[22]

In this section we provide the results of an interaction analysis, in which we explore how the market power entry relationship changes with the characteristics of the entrants, of the target markets, and the mode of entry. These further specifications try to shed light on the existence of strategic and informational channels behind the estimated nexus between entry and monopoly power.

The strategic explanation of the negative relationship between market power and entry relies on one main argument: incumbents that have been protected by regulation for decades have accumulated "deep pockets" that can be exploited to discourage entry after the removal of administrative barriers. The strategic deterrence effect of market power is reinforced by the incumbents' ability to coordinate in their actions. This coordination is much more likely where the regulation created a strongly concentrated market. The strategic channel story suggests that the ability to overcome the entry barrier represented by incumbents' market power should be a function of the availability of slack resources for potential entrants or, more generally, of their financial strength. Therefore we interact our independent market power variable with dummies that identify the group of banks that appear more financially equipped to engage in an entry fight and reap the benefits of higher margins. The results are presented in Table 5. The first variable that we consider in column (1) is **size**, always measured by the bank's branches network. Size can be seen as a proxy for financial strength: bigger banks should be better equipped for surmounting the strategic barriers erected by incumbents. We test whether the observed market power

[22]Unfortunately, the lack of pricing data does not allow us to verify the effects of the post-deregulation entry behavior on the commercial conditions faced by firms. However, a simple (unreported) analysis on average interest rates, seems to support the idea that less competitive provinces, where interest rates on loans were higher in the late 1980s, did not converge rapidly to the levels of more competitive provinces in the years that follow the liberalization.

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entry relationship changes according to the size of entrant banks. We defined three size categories (small, medium and large banks) using the size empirical distribution. Small banks are those whose size does not exceed the first quartile of the distribution, while big banks are those whose size exceeds the third quartile. Medium banks are those whose size lies between the first and the third quartile. We tested the differential effect of market power on entry estimating three different coefficients for our market power variable, that is interacting the market power variable with three dummies, one for each size category. For this interaction analysis, we employed the linear instrumental variable model, which facilitates the interpretation of interaction coefficients. Column (1) of Table 5 illustrates that the negative effect of market power on entry is statistically significant only for small and medium sized banks. For large banks, the effect is still negative, but is greatly reduced in magnitude and no longer statistically significant. This result is confirmed by column (2), where we use a different proxy for a bank's size, based on the total amount of loans extended (the variable **loans** described above). Again, the market power entry deterrent effect disappear when we look at large banks.

Size is only one of the potential proxies of the financial strength of a bank and of its ability to surmount the barriers represented by incumbents' market power. The market power entry relationship may also be affected the financial soundness of the entrant. Among the potentially available proxies of a bank's financial soundness, we focus on the the proportion of bad loans over total loans. This variable should capture the allocative efficiency of banks and the possibility to sustain the short term losses associated to the incumbents' reaction upon entry. As for the previous interactions, we estimate the effect of market power on entry for three groups of banks, identified by the size of the ratio between bad loans and total loans. The results are shown in column (3). The results indeed confirm that the entry deterrent effect of market power on entry disappears for banks whose financial position appears sounder. Overall, the results presented in Table 5 suggest that incumbents' market power does not reduce the probability for banks which are financially stronger. Being aware that multiple stories might support such empirical findings, the results appear consistent with the strategic interaction channel proposed above.

The deterrent effect of market power might also be attributed to an informational advantage of incumbents, as we saw in the introduction. The idea is that the regulation,

 DOI: 10.2870/31694

Table 1.5: Market Power and entry: the role of entrants' characteristics

	(1) 2sls	(2) 2sls	(3) 2sls
mpsmallsize	-0.0101* (0.00562)		
mpmediumsize	-0.0137** (0.00565)		
mpbigsize	-0.00562 (0.00565)		
mpsmallsizeloans		-0.0158*** (0.00572)	
mpmediumsizeloans		-0.0121** (0.00569)	
mpbigsizeloans		-0.00271 (0.00559)	
mplowbadloans			-0.00198 (0.00547)
mpmediumbadloans			-0.0124** (0.00551)
mphighbadloans			-0.0160*** (0.00588)
size	0.237*** (0.0324)		0.261*** (0.0261)
loans		0.0103*** (0.00142)	
badloans			2.912** (1.343)
scope (d)	0.00491** (0.00231)	0.000605 (0.00209)	0.00461** (0.00219)
scopeofentry	-0.0145 (0.00957)	-0.0145 (0.00970)	-0.0143 (0.00962)
distance	-0.379*** (0.0503)	-0.375*** (0.0478)	-0.376*** (0.0478)
loans	0.00287*** (0.000779)	0.00292*** (0.000783)	0.00292*** (0.000783)
loansgrowth	0.0567** (0.0256)	0.0575** (0.0257)	0.0568** (0.0258)
vagrowth	0.276* (0.149)	0.286* (0.150)	0.282* (0.150)
Observations	20164	20069	19974

Marginal effects; Cluster robust standard errors in parentheses

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insofar as it protected incumbents from the entry of new competitors, has contributed to the creation or at least to the reinforcement of an informational dividend. This dividend indeed should be higher where competition was relatively more restricted from regulation. We explore the existence of an informational channel as a potential explanation of our results through four further specifications presented in Table 6. In column (1) we change our dependent variable, looking at entry by acquisition instead of entry through branching. The idea is that if market power acts on entry as it signals an informational advantage of incumbents over entrants, the effect should be greatly reduced or even reversed when entry takes place through the acquisition of an incumbent bank. The reason is that the assets acquired by the entrant include the informational capital of the incumbent. The results seem to confirm the intuition, as market power does not exert a significantly negative effect on entry by acquisition.[23]

In column (2) we look at the role of distance in shaping the market power entry relationship. The idea is again suggested by the literature on the informational barriers to entry in the banking sector. Felici and Pagnini (2008) stress that the cost of collecting information about local borrowers should be lower when the entrant is closer to the target market. This suggests the possibility to test whether market power acts on entry through the information channel by looking at whether the estimated relationship changes when market power is interacted with distance. Indeed, interacting our market power variable with a dummy that identifies a close distance between potential entrants and target markets, we see that the negative effect of market power is reverted for entrants that are located close to the target market. In column (3) we test how the market power entry relationship changes with the size of non-financial firms operating in the target province: in the methodological section above we explained how the literature that describes the asymmetric information problem associated to entry in the banking sector suggests that information asymmetries might be reduced if the requirement of soft information about local firms is lower. When the non-financial firms operating in a province are relatively big, the screening of their quality as borrowers is based mainly on balance sheet, that is on hard information, which reduces the informational gap of entrants vis-a-vis the incumbents. This suggests that, if the market power entry relationship is determined by

[23]The result is also consistent with the strategic deterrence story. Indeed, when entry takes place through acquisition, the entrant replaces an existing incumbent and does not represent a threat as in the case of a de-novo entrant.

 DOI: 10.2870/31694

Table 1.6: Market power and entry: the role of acquisitions, distance, and target market characteristics

	(1) entryacq	(2) entrynet	(3) entrynet	(4) entrynet
marketpower	-0.00168	-0.0114**		
	(0.00128)	(0.00452)		
mplowdist		0.0241***		
		(0.00182)		
mplowsizefirms			-0.0104**	
			(0.00420)	
mpmediumsizefirms			-0.00572	
			(0.00381)	
mphighsizefirms			0.0132***	
			(0.00420)	
mplowsecurities				-0.00769**
				(0.00365)
mpmediumsecurities				-0.00724
				(0.00465)
mphighsecurities				-0.00475
				(0.00571)
size	0.00834***	0.276***	0.271***	0.270***
	(0.00247)	(0.0117)	(0.0276)	(0.0276)
empl			-0.000454*	
			(0.000232)	
securities				0.0139
				(0.0110)
scope (d)	0.00394***	0.00394*	0.00449**	0.00449**
	(0.00104)	(0.00226)	(0.00190)	(0.00190)
scopeofentry	-0.000645	-0.0141*	-0.0147*	-0.0328**
	(0.00157)	(0.00828)	(0.00836)	(0.0131)
distance	-0.0555***	-0.0807*	-0.415***	-0.387***
	(0.0179)	(0.0458)	(0.0361)	(0.0358)
avimp	0.000571**	0.00281***	0.00510***	0.00207***
	(0.0000245)	(0.000283)	(0.00172)	(0.000659)
avimpgrowth	0.00797	0.0489***	0.0533***	0.0511***
	(0.00556)	(0.0181)	(0.0168)	(0.0170)
avvagrowth	0.0161	0.224*	0.0319	0.206*
	(0.0270)	(0.118)	(0.109)	(0.108)
Observations	20164	20164	20164	20164

Marginal effects; Cluster robust standard errors in parentheses

(d) for discrete change of dummy variable from 0 to 1

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Ciari, Lorenzo (2011), Essays in Economic Policy
European University Institute
DOI: 10.2870/31694

an adverse selection problem, the negative effect of market power on entry would be reduced if the non-financial firms that operate in the market are relatively big. We measure the average size of non-financial firms in a province by their average number of employees. Using the same approach for the previous interaction analysis, the results in column (3) show that indeed, the negative effect of market power on entry disappears in markets where firms are relatively big. In column (4) we present the final results of our interaction analysis, where we look again for evidence of an asymmetric information channel driving the observed relationship between incumbents' market power and entry. The scope of asymmetric information between entrants and incumbents is mainly related to the loan segment of a bank's activity. In other words, the greater is the proportion of banks' revenues coming from non loan-related activities, the lower is the scope for informational barriers to entry. This suggests that the entry deterrent effect of market power should be reduced the higher the potential for non loan-related revenues. The scope of non-loan related revenues for a banks is captured by the amount of securities held on behalf of customers within the boundaries of a given province. The interaction analysis confirms that the negative role exerted by market power on entry is significant only in those markets in which the amount of securities held on behalf of customers is relatively low.

Overall, our interaction analysis shows how the observed average relationship changes when we look at subsamples of entrants and local markets. The results do not rule out any of the proposed channels through which market power might act as an entry deterrent mechanism. On the contrary, our exercise points to the existence of multiple channels operating at the same time.

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1.7 Conclusion

In this paper we obtain three main results. First we find that entry in the years that followed branching deregulation was targeted towards more competitive markets, i.e. where the incumbents had less market power. As underlined by North (1993), institutions and time matter. The survival of a strict regulation on banking entry for more than 50 years contributed to the incumbents having strong market power. We measure market power with a risk-adjusted spread between loan and deposit rates. Given the potential endogeneity of the spread, we use the characteristics of the banking markets in the thirties as instrumental variables for market power. These characteristics - essentially the number of small/local banks/branches in provincial markets - were highly persistent. They lasted until the eigthies due to the framing of the regulation, and are able to explain in large part the development of competitive interaction in local markets for the following fifty years. Our results hold: i.e. instrumental variable regressions confirm the capacity of incumbents to deter entry. This evidence is also consistent with the idea that extra-profits persist in the long run because incumbent firms are able to discourage the entry of new competitors (Mueller, 1986). Second, our econometric exercises suggest that the market power entry relationship depends on the quality of the potential entrants and on other structural characteristics of the target market. The results are compatible both with an information and a strategic channel explaining the nexus between market power and entry. Third, if entry in local markets takes place through acquisition of an incumbent bank, market power does not exert a negative effect on entry. Again, this is consistent with the ability of entrant banks to overcome the entry barrier represented by incumbents' market power, be it linked to a strategic or to an informative advantage. Our evidence is consistent with the idea that in the banking industry large market shares may be acquired by new intermediaries only through acquisitions.

Ciari, Lorenzo (2011), Essays in Economic Policy
European University Institute DOI: 10.2870/31694

APPENDICES

A. Appendix

In this appendix we provide a set of robustness checks performed in order to test how the main result presented in the paper is affected by the choice of the specification, by the definition of the pool of potential entrants into a market and by the consideration of the potential interdependence of entry decisions among banks.

We start in column (1) of Table 7 by presenting the results of the estimation of our baseline specification by using a conditional fixed effect logit model. This model applied to the data allows to control for the possible existence of unobservable bank level heterogeneity. The model, described in detail in Cameron and Trivedi (2005), determines the probability of entry among the set of Italian provinces, conditioned on the the total number of entries effectively undertaken by each bank. Such transformation, analogously to the linear panel data transformation (the de-meaning of variables), gets rid of the individual fixed effects and allows to retrieve consistent and efficient estimates of the parameters of interest. This model is relevant if unobservable bank level heterogeneity is deemed to play an important role, as suggested among others by Fuentelsaz and Gomes (2001) and more recently by Felici and Pagnini (2008). The conditional fixed effect approach has two drawbacks: first, the effect on the probability of entry of bank specific variables is no longer identifiable; second, the conditioning approach is such all the observations corresponding to those banks that did not enter any market over the considered period are lost in the estimation, so we have a considerably lower number of observations. The results confirm our main finding that market power, as measured by the spread between loan and deposit rates, exerts a negative effect on entry.

In column (2) we present the results of a specification in which we modify the definition of potential entrants. In the main model, all banks operating in the country at the end of the sample period (1995) are set as potential entrants in each local market. Although

Ciari, Lorenzo (2011), Essays in Economic Policy
European University Institute DOI: 10.2870/31694

we consider this as the preferable approach, we test the robustness of our main findings against the exclusion from the set of potential entrants in each local markets the banks whose headquarters are far away from the target market. We use a statistical criterion, and drop the fourth quartile of the distribution of the variable **distance**. Again, the results of the specification, estimated with IV probit, confirm the negative effect exerted by market power on the probability of entry.

In column (3) and (4) we propose a preliminary way to address the potential concern that entry decisions of banks are not conditionally independent. The approach we follow consists in controlling for factors that potentially determine the dependence structure of the entry decisions, in order to verify whether the observed negative relationship between market power and entry still holds. The first control in column (3) is suggested by Felici and Pagnini (2008), and their argument goes as follow: a bank can expand its network of branches either by opening a new outlet in its pre-entry locations or by branching into new geographic markets. The two expansion strategies may be independent, complement or substitutes. If the strategies are indeed substitutes, in order to branch into a new geographic market a bank should abandon some expansion projects in its pre entry locations. This would imply that the bank under consideration is subject to some constraints and that these constraints may determine a lack of independence of entry decisions. Essentially, what Felici and Pagnini (2008) aim at modeling is the dependence of the entry decisions of a given bank across different markets. In order to control for this effect, we follow them and introduce a variable (**expansion**), defined by the ratio between the number of pre-entry locations where a bank opened a new outlet and the total number of its pre-entry locations (recorded at the beginning of our sample period, that is prior to deregulation). As for Felici and Pagnini (2008), the variable enters significantly in the estimated specification with a positive sign (which suggests complementarity between the two expansion strategies), but the main result of our paper related to the market power-entry relationship does not change. In column (4) we try to model an additional factor that might shape the dependence of the entry decisions, namely the intensity of multi-market contacts between banks. The banks included in our estimation are both potential entrants for the markets in which they do not operate at the time of deregulation and incumbents in all the markets in which they possess branches. A bank deciding whether or not to enter a new geographic market might take into consideration the number of "contacts"

 DOI: 10.2870/31694

Table 1.7: Market Power and entry: robustness checks

	(1) Logit FE	(2) ivprobit	(3) ivprobit	(4) ivprobit
marketpower	-0.0434**	-0.00933*	-0.0109**	-0.0177**
	(0.0203)	(0.00503)	(0.00542)	(0.00790)
size		0.273***	0.272***	0.327***
		(0.0276)	(0.0259)	(0.0278)
scope (d)		0.00486**	0.00649***	0.00408*
		(0.00234)	(0.00239)	(0.00214)
scopeofentry	-0.110	-0.0146*	-0.0146	-0.0440***
	(0.0765)	(0.00890)	(0.00955)	(0.0144)
distance	-0.0102***	-0.000658***	-0.000361***	-0.000249***
	(0.00119)	(0.0000706)	(0.0000492)	(0.0000568)
loans	0.0218***	0.00312***	0.00287***	0.000563
	(0.00229)	(0.000756)	(0.000778)	(0.000566)
loansgrowth	0.641***	0.0559**	0.0570**	0.113**
	(0.238)	(0.0253)	(0.0259)	(0.0455)
vagrowth	2.968**	0.321**	0.283*	-0.0320
	(1.345)	(0.138)	(0.148)	(0.227)
expansion			0.0115***	
			(0.00316)	
multimarket				0.00934***
				(0.000886)
Observations	12201	18397	20164	20069

Marginal effects; Cluster robust standard errors in parentheses
(d) for discrete change of dummy variable from 0 to 1
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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it has with the incumbents operating in the target market, that is the fact that it is contemporaneously present with those incumbents in other markets. The acknowledgement of this link between entrants and incumbents might shape the dependence of entry decisions. The literature on mutual forbearance-collusion and multi-market contact is well known (see the theoretical contributions of Bernheim and Whinston, 1990 and Spagnolo, 1999 among others). This literature suggests that banks might refrain from entering a market in which operate incumbents with whom they have contacts in other local markets. However, a recent contribution by Fuentelsaz and Gomez (2006) shows that, for low levels of multi-market contacts, there might be an incentive to enter those markets, precisely to set up a network that might facilitate collusive practices afterwards. Whatever the story is, multi-market contact between entrants and incumbents might generate a dependence in the entry patterns, both between the entry decisions of a given bank in different markets (that share the same incumbents) and between the entry decisions of different banks. For this reason, we introduce a control variable that counts the number of multi-market contacts that each bank has with the incumbents in the target market. The variable **multimarket** is given by the ratio between the sum of contacts that a bank has with the incumbents in the target market and the number of provinces in which a bank is operating at the beginning of the sample period. The variable enters positively the estimated specification, which suggests that banks, at least at the early stage of deregulation, were targeting markets in which incumbents were "known" incumbents. This, however, does not alter the main finding of our paper, that is the negative link between market power and entry.

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CHAPTER 2

MEASURING THE DETERRENCE PROPERTIES OF COMPETITION POLICY: THE COMPETITION POLICY INDEXES*

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Abstract

This paper describes in detail a set of newly developed indicators of the quality of competition policy, the Competition Policy Indexes, or CPIs. The CPIs measure the deterrence properties of a jurisdictions competition policy where for competition policy we mean the antitrust legislation including the merger control provisions and its enforcement. They incorporate data on how the key features of a competition policy regime score against a benchmark of generally-agreed best practices and summarise them so as to allow cross-country and cross-time comparisons. The CPIs have been calculated for a sample of 13 OECD jurisdictions over the period 19952005.

Keywords: Competition Policy, Indicator, Deterrence, Competition Law
JEL classification:K21, K42, L40

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A. Introduction

The aim of this paper is to introduce the Competition Policy Indexes, from hereon CPIs, a novel set of indicators of the quality and intensity of competition policy. The CPIs measure the deterrence properties of a jurisdictions competition policy where for competition policy we mean the antitrust legislation, including the merger control provisions and its enforcement.[1] The CPIs incorporate data on how the key features of a competition policy regime score against a benchmark of generally-agreed best practices and summarise them, so as to allow cross-country and cross-time comparisons.[2] The CPIs are based on a bottom-up approach in which each jurisdictions scores can be related to specific features of its competition policy. Applying a consolidated methodology, similar to that developed by the OECD for the indicators of product market regulations (PMR)[3] and the competition law and policy indexes (CPL),[4] the CPIs have a pyramidal structure which encompasses a large number of sub-indicators that are progressively aggregated using a set of weights at each level of aggregation. We first use an aggregation scheme in which the weights of the different sub-indicators are assigned according to the relevance that, in our view, each item deserves. Subsequently we adopt an alternative scheme, which aggregates the different features of a competition policy regime using factor analysis, as a robustness check. As mentioned above, the methodology herein proposed for building the CPIs is akin to the one used by the OECD for building the PMR indicators and the CPL indexes. However, the former aims at measuring restrictions to competi-

[1] A jurisdiction is the territory within which the power to interpret and apply a specific legislation can be exercised. It does not always coincide with the boundaries of a nation (e.g. the European Union).

[2] Buccirossi P., L. Ciari, T. Duso, G. Spagnolo, and C. Vitale, Competition Policy and Productivity Growth: An Empirical Assessment, London, CEPR Discussion Paper No. 7470, Centre for Economic Policy Research (2009), estimate the effects of competition policy on total factor productivity (TFP) growth in a panel of 22 industries in 12 countries between 1995 and 2005. They find a robust, positive and significant relationship between the CPIs and TFP growth and conclude that good competition policy institutions are beneficial to society by increasing efficiency and, hence, welfare.

[3] See Boylaud O., G. Nicoletti and S. Scarpetta, Summary Indicators of Product Market Regulation with an Extension to Employment Protection Legislation, OECD Economic Department Working Paper, No 226, OECD Publishing (2000); Conway P,.V. Janod and G. Nicoletti, Product Market Regulation in OECD Countries, OECD Economic Department Working Paper, No 568, OECD Publishing, (2005); Conway, G. Nicoletti, Product Market Regulation in the Non-Manufacturing Sector of OECD Countries: Measurement and Highlights, OECD Economics Department Working Paper, No 530, OECD Publishing (2006); Wolfl A., I. Wanner, T. Kozluk and G. Nicoletti, Ten Years of Product Market Reform in OECD Countries: Insights from a Revised PMR Indicator, OECD Economic Department Working Paper, No 695, OECD Publishing, (2009).

[4] See Hj J., Competition Law and Policy Indicators for OECD Countries, OECD Economic Department Working Paper, No 568, OECD Publishing, (2007).

Ciari, Lorenzo (2011), Essays in Economic Policy
European University Institute DOI: 10.2870/31694

tion due to inappropriate regulations (e.g. on entry or business activities) and the latter considers both policies that enhance the general level of competition (i.e. ex-post policies implemented by the Competition Authorities, from hereon CAs) and policies that encourage and promote competition in deregulated network industries (i.e. ex-ante policies implemented by sector regulators). The CPIs, instead, focus solely on the policies that enhance the general level of competition. In addition, while the PMR indicators have been calculated only for three years (1998, 2003, and 2008) and the CPL indexes only for one year (2003), the CPIs have both a cross-country and a cross-time dimension, as we calculated them for 13 OECD jurisdictions over a period of ten years (19952005).[5] The next section discusses the features of the competition policy regime that we have included in the CPIs because we believe them to be the most important determinants of its effectiveness. Section III explains how the CPIs are structured, while sections IV, V and VI explain in more detail the steps followed in their construction. Section VII describes the data we have used to calculate the CPIs over our sample. Section VIII explains how we derived the weighting schemes based on factor analysis. Section IX illustrates how well competition policy works in the jurisdictions in our sample by examining the evolution of some of the CPIs over the relevant period. Section X compares the CPIs with other indicators of a similar kind that have been developed in the literature. The last section contains some concluding remarks.

B. What makes competition policy work?

In this paper the term competition policy refers to the competition legislation (including the merger control provisions) and its enforcement. All other forms of competition-enhancing policies, such as the reduction of red tape that favours the entry of new firms, consumer protection, competition advocacy, state aid controls or ex-ante sectoral regulation, are not included in our definition of competition policy. Hence, for the purpose of this paper, a competition policy includes a set of prohibitions and obligations that firms have to comply with to ensure that competition is not reduced or altered, together with

[5]The 13 jurisdictions included in our sample are: Canada, Czech Republic, European Union, France, Germany, Hungary, Italy, Japan, Netherlands, Spain, Sweden, UK and USA. These OECD countries have been selected to be representative of different legal systems (common law and civil law), to include both EU and non-EU countries and, among the EU countries, both founding members and countries that have recently entered the Union, namely Hungary and the Czech Republic.

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an array of tools for policing and punishing any violation. We will generically refer to these as the features of a competition policy regime. Many economists share the view that the ultimate aim of competition policy should be to maximise social welfare, which is given by the un-weighted sum of the profits of all the firms and of aggregate consumer surplus.[6] Other alternatives have been proposed, where a lower weight is given to the welfare of the firms with respect to that of the consumers, or where the welfare of society is identified only with that of the consumers.[7] Yet, in the praxis, the objective function of the European Commission, the US antitrust authorities, as well as those of most other national CAs, incorporates a definition of social welfare that includes only the consumer surplus. In this paper, we are not going to discuss what should be the appropriate definition of social welfare that a competition policy should protect and enhance. Hence, we shall take as given the way in which each jurisdiction has designed, and each CA has implemented, its competition policy over the years considered in our sample. The role of a CA consists of using the powers and the resources conferred on it by the law to ensure that firms operating within its jurisdiction undertake the least possible number of behaviours that reduce social welfare by impairing competition. This implies that the aim of a CA consists of deterring anticompetitive behaviours.[8] It follows that the most

[6]Kaplow L., and S. Shavell, Fairness versus Efficiency (Harvard University Press, 2002); Motta M., Competition Policy: Theory and Practice (Cambridge, Cambridge University press, MA 2004); Buccirossi P., Introduction in Buccirossi P. (Ed.), Handbook of Antitrust Economics (Boston, MIT Press, 2008).

[7]Neven D.J., and L.H Rller, Consumer Surplus vs. Welfare Standard in a Political Economy Model of Merger Control, 33 (910) International Journal of Industrial Organization (2005) at 829848 consider the political economy environment that an antitrust agency is operating in and how this impacts on the choice of the appropriate welfare standard in merger control. The authors show that, when the antitrust agency can be influenced by third parties and it is imperfectly monitored, neither a consumer surplus standard nor a welfare standard dominates. Yet, when lobbying is efficient, accountability is low, mergers are large, and a marginal increase in merger size is highly profitable, a consumer surplus standard is more attractive. The authors do not discuss whether their analysis can or should be extended to other competition law infringements. On this topic see also Salop S. What is the real and proper Antitrust Welfare Standard? Answer: The True Consumer Welfare Standard, Statement before the Antitrust Modernization Commission, (2005).

[8]In order to avoid confusion we want to stress that the form of deterrence we refer to here is the one called ex-ante, or general deterrence, which consists of preventing agents from undertaking illegal behaviours by threatening violators with sufficiently heavy and prompt sanctions. There is also a second form of deterrence, called specific deterrence, or desistance, which takes place only ex-post (i.e. after an unlawful behaviour had already taken place and was discovered or when an anticompetitive merger is blocked or remedied) and works through a corrective change in behaviour induced in the economic agents prosecuted and convicted for the detected violation (or whose merger was stopped). Specific deterrence is of course much less important, as it has a limited effect and comes with prosecution costs, but it still plays a relevant role for those complex behaviours where mistakes in the forecast of their effects on social welfare

 DOI: 10.2870/31694

effective competition policy regime is one in which the CA achieves total deterrence and, hence, never has to block a merger, never has to uncover a cartel or any other anticompetitive agreement, and never has to condemn a firm for abusing its dominant position.[9] In such an ideal regime firms do not dare to propose an anticompetitive merger, do not attempt to form a cartel, never enter into an anticompetitive agreement and do not even consider using their market power with the aim of excluding rivals and reducing social welfare.[10] In addition, in the ideal competition policy regime, firms never refrain from attempting a merger, concluding a contract or undertaking a unilateral conduct, if these actions improve social welfare. In this paper we evaluate a competition policy regime on the basis of its ability to deter all those market conducts that harm social welfare. To do so we identify those features of a competition policy regime that we believe to have the strongest impact on the level of deterrence it can engender. We base our choice of these features on the economic theory of the public enforcement of law. This theory originates from Becker's seminal paper,[11] which shows that entry into illegal activities can be explained by the same model of choice that economists use to explain entry into legal activities, and which applies the economic approach to incentive design to address the legal problem of deterring unlawful behaviours. This theory claims that the level of deterrence depends on: 1) the level of the punishment wrongdoers can expect to suffer if they are convicted relative to their expected gain from the violation, 2) the perceived probability of being caught and convicted, and 3) the perceived probability of errors in the investigation and evaluation of the violations.[12] Since Beckers contribution, competition law enforce-

are likely.

[9]There is no reason to believe that the ideal competition policy regime is the one that a jurisdiction should strive for. Indeed, the ideal regime, even if it were feasible, would entail very high implementation costs, and these are probably much higher than the ones society would be rationally willing to bear: the ideal competition policy regime is in general not the most efficient one.

[10]The reason why our indicators measure the deterrence properties, rather than the quality of a competition policy regime, is because the latter increases with the level of deterrence up to the point when this becomes over-deterrence. However, it is very hard to say when the level of deterrence engendered by a competition policy regime has reached the point when it also starts to inhibit efficient behaviours. Hence, we consider it more appropriate to limit our analysis to the level of deterrence.

[11]Becker G., Crime and Punishment an Economic Approach, 76 (2) Journal of Political Economy (1968) at 169217.

[12]See Polinsky A.M. and S. Shavell, The Economic Theory of Public Enforcement of Law, 38 Journal of Economic Literature, (2000) at 4576; Buccirossi P., G. Spagnolo and C. Vitale, The Cost of Inappropriate Interventions/non Interventions under Article 82 OFT 864 (2006), and Schinkel M. P. and J. Tuinstra, Imperfect competition law enforcement, 24(6) International Journal of Industrial Organization (2006) at 539572. These errors weaken the level of deterrence a given sanction can induce. An enforcement agency can commit an

 DOI: 10.2870/31694

ment has become a specific research subject, which has gone well beyond extending, or adapting, results in the economic theory of the public enforcement of law. Building on this literature, we identify the policy variables/dimensions that are most likely to affect the three key determinants of deterrence when the relevant law is the competition legislation, and, thus, make the policy more or less effective.[13] With regard to violation of antitrust rules these are: 1) the degree of independence of the CA with respect to political or economic interests; 2) the separation between adjudicator and prosecutor; 3) the quality of the law on the books (i.e. how close are the rules that make the partition between legal and illegal conducts closer to their effect on social welfare); 4) the scope of investigative powers the CA holds; 5) the level of the financial loss (i.e. the overall sanction) that firms and their employees can expect to suffer as a consequence of a conviction;[14] 6) the level of activity of a CA, and the amount and the quality of the financial and human resources the CA can rely on when performing its tasks.[15] In the case of merger control, the selected features are slightly different because investigative powers are not very relevant in merger cases (as these are ex-ante investigations which do not involve infringement of legal obligations, but rather a request for approval for a business operation) and there are no sanctions for potentially anticompetitive mergers but only (small) sanctions for procedural violations.

error when it convicts someone who has not violated the law (normally referred to as a type I error) or when it acquits someone who is effectively guilty (normally referred to as a type II error). The probability that someone may be held liable even when she is adopting a legal behaviour reduces the rewards that are obtained from respecting the law, thus increasing the net gain from a breach of the law. Similarly the probability of being acquitted although one is violating the law renders the probability of being investigated and convicted lower, reducing the expected sanction. Hence, both types of errors make the alternative of violating the law more attractive.

[13]See Buccirossi P., L. Ciari, T. Duso, G. Spagnolo, and C. Vitale, Deterrence in Competition Law, Mimeo, (2009).

[14]The expected sanction depends on both the types and the levels of the sanction that can be imposed and the types and the levels of the sanction that are actually imposed.

[15]There are of course other potential determinants of deterrence that do not fall among the categories discussed above. For example, when a cartel is international in scope and leniency policies are not coordinated across countries and agencies, the risk for the first whistleblower in a country to be only the second one (hence, obtaining reduced or no leniency) in other countries because cartel partners react by rushing to self-report elsewhere may clearly hinder the deterrence effects of leniency programs. However, in this study we are focusing on cross-country differences, hence these issues, though interesting, fall outside the scope of our analysis.

 DOI: 10.2870/31694

C. The structure of the Competition Policy Indexes

Each indicator is obtained from the linear aggregation of data on the competition policy variables discussed above.[16] This aggregation follows a series of steps, which are discussed below and summarised in Table 1.

1. Each piece of information on each policy feature is assigned a score on a scale of 0-1 against a benchmark of generally-agreed best practice (from worst to best). In order to assign scores we determine what could be considered as best practice by relying on scientific papers and books, on documents prepared by international organisations such as the International Competition Network and the OECD, and on our judgement. These references are cited below, when we discuss in more detail how each feature is scored, and are summarised in two tables included in Appendix A.

2. All the information on a specific policy feature is summarised in a separate low-level index using a set of weights to aggregate it.

3. The low-level indexes are aggregated into two medium-level indexes for each of three types of possible competition law infringements and for mergers. The first one summarises the institutional features of the competition policy and the second one summarises the enforcement features.

4. The medium-level indexes are then aggregated to form a number of different summary indexes, which we generically refer to as the CPIs. More specifically we calculate (for each jurisdiction and each year in the sample):

- one index that measures the deterrence effect of the competition policy with regard to all antitrust infringements (the Antitrust CPI) and one that measures its deterrence effect in the merger control process (the Mergers CPI);

- one index that assesses the deterrence effect of the institutional features (the Institutional CPI) and one that assesses the deterrence effect of the enforcement features (the Enforcement CPI);[17]

[16] We are aware that there might be complementarities among different aspects of competition policy that we may miss by using this linearly additive specification. However, we believe that it would be difficult to choose a more precise approximation of the relationship that could exist between these variables. Hence, we decided to select this aggregation form that has the advantage of being simple, transparent and at the same time rather complete.

[17] The Enforcement CPI summarises information about the quality and quantity of resources available to CAs, together with information about the level of activity and the criminal sanctions imposed. The possibility to have wider enforcement information included in our index was limited by data availability problems.

 DOI: 10.2870/31694

- a single index that incorporates all the information on the overall deterrence effect of the competition policy regime in a jurisdiction (the Aggregate CPI).

D. The construction and composition of the low-level indices

The first two steps in the construction of the CPIs consist of calculating the low-level indexes. Each of these indexes includes information on one of the sets of policy variables discussed above (in section II), which we believe affect the level of deterrence engendered by the competition policy of a jurisdiction, and hence its effectiveness. We calculate separate indexes for each of the three possible competition law infringements (i.e. hard-core cartels, abuses of dominance and agreements other than hard-core cartels) and for mergers to take into account the differences in the legal framework and, where possible, in the enforcement.[18] We mentioned earlier that each piece of information is assigned a score on a scale of 0-1 against a benchmark of generally agreed best practice (from worst to best). When a data entry is quantitative it is normalised by dividing it by the highest corresponding value held by any CAs in the sample, so that even quantitative information assumes a value between 0-1. More details on how we assigned the scores can be found in thenext subsections. When an index includes more than one piece of information, these (or more precisely their scores) are weighted and summed together to obtain a single value for each low-level index. The weights used for the aggregation of the scores are based on our own evaluation of the importance of the various data. Details on how the subjective weights are chosen can be found in subsection IV.H. In order to check whether our choice of the weights has a significant influence on the results, we also use a different set of weights, generated by a statistical technique: the factor analysis. This robustness check shows that the results do not significantly vary, when this alternative set of weights is employed (see section VIII for more details). We move now to the description of the low-level indexes that form the basis of our CPIs. Table 1 shows the content of each of the low-level indexes. The numbers in brackets refer to the weights used to sum up the information contained in each index.

[18]This was not always easy. For example the CAs rarely have separate divisions that deal with the different types of infringements, hence we could not obtain separate data on the resources employed to police each one.

 DOI: 10.2870/31694

Independence of the competition authorities

An important determinant of the effectiveness of a competition policy regime is the independence of the CA with respect to political or economic interests. A CA which takes into account interests that are (potentially) in contrast with those that should guide its activity is more likely to commit errors when reaching decisions.[19] Thus, this first index measures the independence of a CA by considering its institutional status, as well as the role that the government plays in the adjudication of competition infringements and in the assessment of mergers. With respect to competition cases, in some jurisdictions separate bodies are responsible for the investigation of a case and for its adjudication. Hence, this low-level index has two components: i) the institutional nature of the body that performs the investigation, and ii) the institutional nature of the body that makes the decision and the role of the government in this decision-making process.

i) A jurisdiction scores 1 when the body that performs the investigation has total statutory independence, because it is either a court or an independent agency. It scores 0 if it is a ministerial agency/department. An intermediate score is given to the case in which the investigation can be performed by either an independent agency or a ministerial agency/department.

ii) A jurisdiction scores 1 when the body that takes the decision has total statutory independence and the government cannot over-rule a decision by the relevant CA, it scores 0.5 when the adjudicator has total statutory independence but the government can

[19]There is a wide and consistent literature that discusses the importance of having an independent competition authority in line with our explanation; see Genoud C. Toward a content and contextual approach of delegation, or how and why we should open the regulation black box ECPR Joint Session of Workshops, Edinburgh (2003), Majone D. Regulating Europe Routledge (1996), Oliveira G., E.L. Machado, and L.M. Novaes Aspect of the independence of Regulatory Agency and Competition Advocacy in Mehta S.P. and S.J. Evenett (Eds.) Politics Triumph Economics? Political Economic Regulation and the Implementation of Competition Law and Economic Regulation in Developing Countries, Academic Foundation (2009), OECD Optimal Design of a Competition Agency Note by the Secretariat CCNM/GF/COMP (2003); OECD Designing Independent and Accountable Regulatory Authorities for High Quality Regulation(2005), OECD European Commission Peer Review of Competition Law and Policy (2005), Voigt S. The Economic Effects of Competition Policy on Development Cross-Country Evidence Using Four New Indicators, 45(8) Journal of Development Studies, (2009) at 12251248. Gilardi makes a slightly different argument in that he claims that independent regulatory and competition agencies are more protected from political and electoral influence and thus they can adjust their regulatory policies in the long term and create a more stable and predictable regulatory environment; see Gilardi F. Policy credibility and Delegation to Independent Regulatory Agencies: a comparative empirical 9(6) Journal of European Public Policy (2002) at 873893, Gilardi F. Delegation to Independent Regulatory Agencies in Western Europe: a Cross-Sectional Comparison, Paper prepared for the workshop Delegation in Contemporary Democracies ECPR Joint Session of Workshops, Edinburgh (2003).

 DOI: 10.2870/31694

over-rule a decision, and it scores 0 if it is a ministerial agency/ department.

We give equal weights to each piece of information. In the case of merger control, there are jurisdictions in which one body first performs a high-level evaluation also referred to as Phase 1 and another one undertakes, when deemed necessary by the first one, a more detailed examination also referred to as Phase 2. Hence, in the case of mergers this index includes: i) the institutional nature of the bodies involved in Phase 1 and Phase 2; and ii) the role of the government.

i) A jurisdiction scores 1 when the bodies that reach a decision in Phase 1 and Phase 2 (if these are separate) are independent, 0 if both bodies are ministerial agencies/departments, and 0.5 if one is independent and the other is not. If there is only one body, the score is 1 if it is independent and 0 if it is not.

ii) The score is 1 if the government cannot over-rule a decision on a merger, and 0 if it can.

Also in this case, we give equal weights to each piece of information.

Separation of powers

A second relevant characteristic is the degree of separation between the body that performs the investigation on an allegedly anticompetitive behaviour (or merger) and the one which takes the decision on whether the behaviour should be sanctioned (or the merger blocked). The stronger the separation between prosecutor and adjudicator (e.g. when the investigation is made by an independent public body and the decision by a court) the more balanced the decision is likely to be and this, in turn, lowers the probability of an error.[20] Similarly it matters whether the appeal court i.e. the court that is responsible for reviewing the CAs decision is a specialised body with competence only in competition matters or whether it is the appeal body for all judicial decisions.[21] (e.g.

[20]For an in-depth discussion of the role of separation of powers in the context of institutions in general see Posner R. Comment: Responding to Gordon Tullok 2 Research in Law and Policy Studies (1988), Block M., J. Parker, O. Vyborna and L. Dusek An Experimental Comparison of Adversarial and Inquisitorial Procedural Regimes 2(1) American Law and Economic Review (2000) at 170-94;, Dewatripont M. and J. Tirole Advocates 107(1) Journal of Political Economy (1999) at 139. Wils W. The Combination of the Investigative and Prosecutorial Function and the Adjudicative Function in EC Antitrust Enforcement: a Legal and Economic Analysis 27(2) World Competition (2004) at 20124; and Neven D.J, Competition Economics and Antitrust in Europe, Economic Policy (2006) at 741791 discuss the importance of separation of powers with regard to competition and regulatory institutions.

[21]See OECD, Private Remedies, Policy Roundtables, Paris (2007).

DOI: 10.2870/31694

OECD 2007). A specialised body is formed by individuals that have competence in those specific subjects and are therefore better able to consider all the details and correctly evaluate all the evidence when deciding on a case. This low-level index captures information on these elements, more precisely on: i) the existence of a separation between the adjudicator and the prosecutor, which in our view reduces the bias in the decision; ii) the nature of the appeal body; and only in the case of mergers iii) whether the body that decides if a merger should undergo a Phase 2 investigation and the body responsible for undertaking the Phase 2 investigation are separate.

i) A jurisdiction scores 0 when the same body adjudicates and prosecutes, while it scores 1 if these two activities are performed by separate bodies.

ii) A jurisdiction scores 1 when the relevant appeal court specialises in competition matters and 0 when this court deals with appeals on all kinds of decisions.[22]

iii) A jurisdiction scores 0 when the same body performs Phase 1 and Phase 2 investigations, and scores 1 when two different bodies undertake the two activities.

In the low-level indexes for the competition law infringements we give a weight of 2/3 to the scores on the degree of separation between adjudicator and prosecutor and a weight of 1/3 to the nature of the appeal court. In the index for mergers, where we have three elements, we give equal weight to each of them.

Quality of the law

We define deterrence as the prevention of conducts that reduce social welfare, however the latter may not always be the conducts that are declared illegal by the competition legislation. Rules are indeed imperfect as they can ban conducts that are competitive, or allow conducts that are anticompetitive. Hence, the third policy variable we need to consider is the quality of these rules, i.e. the quality of the law on the books. This is a matter of judgement, which makes measuring this policy variable extremely difficult. However, we can observe whether the competition legislation (and the soft law that disciplines its

[22]In most jurisdictions, all mergers that undergo some form of control are first subject to a general investigation, referred to as Phase 1. Those mergers that raise concerns and that may be blocked or may require remedies, are subject to a second more detailed analysis, called a Phase 2 investigation. In some jurisdictions the same body that decides on whether a merger should undergo a Phase 2 investigation, also performs this investigation. In other jurisdictions, a separate body is responsible for undertaking the Phase 2 investigation. The decision on the outcome of each investigation can be made by the same body that investigates or from a separate one.

 DOI: 10.2870/31694

actual application, e.g. guidelines) has rules that make the partition between legal and illegal conducts closer to their effect on social welfare. In the case of antitrust infringements, this index focuses on: the standard of proof that is required when deciding on a specific type of violation, which can be a per-se prohibition or a rule-of-reason approach; and the goals that inform the decision-making process. For abuses of dominance, we consider the standard of proof required for a price exclusionary practice, predation, a non-price exclusionary practice, and refusal to deal. If, in assessing each of these alleged abuses, a jurisdiction applies a rule-of-reason standard and it considers only economic goals it scores 1. The reason is that, in this case, the CA decides whether there has been an abuse on the basis of the effects of the behaviour rather than by relying on set rules. On the other hand, if it imposes a per-se prohibition a jurisdiction scores 0. An intermediate score applies if the CA applies a rule-of-reason standard, but it also considers non-economic goals when evaluating the effects of the action (e.g. the effect of the behaviour on the level of employment).[23] For anticompetitive agreements other than hard-core cartels, we only consider the practice of exclusive contracts, because this is very common in most markets. If, in assessing such an infringement, a CA requires that the actual effects of the behaviour are proven and it considers only economic goals when evaluating the effects, it scores 1. If it also considers non-economic goals it scores 0.5, and if it imposes a per se prohibition it scores 0.[24] For hard-core cartels, instead, a per-se ban scores 1. Instead, if the imposition of a sanction requires showing that the cartel had an effect on the market and the CA considers only economic goals, the score is 0.5, otherwise, if it considers also non-economic goals, the score is 0. The reason why the scoring is reversed in the case of cartels is the gravity of this practice and of its consequences, which, as is generally agreed, calls for a stricter rule.[25] The index for hard-core cartels includes also a second element: the leniency program. A CA that has such a program is more likely to discover and deter a higher number of cartels.[26] Hence, a jurisdiction scores 1 if it has a leniency

[23]See Voigt above n. 19.

[24]See Voigt id.

[25]See Motta above n. 6 and OECD, Report on the Nature and Impact of Hard Core Cartels and Sanction against Cartels under National Competition Laws (2002).

[26]There exists a number of theoretical, empirical, and policy studies pointing to the leniency programs as one of the most successful policy tools with which to fight hard-core cartels. See Aubert C., W. Kovacic, and P. Rey, The Impact of Leniency and Whistleblowers Program on Cartel 24 International Journal of Industrial Organization (2006); Harrington J. Optimal Corporate Leniency Program 56(2) Journal of Industrial Economics (2008) at 215216; ICN Recommended Practices for Merger Notification Procedures and Review

 DOI: 10.2870/31694

program for cartel whistleblowers and 0 if it does not. The merger control index has a different composition as it is based on the characteristics of the notification obligation, and on the criteria used for assessing concentrations.

i) With regard to notification, the absence of any obligation to notify is scored 0, while a score of 0.33 is given to the CAs that impose such an obligation but have no minimum threshold, since the lack of such a limit renders it more difficult for CAs to focus resources on important cases.[27] Higher scores are given when there is such a threshold: 0.66 is given to a CA with a minimum threshold based on market shares, and 1 to a CA with a minimum threshold based on the firms turnover. The reason why turnover is considered to be best practice is that it is easier to apply and is less open to uncertainty.

ii) The application of an efficiency defence in the competitive assessment of mergers is scored 1, because it allows us to take into consideration all the economic consequences of the concentration on the market and on consumers. The absence of any efficiency defence is scored 0.

In the aggregation process, we give equal weights to both elements.

Powers during investigations

This index, which is calculated only for competition law infringements, measures the type of powers a CA holds during the investigation phase. These include i) the power to impose, or request, interim measures, that allows preventing any anticompetitive behaviour from leading to serious and irreversible damages while a final decision is being reached. Furthermore, they include ii) the powers to gather information by inspecting the premises of the firms under investigation and the private premises of their employees, as well as by wiretapping conversations. The stronger the latter powers, the more and the better the information at the CAs disposal is, and thus the higher the probability of detection and the lower the probability of errors, especially type II errors.

www.internationalcompetitiononnetwork.org/media/archive0611/mnprecpractices.pdf (2006); Motta M. and M. Polo, Leniency Program and Cartel Prosecution 21 International Journal of Industrial Organization (2003)at 347379; Motta above n. 6; OECD Fighting Hard Core Cartels: Harm, Effective Sanction and Leniency Programmes (2002); OECD, Report on the Nature and Impact of Hard Core Cartels, above n. 25; Spagnolo G. Divide and Imperia: Optimal Leniency Programs CEPR Discussion Paper No 4840 (2004); Spagnolo G., Leniency and Whistleblowers in Antitrust, in Buccirossi P. (Ed.) Handbook of Antitrust Economics (MIT Press, Cambridge MA 2008).

[27] See ICN id.

 DOI: 10.2870/31694

i) With respect to interim measures, a jurisdiction scores 1 if it has interim measures and 0 if it does not.

ii) With regard to information gathering powers, a jurisdiction scores 1 if both business and private premises can be inspected, 0 if none of them can be inspected, and 0.5 if only business premises can be inspected, as the wider the powers the more thorough the investigation.

We give a weight of 1/4 to the availability of interim measures and of 3/4 to the types of information gathering powers held by the CAs. With respect to hard-core cartels, the power to impose interim measures is not relevant. Hence, this index only measures the types of powers to gather information. Moreover, we do not build this low-level index for mergers because investigative powers are not very relevant in merger cases as these are ex-ante investigations, which do not involve infringement of legal obligations but rather a request for approval for a business operation.

Sanctions and damages written on the books

One important element in deterring anticompetitive behaviours is the credible threat of financial losses that firms (and their employees) can expect to suffer as a consequence of a conviction.[28] This low-level index considers i) the range of potential sanctions that offenders firms and ii) their employees are faced with and iii) whether affected parties can sue for damages. The overall index is composed in equal parts by the scores of these three elements. These losses are determined by the sum of the sanctions that can be imposed

[28]For a theoretical analysis of the role of the sanctions in achieving deterrence see Becker above n. 11; Landes, W.M. Optimal Sanction for Antitrust Violation, 50 The University of Chicago Law Review (1983) at 625678; Simon M.J. and G. J. Werden Why Price Fixers Should Go to Prison 32 Antitrust Bulletin (1987) at 917937; Geradin D. and D. Henry, The EC Fining Policy for Violation of Competition Law: an empirical review of Commission Decisional Practice and the Community Courts Judgement in Cseres K.J., M.P. Schinkel. and F.O.W. Vogelaar (Eds.) Remedies and Sanctions in Competition Policy: Economic and Legal Implication of the Tendency to Criminalize Antitrust Enforcement in the EU Member States, (London, Edwar Elgar, 2005); Kobayashi, B., Antitrust, Agency and Amnesty: An Economic Analysis of the Criminal Enforcement of the Antitrust Laws Against Corporations 69 George Washington Law Review, (2001), 715; Buccirossi P. and G. Spagnolo, Optimal Fines in the Era of Whistleblowers: Should Price Fixers Still Go to Prison in V. Goshal and J. Stennek (Eds.), The Political Economy of Antitrust, (Elvesier, North Holland 2007); Schinkel M.P. Effective Cartel Enforcement in Europe 30(4) World Competition (2007) at. 539572. Empirical analyses can be found in Craycraft C. Antitrust Sanctions and Firm Ability to Pay 12 Review of Industrial Organization (1994) at 171183; Craycraft J.L., J.C. Gallo, K.G. Dau Schmidt and C.J. Parker Criminal Penalties Under the Sherman Act: A study of Law and Economics 16 Research in Law and Economics, (1997) at 2571; Connor J.M Optimal Deterrence and Private Antitrust Enforcement Mimeo Purdue University, (2005).

 DOI: 10.2870/31694

by the CA, and/or the court, (e.g. fines, imprisonment, disqualification, damages), to which it is necessary to add any damage repayment to the affected parties, because what determines the behaviour of a firm are the total losses imposed by a given course of action. It is important to highlight that the level of the financial loss depends on two elements: the law on the books and how this is enforced. For example, the sanctions imposed by the CA (or a court) depend: on the criteria set out in the law regarding the type of intended sanctions and maximum level they can reach, and on how these criteria are applied (i.e. their enforcement). If the monetary fine can reach up to 10 per cent of the turnover of a firm, but no fine of this level has ever been imposed, even when a serious breach of the law took place, as such firms will not expect to have to pay such a figure, despite what the law says. This index only refers to what is set out in the law. We consider separately the level that the actually imposed sanctions. Since no sanctions are imposed following merger investigations, there is no such index for mergers.[29]

i) With regard to the sanctions that can be imposed on firms, this index considers how the maximum level of the fine is set: the score is 1 if this limit is expressed as a proportion of the turnover of the offending firm or of the illicit gain obtained from the infringement, 0.66 if the level of the fine is left to the discretion of the adjudicator, 0.33 if the maximum level of the fine is set in absolute terms, and 0 if no fines are imposed.[30] For the abuses of dominance index we also include the types of sanctions that can be imposed. A jurisdiction scores 0 if neither monetary fines nor structural remedies can be imposed, 0.75 if only monetary sanctions are possible, and 1 if both are allowed. To obtain a single score for the sanction to firms, we give a weight of 1/3 to the type of possible sanctions and of 2/3 to the criterion for its calculation.[31]

ii) With regard to sanctions on the employees of the offending firms, the index considers both the types of sanctions and their maximum level:

- for monetary fines, the score is 0 if no such fines can be imposed and 1 if there is no explicit limit to this type of sanction; instead, if there is a maximum value set by law, the score is the normalisation of this value, which is obtained by dividing this value by the maximum value in the sample;

[29]There are fines only for breaching procedural obligations, such as the duty to notify (when this exists), and for completing a merger that was prohibited. These, however, are very limited.

[30]These weights are based on the discussion put forward by OECD, Fighting Hard Core Cartels above n. 26, at 11 and OECD Report on the Nature and Impact of Hard Core Cartels above n. 25

[31]Again these insights are based on the considerations expressed by OECD id

DOI: 10.2870/31694

- for disqualification, the score is 1 if the employee can be disqualified from the position of director and 0 if this is not possible;

- for jail sentences, the score is 0 if the individual cannot be imprisoned; in all other cases, the score is the maximum jail term that the courts can impose, divided by the longest jail term available in any jurisdiction enclosed in the sample.

To obtain a single score for this element of the index, we have given a weight of 3/10 to monetary fines, a weight of 2/10 to disqualification and a weight of 5/10 to imprisonment.

iii) With regard to private actions, the score is 0 if no private actions are possible, while it is 1 if both affected firms and affected individuals can appeal to a court for a damage payment and if class actions are possible. The intermediate scores 0.33 and 0.66 are given only if the affected firms, or both the affected individuals and the affected firms respectively, can undertake a private action, but class actions are not available.

Resources

The effectiveness of the enforcement activity of a CA is likely to be affected by the financial and human resources devoted to it. This index measures both the quantity of these resources, i.e. i) budget and ii) total staff of the CAs, and their iii) quality, more specifically the number of economists with a relevant PhD and of qualified lawyers. When a jurisdiction has two CAs we consider their resources jointly. Since all this data is quantitative we normalise the original data between 0-1 in the following way:

i) The budget is divided by the nominal GDP of the country (both expressed in US dollars using PPP exchange rates), so as to allow a comparison between countries of different sizes and levels of economic development. This value is then divided by the highest corresponding value held by any CAs in the sample.

ii) The number of staff members is divided by the real GDP of the country, to allow a meaningful comparison between countries. This value is then divided by the highest corresponding value held by any CAs in the sample.

iii) Both the number of economists with a PhD and the number of qualified lawyers are divided by the number of total staff. This value is then divided by the highest corresponding value held by any CAs in the sample.

We give a weight of 1/2 to the budget data, a weight of 1/4 to the data on the total staff

 DOI: 10.2870/31694

and a weight of 1/4 to the data on the composition of this staff. This index has the same value for all the three possible infringements, as well as for merger control, because we do not have separate data on the resources devoted to each type of practice. This is due to many CAs not having separate divisions that deal with different types of behaviours and/or not keeping a record of the personnel and resources of different divisions.

Actually imposed sanctions and cases

How effective sanctions are as a deterrent depends not just on their type and level as set in the law, but also on the strictness of sanctions that have actually been issued. Unfortunately, data on this subject are scarce.[32] We obtained only limited data for hard-core cartels. These refer to the maximum jail term imposed on the employees of the offending firms (for those countries in which such a sanction is possible). In order to score this data we divide the relevant figure by the highest one imposed by any CAs in the sample.[33]

The credibility of a CA in preventing anticompetitive behaviours/mergers also depends on how active it is in assessing mergers and investigating complaints of infringements. This level of activity is proxied with the number of cartels investigations opened and the number of mergers examined, each divided by the real GDP of the relevant country, as the size of the economy can have an impact on the absolute number of anticompetitive behaviours. We then normalise this ratio by dividing it by the highest one in the sample.[34] When a country has two CAs we consider the number of cartel investigations performed by both of them.

For hard-core cartels we give a weight of 2/3 to the data on the jail term and 1/3 to the number of cases investigated.

[32]

[33]CAs do not keep easily accessible records of fines and other sanctions, especially if one wants to relate them to seriousness and the duration of the infringement or to the magnitude of the affected commerce. In addition, in most instances, the CAs decisions have been appealed and it is difficult to track down the outcome of the appeal, which is the one that really matters. This element of the indicator could benefit from further work.

[34]The reason why we have not also included the number of cases of other types of antitrust infringements is that, unfortunately, it has proved impossible to collect consistent data on the number of investigations carried out on abuses and agreements other than cartels.

DOI: 10.2870/31694

Rationale behind the subjective weights

In the preceding sections we indicated the weights that we used to aggregate the single pieces of information to construct the low-level indexes. We now explain how we select them. The general rule we follow is a sort of Principle of insufficient reason, whereby whenever we do not have specific reasons to believe that one feature matters more than others, we give equal weights to all elements in the low-level index.[35] There are six cases in which this neutrality rule is not applied. These are explained below.

1) In the low-level indexes on the separation of powers for all antitrust infringements, Separation between adjudicator and prosecutor is weighted 2/3, while Nature of appeal court is weighted only 1/3. The rationale behind this choice is that the appeal court does not intervene in all cases, as the undertaking may not appeal. In addition the appeal decision is taken much later, with respect to the decision of the CA. Hence, the nature of an appeal court should have a weaker and less certain influence on the effectiveness of a competition policy regime.

2) In the low-level indexes on the powers to investigate for abuses of dominance and for agreements other than cartels, Availability of interim measures we give a weight 1/4, while for Combination of powers we give a weight of 3/4. This choice rests on the fact that, while the latter is crucial for the CAs intervention since it affects how thorough an investigation can be, the former only affects the timeliness of the intervention, but does not alter the probability of errors.

3) In the low-level indexes on sanctions and damages for abuses of dominance, the sanctions on firms include two elements: the types of sanctions that can be imposed and their level. To obtain a single score we give a weight of 1/3 to the type of possible sanctions and of 2/3 to the criterion for its calculation, because we believe that the latter has a stronger impact on deterrence.[36]

4) In the low-level indexes on sanctions and damages, we have different types of sanctions that can be imposed on offending individuals. To obtain a single score we give a weight of 3/10 to monetary fines, a weight of 2/10 to disqualification and a weight

[35]For a discussion of this principle in statistics in a historical perspective see Stigler S. The History of Statistics: The Measurement of Uncertainty before 1900 (Cambridge MA, Harvard University Press 1986). The principle of insufficient reason was renamed the principle of indifference by Keynes J.M., A treatise on Probability, (MacMillan,1921).

[36]The reason why we believe that the criterion for setting the level of the fine is so important is that this most affects the incentives faced by a firm in the course of its decision process.

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of 5/10 to imprisonment. These weights are based on our view that monetary fines can be paid by the companies the individuals work for, while prison sentences have to be undergone by the individuals found guilty.

5) In the low-level indexes on resources we give a weight of 1/2 to the budget data, a weight of 1/4 to the data on the total staff and a weight of 1/4 to the data on the composition of this staff. The reason is that we believe that the monetary resources are those that most affect the means that a CA has to undertake its investigative and enforcement activities.

6) In the low-level indexes on cases for hard-core cartels we give a weight of 2/3 to the data on the maximum jail term and 1/3 to the number of cases investigated, because we believe that the former data is more important in signalling the toughness of a competition regime.

E. The construction of the medium level indexes

The next step in the construction of the CPIs consist of vertically aggregating the low-level indexes to obtain, for each type of infringement and for mergers, a medium-level index that encompasses all the information on the institutional features as well as a medium-level index that encompasses all the information on the enforcement features. The value of each of these eight medium-level indexes is given by the weighted average of the low-level indexes they comprise. These weights are shown in Table 2.

The weights are chosen so as to attribute greater importance to the low-level indexes that incorporate the most important policy features. Hence, in the institutional feature index, in the case of the antitrust infringements, we give a weight of 1/3 to sanctions and damages, while we give a weight of 1/6 to all the other features. This is due to the fact that sanctions seem to have a stronger impact on deterrence.[37] In the enforcement feature index, we give a lower weight to the data on the number of cases if at all available because we believe that the resources are a better indicator of how active a CA is in its competition enforcement activities.

[37]See Levitt S.D., Deterrence in Wilson J.Q. and Petersilia J., (Eds.) Crime (ICS Press, 2001), Levitt S.D. Juvenile Crime and Punishment, 106(6) Journal of Political Economy (1998) at 11561185; Levitt S.D. and T.J. Miles Economic Contribution to the Understanding of Crime 2 Annual Review of Law and Social Sciences (2006) at 147164.

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F. The construction of the high-level indexes

The last step consists of aggregating the medium-level indexes in a set of high-level indexes, the CPIs, that incorporate all the information on the deterrence effect of the competition policy regime in a jurisdiction in a specific year. Table 3 shows these CPIs and the weights (in brackets) used in the aggregation process.

First, we calculate the Antitrust CPI as the weighted average of all the medium-level indexes relative to antitrust infringements, and the Mergers CPI as the weighted average of two medium-level indexes relative to merger control. We then calculate the Institutional CPI as the weighted average of the four medium-level indexes relative to the institutional features, and the Enforcement CPI as the weighted average of four medium-level indexes relative to the enforcement features. Finally, we calculate an index that incorporates all the information on the deterrence effect of the competition policy regime in a jurisdiction in a specific year (the Aggregate CPI).

G. Data

In this section we explain how we collected the data on the relevant competition policy features that we employed to calculate the CPIs. Most of the data were directly obtained from the CAs operating in the 13 jurisdiction included in our sample.[38] We submitted a tailored questionnaire to each of them with questions on the institutional framework of their competition policy regime and on how this evolved over time (to capture any changes that happened over the ten-year period 19952005). In addition, we asked them about the quantity and quality of the resources they employed to enforce the competition legislation over that time period, as well as about the sanctions imposed on firms and their employees and the cases/mergers they have investigated. The data from this survey were integrated with information derived from the country studies carried out by

[38]We surveyed only the CAs which are either independent public bodies or ministerial agencies/departments, and did not survey the courts (though we collected data on their powers and activities). The bodies that we surveyed are: Competition Bureau (Canada); Urad pro ochranu hospodarske souteze (Czech Republic); Directorate General for Competition Affairs (European Union); Conseil de la Concurrence (France); Direction Gnrale de la Concurrence (France); Bundeskartellaamt (Germany); Gazdasgi Versenyhivatal (Hungary); Autorit Garante della Concorrenza e del Mercato (Italy); Japan Fair Trade Commission (Japan); Nederlandse Mededingingsautoriteit (Netherlands); Servicio de Defensa de la Competencia (Spain); Tribunal de Defensa de la Competencia (Spain); Konkurrensverket (Sweden); Office of Fair trading (UK); Competition Commission (UK), Federal Trade Commission (US); Antitrust Division - Department of Justice (US).

 DOI: 10.2870/31694

the OECD in the context of its reviews of regulatory reforms, from the chapters on competition and economic performance in the OECD Economic Surveys and from the CAs own websites.

Missing data

Despite the active collaboration of most CAs, it was not possible to collect all data on the enforcement characteristics of the competition policy necessary to build the CPIs for the period considered (19952005). Hence our database had some missing observations. In order to fill them in, we asked the CAs to provide us with an imputation of the missing observations based either on other data at their disposal or on their historical knowledge of the trends. When this was not possible, we performed some very limited imputation of the missing data, whenever this was allowed by the characteristics of the other available data on that specific feature. More specifically, we performed two types of imputation. The first consisted of extending a series of data over time, if we had enough data (at least five observations) and if it was possible to trace a clear trend in them. For example, if we had data on the level of a CAs budget from 1996 to 2000 (i.e. 5 years) and this was constantly growing, we calculated the budget for 2001 and 2002 using the average growth rate observed in the available data. We calculated only two of the missing data because we believe that our imputation should not exceed 50 per cent (i.e. since we had 5 observations we calculated 2 more, whereas if we had had 7 observations we could have calculated the 3 missing ones). The second imputation consisted of exploiting the information from other data to impute a different, unavailable, series of data. We used this imputation criterion only for two specific variables: the level of a CAs budget for competition activities and the number of its staff devoted to competition activities. Where we only had data on the budget for competition activities but not on the staff, and had data on the overall budget of the CA and on the total staff employed by the CA, we used the ratio between the budget in competition activities and the total budget to impute the fraction of the staff employed in competition activity. Despite this work, we were not able to fill all the existing gaps. This means that in some cases we did not have all the information necessary to calculate a specific index. To avoid calculating indexes whose value could be altered by the lack of information, we chose not to calculate an index (both at the low, medium and high level of the pyramid) if 50 per cent or more of the relevant

 DOI: 10.2870/31694

information content was missing. For example, the low-level index on resources includes information on the CAs budget with a weight of 1/2, on quality of its staff with a weight of 1/4, and on the composition of its staff with a weight of 1/4. If we did not have the data on the level of the budget for a given country in a given year then we did not calculate this index because half of the information content was missing. On the contrary, if we had no information on the composition of the staff, we could still calculate the index as only a quarter of the information content would be missing, i.e. we would be above the 50 per cent threshold. In cases like these, however, we adjusted the weights to account for this missing observation. In our example, the budget was given a weight of 2/3 and the quality of the staff a weight of 1/3. We made only one exception to this rule, in that we did not calculate the Aggregate CPI if we could not calculate the relevant Enforcement CPI, even if this just accounted for 1/3 of the overall information content of the Aggregate index. We decided that in the case of the Aggregate CPI it was important to have data on both the institutional and enforcement features.

The EU

Our sample includes nine European countries, which are part of the European Union.[39] Hence, in these countries the EU competition policy works alongside their national competition policy. This means that, in order to correctly evaluate the effectiveness of the competition policy regime in each Member State it is necessary to consider both the national and the EU regime. Therefore for these countries, we also built a set of CPIs, which incorporate information on both the national and the EU competition policy. However, since we have no information on the EU enforcement features, we have only been able to calculate this set of indexes for the institutional features. These indexes have been calculated as the simple average of the countrys Institutional CPI and the EU Institutional CPI.

H. Robustness of the indexes

The construction of the CPIs contains a crucial element of subjective evaluation, which consists of the set of weights employed to combine the information gathered at each level

[39] These are France, Germany, Italy, the Netherlands, Spain, Sweden, the UK and since 2004 also the Czech Republic and Hungary.

 DOI: 10.2870/31694

of aggregation. There is thus a risk that the value of the CPIs may be driven by the adopted subjective weighting scheme. In the previous sections we justified our choice of weights (see section IV.H). Nonetheless, to verify if the CPIs are sensitive to the adopted weighting scheme, we employed a statistical technique, the factor analysis, to derive a new set of CPIs where the weights assigned to each piece of information are totally driven by the characteristics of the data themselves. The factor analysis is a statistical method which groups together variables that are highly correlated (and thus, to some extent, redundant) into a number of latent factors. The most important output of the factor analysis is the matrix of loadings. The loadings measure the correlation between the variables and the factors, and allow the assignment of each variable to a given factor based on the strength of their correlation. Different techniques can be used within the framework of factor analysis to compute the loadings and to estimate the factors. Our analysis is based on the methodology employed by the OECD when calculating the PMR indicators.[40] This methodology involves a number of steps:

1. The first step consists of grouping the variables according to different areas of the competition policy: hard-core cartels, abuses, other agreements, and mergers, with no distinction between institutional and enforcement features.

2. The second step consists of extracting the factors i.e. identifying the number of factors necessary to represent the original data using the principal component method. With this method, the factors are chosen so that the first one explains as much information contained in the original data as possible; the second factor is orthogonal to the first and explains as much residual information as possible, and so on. The exact number of factors that should be retained can be decided by the researcher. Yet, usually one keeps adding factors until the explanatory power of the last factor included remains above a certain threshold.[41]

3. The third step consists of the rotation of the factors, which permits a better interpretation of the results. The rotation allows us to get loadings that are closer to 1 or 0, thus allowing us to more easily assign a selected variable to a unique factor. We use the varimax rotation technique, which preserves the orthogonality between the factors.

[40] See Conway P,.V. Janod and G. Nicoletti, Product Market Regulation, above n. 3.

[41] The threshold is set with reference to the value of the eingenvalue associated to each factor. In most applications and statistical packages (e.g. STATA, which we used) that perform factor analyses, the level of threshold is set by default to the value of 1.

 DOI: 10.2870/31694

4. The fourth step consists of the construction of the factors. We construct the factors as the weighted average of the original variables, where the weights are the normalised squared factor loadings of each variables.

5. The fifth step consists of the aggregation of the factors in order to have a single indicator for each of the areas of the competition policy (hard-core cartels, abuses, other agreements, and merger control). The factors are weighted according to the proportion of the overall variance of the data explained by each one and summed one to the other.

6. Finally, we run the factor analysis on these four indicators again (repeating the procedure described above) to calculate the aggregate CPI.

Table 4 shows the output of the factor analysis for one of the areas of competition policy: hard-core cartels. In the first column, we report the entire list of variables on which the factor analysis has been performed. All the institutional and the enforcement variables have been included. The principal component method allows us to identify four separate factors that capture 73 per cent of the variability in the original data. The columns called factor loading show the loadings for each factor, which measure the correlation between each variable and that specific factor, while the third column, called weights of variables, show the weights that each variable gets in the computation of the factor, based on the normalised squared of the factor loadings. The four factors are then aggregated as a weighted sum, where the weight is proportional to the explanatory power of the factor with respect to the original data, captured by the normalised sum of the squared factor loadings.

A similar procedure is used for the other areas of competition policy: abuses, other agreements and mergers. Then we run the factor analysis on the results again to obtain the aggregate CPI.

I. Results

In this section we present the results and discuss the CPIs. We start by showing, in Figures 1 to 6, the values of the Institutional CPIs and the Enforcement CPIs for the jurisdictions in our sample over the period 19952005.[42] To allow for a clearer interpretation of the results we include only a limited number of jurisdictions in each figure. Yet, to allow

[42]We were not able to collect any data on the enforcement features for the European Union, hence we could not calculate the Enforcement CPI for this jurisdiction.

 DOI: 10.2870/31694

readers to easily perform comparisons among them, we also report the simple average in each figure. Figure 1 shows the Institutional CPIs for the three OECD countries in our sample that are not part of the EU. They remain relatively stable over the period under exam, but they differ considerably among each other. The one for the US takes very high values (ranging between 0.74 and 0.76), which are constantly among the highest in the sample and well above the sample average (ranging between 0.54 and 0.62); the values for Canada are also above the sample average (ranging between 0.58 and 0.62), while Japans values are very low (between 0.46 and 0.5).

Japan consistently has the lowest Institutional CPIs for the entire sample period. The reason behind Japans low performance is manifold. First, Japan suffers from the lack of a leniency program for cartel whistleblowers. Second, in Japan there is no separation between the body that prosecutes violators of the antitrust law and the body that adjudicates such cases. Further elements are the absence of the possibility to start a class action and the fact that the Japanese competition legislation envisages the consideration of non strictly-economic goals when assessing the effects of abuses of dominance. The index for Canada shows a rise between 1998 and 2000. This improvement in the institutional features of the competition policy can be attributed to two major policy changes: the introduction in 1999 of the power to wiretap during investigations on alleged antitrust infringements and the introduction of a leniency program in 2000. Figure 2 shows the Enforcement CPIs for the same three countries. While the Institutional CPIs tend to be stable over time, because institutional changes are less frequent due to institutional inertia, the evolution of the Enforcement CPIs for the three non-EU countries exhibits more cross-time variation. Moreover, the ranking is different with respect to Figure 1, as Canada is now the country with the highest values (ranging between 0.37 and 0.44). The main reason why Canada has higher values than the US is due to the size of the annual budget for competition activities (relative to the countrys GDP) and the number of the CAs employees (relative to the countrys GDP). However, the positive gap with respect to the US and the sample average tends to shrink over time and, by the end of our sample period, it is almost closed, with both countries as well as the average taking values close to 0.35.

Also in this case, Japan shows very low values for the Enforcement CPIs. This is due to the low level of human and financial resources available to the Japanese CA. The significant drop from a value of 0.13 to a value of 0.05 that can be observed between 1997

 DOI: 10.2870/31694

and 1999 is due to a strong reduction in the number of mergers examined by the Japanese CA, as a result of a change in legislation that modified the criteria for the notification of mergers. Figure 3 depicts the Institutional CPIs for the large EU member states in our sample and for the EU itself. The CPIs for Spain (ranging between 0.48 and 0.54), France (from 0.46 to 0.52) and Italy (which stays stable on the value of 0.51) are consistently below the sample average (0.55 to 0.63). Germany, instead, shows a much better performance (ranging between 0.67 and 0.7) and its Institutional CPI is well above the sample average. The Institutional CPIs for the EU (from 0.52 to 0.65) and the UK (from 0.4 to 0.71) start below the average (from 0.54 to 0.62), but grow significantly over time until they pass it.

The most interesting features of this picture are the changes that characterise three of the jurisdictions. The CPI for the UK jumps from the lowest level to a level well above the sample average. This is due to the major changes that accompanied the introduction of the Competition Act in 2000. Both Spain and France experience a substantial improvement between 2000 and 2003. The former benefited from the introduction of class action in 2001 and of the powers to investigate business premises in 2003. In the latter country, the quality of the institutional CPI improved because of the introduction of a leniency program for cartel whistleblowers and as a consequence of the introduced obligation to notify mergers. Finally, the Institutional CPIs for the EU shows two upward jumps in 1996 and in 2004. The first one, in 1996, is due to the introduction of a leniency program for cartel whistleblowers, while the second, in 2004, is the result of the introduction of the power to inspect private premises in the investigation of hard-core cartels and abuses. Figure 4 depicts the Enforcement CPIs for the same subset of jurisdictions. The figure does not include the EU, as we were not able to collect data on its enforcement features. Moreover, the data for France and Spain in the first five years of the sample are also missing. This lack of information does not allow us a clear picture of the trend for these jurisdictions

Surprisingly, with respect to the enforcement characteristics of the competition policy, Germany (ranging between 0.13 and 0.15) now ranks well below Italy (ranging between 0.18 and 0.28) and the UK (ranging between 0.21 and 0.4), and close to Spain (ranging between 0.13 and 0.17). This is partially due to the fact that less financial resources are available to the German CA, but is also a consequence of its limited number of employees (with respect to the UK) and their lower level of skills (with respect to Italy). Another relevant aspect to note is the consistent improvement in the overall deterrence properties

 DOI: 10.2870/31694

of the enforcement features of the competition policy in the UK, as the introduction of the Competition Act in 2000 was accompanied by a steady growth in the financial and human resources available to the two CAs. The decline of the constantly very low French index (from 0.095 to 0.09) is due to a decrease in the overall number of employees, a reduction in the number of qualified economists and in the budget in real terms. Figure 5 depicts the Institutional CPIs for the small EU countries in our sample. Sweden is consistently the country with the highest Institutional CPI values (ranging between 0.75 and 0.77) not just in this group but in the whole sample. The institutional CPIs for the other jurisdictions start below the sample average. However, both the Czech Republic (ranging between 0.38 and 0.66) and Hungary (ranging between 0.48 and 0.61) improve over time and their Institutional CPI moves above the average. The Czech Republic experiences a first, considerable shift in 1996, due to the CA acquiring independence from the government previously all decisions were taken by a ministerial department. A further improvement takes place in 2004, when the power to investigate business premises is introduced. In Hungary the major increase happens in 2000, and can be attributed to an increase in the investigative powers of the CA and to a shift in the criterion used to set the sanctions for antitrust infringements, which changed from a discretionary decision left to the adjudicator to an approach based on the firms turnover.

The Netherlands did not have a CA before 1998. Hence, it was not possible to calculate a CPI until that year. In subsequent years the index has been substantially stable (ranging between 0.505 and 0.525). It experiences only a small jump in 2002, due to the introduction of a leniency program for cartel whistleblowers. Figure 6 depicts the Enforcement CPIs for the same subset of jurisdictions. Again, Sweden shows the highest values of the Enforcement CPI in the first half of the sample period, yet this consistently declines over time (ranging between 0.6 and 0.4). The main reason behind this decline is a reduction, in real terms, of the financial and human resources available to its CA. The Czech Republic shows a constant pattern over the entire sample period (ranging between 0.19 and 0.27), and its Enforcement CPI is always below the sample average, while Hungary (ranging between 0.43 and 0.55) shows high values and exhibits a substantial improvement in 2002, due to an increase in the budget of the CA. The continuous upward trend for the Dutch Enforcement CPI (ranging between 0.22 and 0.78) is related to a constant increase in the amount and the quality of its CAs resources.

 DOI: 10.2870/31694

Figures 1 to 6 give a general idea of the quality of the competition policy in the jurisdictions included in our sample and of the relevant changes that occurred over time. It is evident from them that there is substantial cross-sectional and cross-time variation in both the Institutional and Enforcement CPIs. In Figures 7, 8, and 9 we show the values of the Aggregate CPIs for the same group of countries. We do not comment on these figures, as from the description above it should be clear why the indexes follow the patterns observed. However, it should be stressed that the institutional component of the aggregate index takes a greater weight (2/3), hence the evolution of the Aggregate CPIs is mostly explained by the institutional features of the competition policy. It should once more be stressed that we could not calculate the Aggregate CPI for the European Union, as data on the enforcement features of this jurisdiction were not available.

Table 5 shows the ranking of the 12 countries in our sample based on the average value of their Aggregate CPIs over the years 1995 to 2005 and on its value in 2005. Sweden and the US are the best-scoring countries and this is true for each year in the sample; similarly, France, Spain and Japan constantly have the lowest scores. The UK and Canada are the countries that experience the most marked changes. Table 6 shows the ranking obtained when the Aggregate CPIs is calculated using the weights obtained through the factor analysis. The rankings resulting from the use of the two weighting schemes are broadly consistent. Sweden and the US rank at the top while France, Spain and Japan lie at the bottom in both tables. Only Germany and the Netherlands have a different ranking. As a further check we calculated the correlation coefficient between the values of the aggregate CPIs built with our weights and the one built with the weights obtained from the factor analysis. This coefficient is very high (equal to 0.96) and it is significantly different from zero at the 1

J. Comparisons with other similar indicators

There exist few indicators in the literature that, like the CPIs, try to measure the strength of competition regimes. As mentioned in the introduction, the OECD has developed a set of CPL indicators (only for the year 2003) to measure the strength of a countrys policies aimed at preserving and promoting competition (Hj, 2007). These indicators measure both the competition policy, as we have defined it in this paper, and the sectoral regulatory policies. The ranking of the CPL indicators, with respect only to the

 DOI: 10.2870/31694

competition policy, slightly differ from the one of the aggregate CPIs.[43] Several factors may determine these differences. First, the CPL indicators do not include information on some institutional characteristics which are included in the Aggregate CPI, namely the extent of powers available for the CAs during the investigations and the separation of powers between the prosecutor and the adjudicator. In addition, the CPL indexes attribute a relatively greater importance to the independence of the CA. Further, the CPL indexes do not rigidly separate the institutional features of a competition policy regime from the enforcement ones. For example, potential sanctions that is, the sanctions envisaged by the national legislation are included among the enforcement features of a competition policy regime together with the actual sanctions; whereas in the CPIs these data are kept separate. Another element that might contribute to the different rankings of the Aggregate CPIs and the CPL Indexes is the inclusion in the latter of more detailed information on the enforcement features of the competition policy regime. This is due to the CPL indexes being constructed for a single year, which makes the collection of enforcement data substantially easier. Another set of indicators that has some similarities with the CPIs are the four indicators developed by Voigt.[44] These indicators focus on the institutional and enforcement features of competition regimes, but they are less comprehensive than the CPIs. In addition they do not attempt to summarise the key features of a regime in a single index, but are more akin to the low-level indexes discussed in section 4 in that each one includes information on a limited aspect of a competition regime.[45] Hylton and Deng also provide a quantitative summary measure of competition law.[46] Their objective was to gauge the size of the overall competition law net by collecting information on the breadth of the law and on its penalty and defence provisions in 102 countries over the time period January 2001 to December 2004. Their scope index differs from the CPIs in that it tries to provide a summary description of the areas covered by competition law rather than an evaluation of its quality. Indeed, the scope index does not attempt to

[43]See Hj above n. 4. Hjs ranking based on the Antitrust Framework index, which is possibly the closest measure to our CPI, for the countries in our sample is: US, Czech Republic, Canada, Hungary, UK, Germany, Japan, Sweden, Italy, Netherlands, France, Spain.

[44]See Voigt above n. 19.

[45]One indicator evaluates the substantive content of the competition legislation, a second indicator evaluates to what degree this legislation adopts an economic as opposed to a legal approach, a third indicator reflects the level of the formal independence of the CA and a fourth one measures its factual independence.

[46]See Hylton K. and F. Deng Antitrust around the World: An empirical analysis of the scope of competition law and their effects 74 (2) Antitrust Law Journal (2007).

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measure how the law is effectively enforced, nor the degree of independence of the CA or the quality of the law.[47] In addition to these indicators, which try to measure the strength of competition regimes in an objective manner by relying on hard data on the characteristics of a countrys competition policy, there also exist other indicators which are based on the subjective assessment of the effectiveness of these policies. The best example of these subjective indexes is the one published every year by the World Economic Forum (WEF) in its Global Competitiveness Report. The WEF indicators score the competition policies of 80 countries on the basis of the results of a survey of top business executives, who are asked to rank their countrys antimonopoly policy between 1 (lax and not effective at promoting competition) and 6 (effective and promotes competition). The strong drawback of these types of indicators is that they are not easily comparable among each other, as they are built on subjective survey answers. Indeed, local business people may not be familiar with competition regimes in other countries and may have difficulties performing a meaningful comparison. As a consequence the scores are likely to depend on peoples expectations with regard to their country.

K. Conclusions

This paper presents a newly-designed set of indicators for measuring the deterrence effect of a competition policy regime, the CPIs. These indicators embody both formal and practical aspects of such a regime by combining key information on the legal framework, the institutional settings, and the enforcement tools. This information is evaluated against a benchmark of best practices and then aggregated. The weights used for the aggregation are based on our own evaluation of the importance of the various features of the competition policy, as well as on the completeness of the data we have managed to collect. We have assessed the sensitivity of the CPIs by recalculating them using a set of weights generated by a purely statistical technique, the factor analysis. There is scope for further research and refinement of the CPIs. Firstly, the exercise could be repeated so as to cover a longer time period, as well as more countries. Secondly there remains room for expanding the database to include more detailed data on the enforcement features. In

[47] The information collected concerns the geographical scope of competition law, the remedies it allows, the type of private enforcement available to the damaged parties, the merger notification and assessment procedure, and the type of abuses of dominance and restrictive trade practices prohibited.

 DOI: 10.2870/31694

particular, the indicators would benefit from the inclusion of more extensive information on the level of the sanctions that are effectively imposed on offending firms and on the extent to which offending firms are sued for damages.

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L. Tables and figures

Table 2.1: The low level indexes

Abuses	Hard-core Cartels	Other anti-competitive agreements	Mergers
Independence: Nature of prosecutor (1/2) Nature of adjudicator and role of government (1/2)	**Independence:** Nature of prosecutor (1/2) Nature of adjudicator and role of government (1/2)	**Independence:** Nature of prosecutor (1/2) Nature of adjudicator and role of government (1/2)	**Independence:** Nature of bodies involved in Phase 1 and 2 (1/2) Role of government in decision (1/2)
Separation of powers: Separation between adjudicator and prosecutor (2/3) Nature of appeal court (1/3)	**Separation of powers:** Separation between adjudicator and prosecutor (2/3) Nature of appeal court (1/3)	**Separation of powers:** Separation between adjudicator and prosecutor (2/3) Nature of appeal court (1/3)	**Separation of powers:** Separation between adjudicator and prosecutor (1/3) Separation between Phase 1 and 2 (1/3) Nature of appeal court (1/3)
Quality of the law: Standard of proof for predation and goals that inform decision (1/2) Standard of proof for refusal to deal and goals that inform decision (1/2)	**Quality of the law:** Standard of proof and goals that inform decision (1/2) Leniency program (1/2)	**Quality of the law:** Standard of proof for exclusive contracts and goals that inform decision	**Quality of the law:** Obligation to notify (1/2) Efficiency clause (1/2)
Powers during investigation: Combination of powers (3/4) Availability of interim measures (1/4)	**Powers during investigation:** Combination of powers	**Powers during investigation:** Combination of powers (3/4) Availability of interim measures (1/4)	
Sanction policy and damages: Sanctions to firms (1/3) Sanctions to individuals (1/3) Private actions (1/3)	**Sanction policy and damages:** Sanctions to firms (1/3) Sanctions to individuals (1/3) Private actions (1/3)	**Sanction policy and damages:** Sanctions to firms (1/3) Sanctions to individuals (1/3) Private actions (1/3)	
Resources: Budget (1/2) Staff (1/4) Staff skills (1/4)	**Resources:** Budget (1/2) Staff (1/4) Staff skills (1/4)	**Resources:** Budget (1/2) Staff (1/4) Staff skills (1/4)	**Resources:** Budget (1/2) Staff (1/4) Staff skills (1/4)
	Sanctions and cases: Number of cases opened (1/3) Max jail term imposed (2/3)		**Cases:** Number of mergers examined

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Table 2.2: The medium level indexes

	Abuses	**Hard-core Cartels**	**Other agreements**	**Mergers**
Institutional features	Independence (1/6) Separation of powers (1/6) Quality of the law (1/6) Powers during investigation (1/6) Sanctions and damages (1/3)	Independence (1/6) Separation of powers (1/6) Quality of the law (1/6) Powers during investigation (1/6) Sanctions and damages (1/3)	Independence (1/6) Separation of powers (1/6) Quality of the law (1/6) Powers during investigation (1/6) Sanctions and damages (1/3)	Independence (1/3) Separation of powers (1/3) Quality of the law (1/3)
Enforcement features	Resources	Resources (2/3) Cases (1/3)	Resources	Resources (2/3) Cases (1/3)

Table 2.3: The CPIs

Aggregate CPI				
	Antitrust CPI (3/4)			**Merger CPI (1/4)**
	Hard-core Cartels (1/3)	**Abuses (1/3)**	**Other agreements (1/3)**	
Institutional CPI (2/3)	Institutional features of hard-core cartels	Institutional features of abuses	Institutional features of other agreements	Institutional features of mergers
Enforcement CPI (1/3)	Enforcement features of hard-core cartels	Enforcement features of abuses	Enforcement features of other agreements	Enforcement features of mergers

DOI: 10.2870/31694

Table 2.4: The output of factor analysis: hard-core cartels

Variable	Factor 1		Factor 2		Factor 3		Factor 4	
	Factor Loadings	Weights of variables in factor (2)	Factor Loadings	Weights of variables in factor (2)	Factor Loadings	Weights of variables in factor (2)	Factor Loadings	Weights of variables in factor (2)
Nature of prosecutor	-0.7047	0.1593	0.0749	0.0023	-0.0284	0.0004	0.5633	0.1704
Nature of adjudicator and role of government	-0.2838	0.0258	0.8378	0.2873	-0.0046	0.0000	0.1088	0.0064
Standard of proof and goals that inform decision	0.0586	0.0011	0.0230	0.0002	-0.1206	0.0071	0.92	0.4546
Leniency program	0.3018	0.0202	0.4393	0.0790	0.5802	0.1648	0.1506	0.0122
Combination of powers	0.2794	0.0250	0.8177	0.2736	0.0708	0.0025	-0.1996	0.0214
Sanctions to firms	-0.2737	0.0240	0.5991	0.1469	-0.3618	0.0641	0.1013	0.0055
Sanctions to individuals-monetary	0.3896	0.0487	0.3527	0.0509	0.2585	0.0327	-0.6135	0.2022
Sanctions to individuals-Jail	0.6711	0.1444	0.4951	0.1003	-0.0414	0.0008	-0.2531	0.0344
Sanction to individuals-Private actions	0.9083	0.2646	-0.0011	0.0000	-0.0968	0.0046	0.0724	0.0028
Nature of appeal court	-0.6444	0.1332	0.2780	0.0316	0.3240	0.0514	-0.0972	0.0051
Separation between adjudicator and prosecutor	0.5056	0.0820	-0.2446	0.0245	0.5020	0.1234	-0.2603	0.0364
Budget	-0.1888	0.0114	-0.0740	0.0022	0.8484	0.3524	-0.1684	0.0152
Staff	-0.4	0.0513	0.0519	0.0011	0.6323	0.1958	-0.2493	0.0334
Weight of Factors in Summary indicators (3)		0.3204		0.2581		0.2158		0.1967
Total variance explained by the factors					0.7281			

1) Rotated unrotated component matrix
2) Normalized squared factor loadings
3) Normalized sum of squared loadings

Table 2.5: The ranking of the countries on the basis of the Aggregate CPIs

Country	Ranking based on average score	Ranking based on 2005 score
Sweden	1	1
US	2	2
Canada	3	6
Netherlands	4	3
Hungary	5	5
Germany	6	8
Czech Republic	7	7
UK	8	4
Spain	9	11
Italy	10	9
France	11	10
Japan	12	12

DOI: 10.2870/31694

Table 2.6: The ranking of the countries on the basis of the factor analysis: Aggregate CPIs

Country	Ranking based on average score	Ranking based on 2005 score
Sweden	1	1
US	2	2
Germany	3	4
Canada	4	5
Hungary	5	6
UK	6	3
Czech Republic	7	7
Netherlands	8	8
Italy	9	9
France	10	10
Spain	11	11
Japan	12	12

Figure 2.1: The Institutional CPIs for the non-EU countries in our sample: Canada, Japan and the US

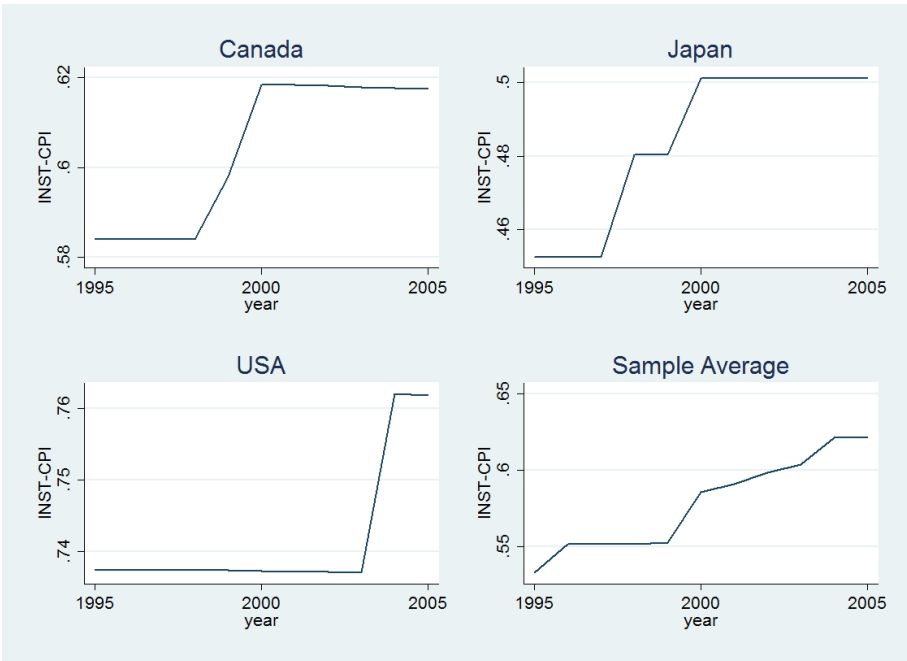

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Figure 2.2: The Enforcement CPIs for the non-EU countries in our sample: Canada, Japan and the US

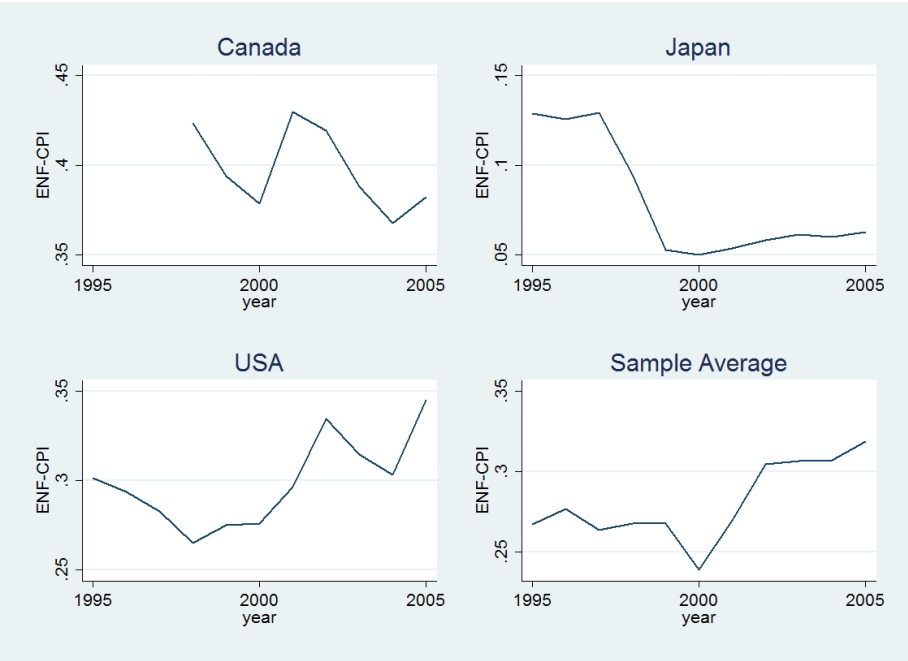

Figure 2.3: The Institutional CPIs for the large EU countries in our sample: France, EU, Italy, Germany, Spain and the UK

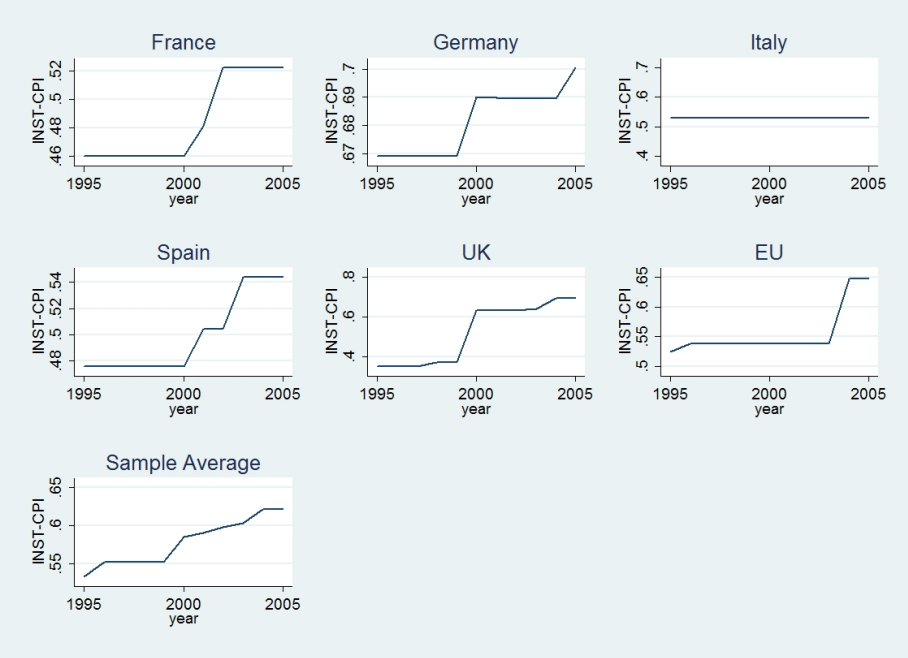

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Figure 2.4: The Enforcement CPIs for the large EU countries in our sample: France, Italy, Germany, Spain and the UK

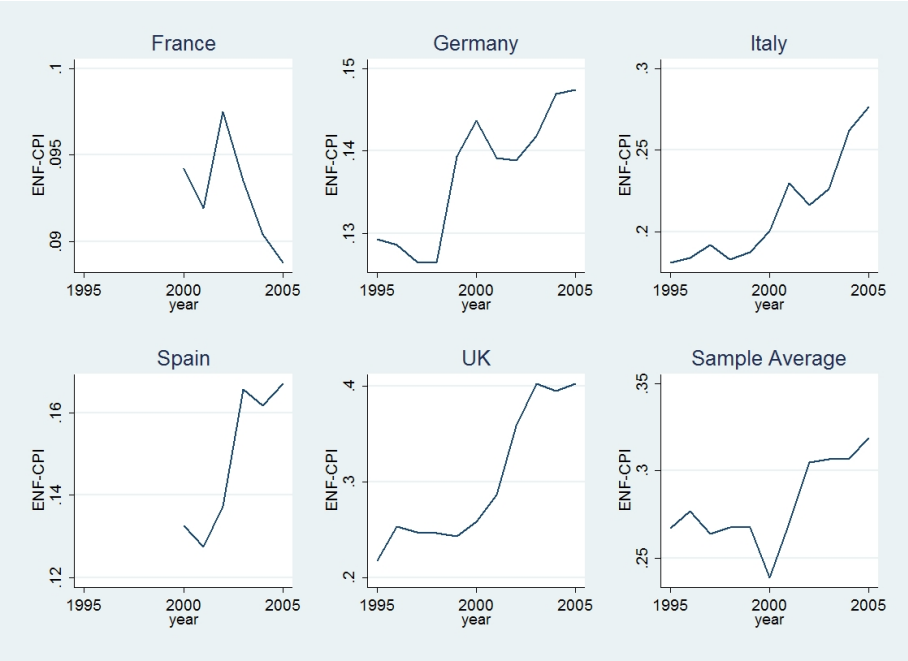

Figure 2.5: The Institutional CPIs for the small EU countries in our sample: Czech Republic, Hungary, the Netherlands and Sweden

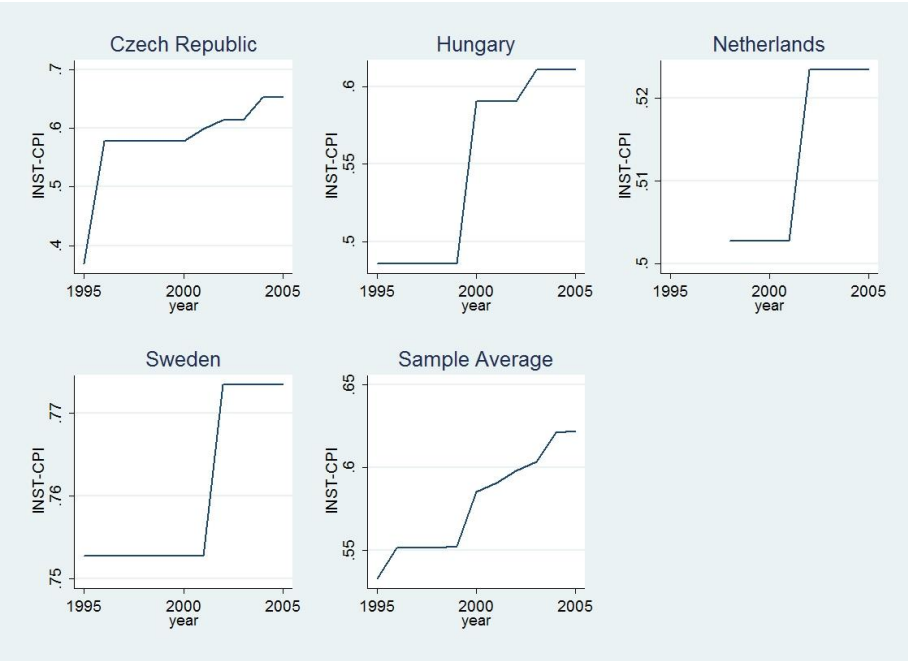

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Figure 2.6: The Enforcement CPIs for the small EU countries in our sample: Czech Republic, Hungary, the Netherlands and Sweden

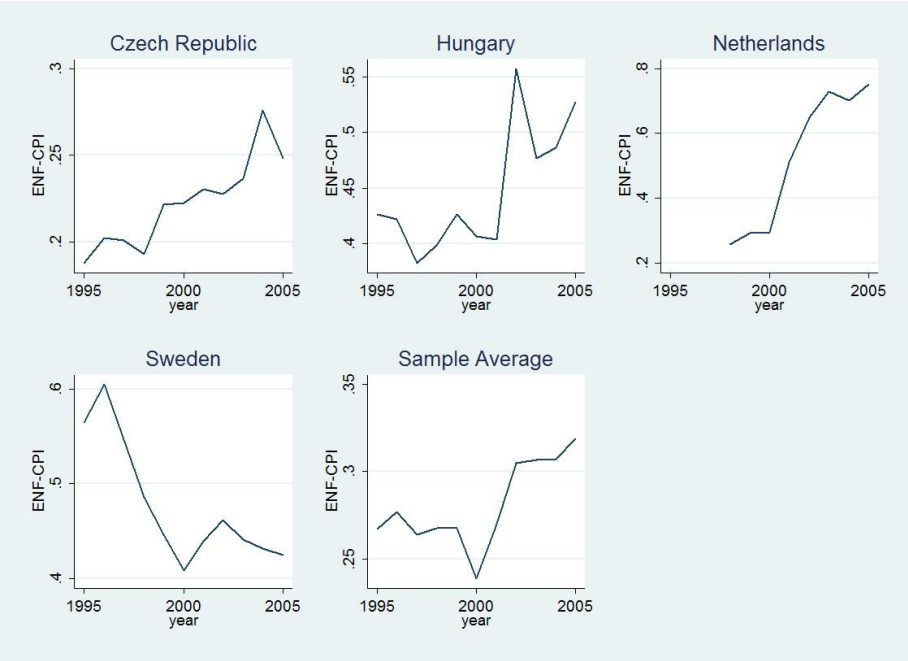

Figure 2.7: The Aggregate CPIs for the non-EU countries in our sample: Canada, Japan and the US

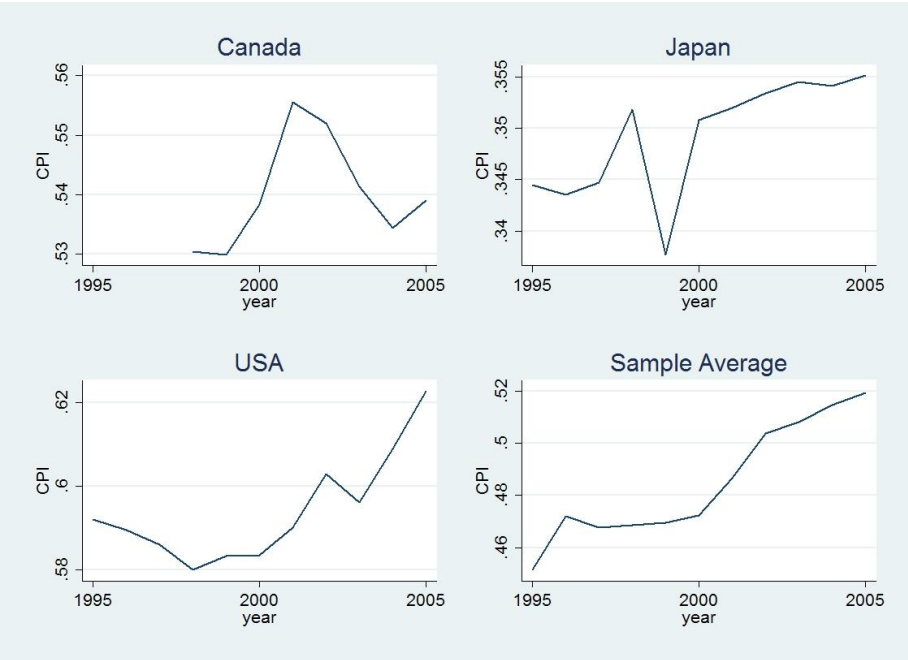

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Figure 2.8: The Aggregate CPIs of the large EU member states in our sample: France, Italy, Germany, Spain and the UK

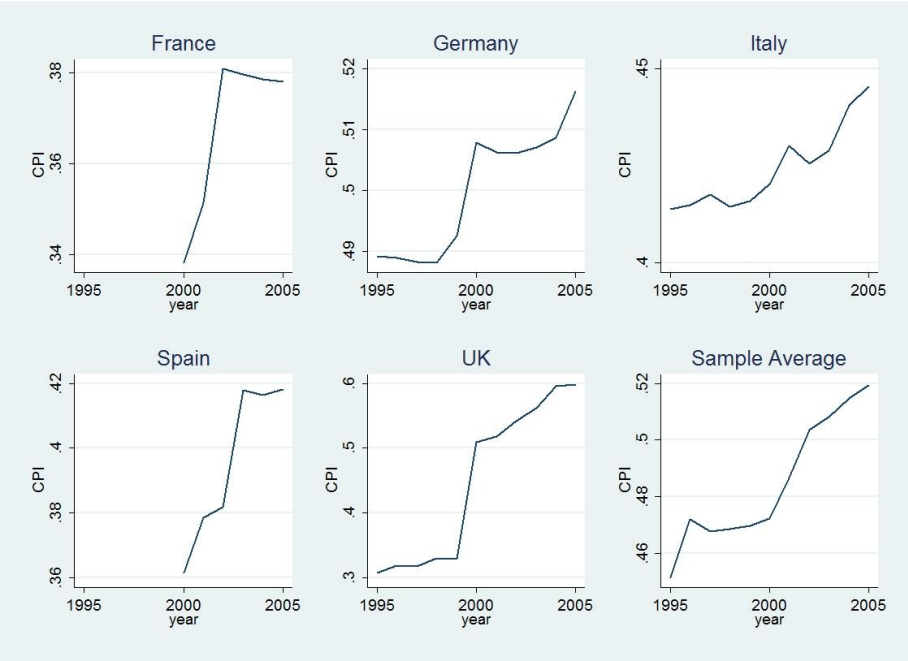
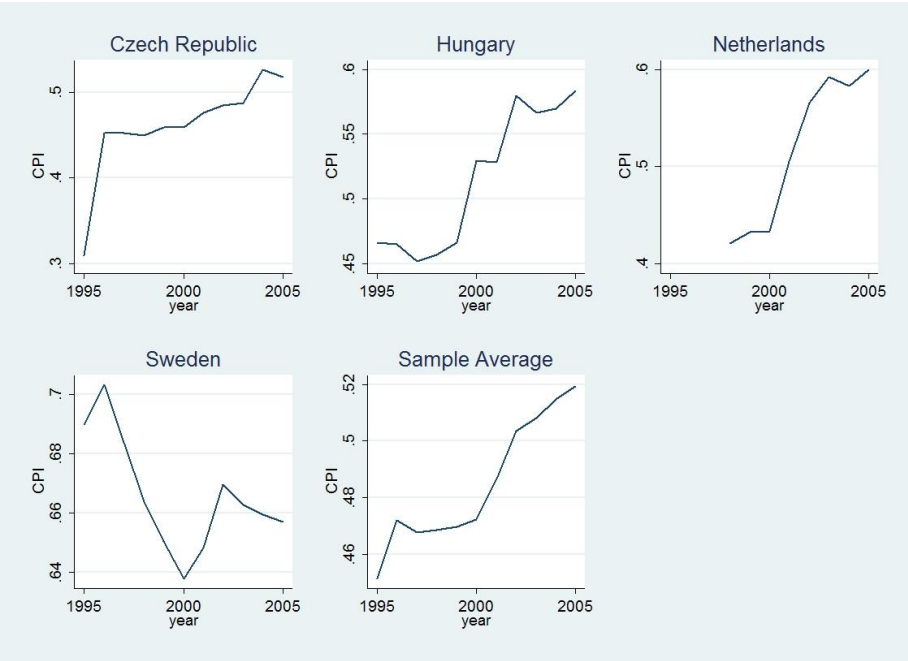


Figure 2.9: The Aggregate CPIs of the small EU member states in our sample: Czech Republic, Hungary, the Netherlands and Sweden



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APPENDICES

A. Appendix

Tables 7 and 8 summarise the scores given to each feature of a competition policy regime in building the low-level indexes (see section 4) and provide reference to the sources on which we based our evaluation. For those variables that could be measured on a meaningful quantitative scale, e.g. those dealing with the amount of resources or with the powers of the CAs, our scoring approach is based on the simple assumption the more, the better.[48] Hence, a jurisdiction obtains a higher score if the relevant CA is endowed with more investigative powers or resources.

[48]This assumption reflects the view that the more powers and resources a CA has, the more accurate the decisions it makes so that errors are less likely. It is apparent that if too much resources and powers are employed to reach a given level of deterrence, some issue on the efficiency of the CA may arise. However, in this paper we are interested only in measuring the effectiveness of competition policy and not in its efficiency.

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Table 2.7: References for questions relative to antitrust features

ANTITRUST INFRINGEMENTS	SCORES	REFERENCES
Independence		
Body that performs the investigation:		
Independent agency	1	Voigt (2009), p. 1233
Investigation splits between an independent and a ministerial agency/department	0.5	Oliveira. et al. (2009) OECD (2005a, 2005b)
Ministerial agency/department	0	
Body that takes the decision		
Independent agency/Court and Gov. cannot over-rule decisions	1	Voigt (2009), p. 1233
Independent agency/Court and Gov. can over-rule decisions	0.5	
Ministerial agency/department	0	
Quality of the law		
Standard of proof for hard-core cartels and goals that inform the decision		Voigt (2009), p. 1232 Motta (2004), p. 191 OECD (2002b)
Per se prohibition	1	
Rule of reason and only economic goals	0.5	
Rule of reason and economic and other goals	0	
Standard of proof for abuses and other agreements and goals pursued		Voigt (2009), p. 1232
Per se prohibition	0	
Rule of reason and only economic goals	1	
Rule of reason and economic and other goals	0.5	
Leniency program		OECD (2002a, 2002b) ICN, (2006) Motta (2004), p. 193 Spagnolo (2000)
There is	1	
There is not	0	
Sanctions and damages		
Sanction to firms and criterion for maximum fine		OECD (2002a, 2002b)
Illicit gain/ turnover	1	
Discretionary decision by adjudicator	0.66	
Maximum value	0.33	
No fine can be imposed	0	
Separation of power		
Nature of appeal court		OECD (2007)
Specialised	1	
Non-specialised	0	
Separation between prosecutor and adjudicator		Posner (1988) Wils (2004) Neven (2006)
There is	1	
There is not	0	

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Table 2.8: References for questions relative to merger control features

MERGER CONTROL	SCORES	REFERENCES
Independence		
The adjudicator is		
Independent in phase 1 and in phase 2	1	Oliveira et al. (2009)
Independent in phase 1 (or 2) but not independent in phase 2 (or 1)	0.5	OECD (2005)
Not independent in phase 1 and in phase 2	0	
Role of government in decision		
Government cannot over-rule decision regarding a merger	1	ICN (2006)
Government can over-rule decision regarding a merger	0	
Quality of the law		
Obligation to notify		
Threshold is based on turnover	1	
Threshold is based on market share	0.66	ICN (2006)
There is no threshold	0.33	
There is no obligation to notify	0	
Efficiency clause defence		Motta (2004), p. 238
There is	1	Williamson (1968)
There is not	0	Farrell et al. (1990)
		ICN (2006)
Separation of powers		
Nature of appeal court		
Specialized	1	OECD (2007)
Not specialized	0	
Separation between prosecutor and adjudicator		Posner (1988)
There is	1	Wils (2004)
There is not	0	Neven (2006)
Separation between bodies that decide in phase 1 and in phase 2		
There is	1	
There is not	0	

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CHAPTER 3

COMPETITION POLICY AND PRODUCTIVITY GROWTH: AN EMPIRICAL ASSESSMENT

Paolo Buccirossi, Lorenzo Ciari, Tomaso Duso, Giancarlo Spagnolo and Cristiana Vitale

Abstract

This paper empirically investigates the effectiveness of competition policy by estimating its impact on Total Factor Productivity (TFP) growth for 22 industries in 12 OECD countries over the period 1995-2005. We find a robust positive and significant effect of competition policy as measured by newly created indexes. We provide several arguments and results based on instrumental variables estimators as well as non-linearities to support the claim that the established link can be interpreted in a causal way. At a disaggregated level, the effect on TFP growth is particularly strong for specific aspects of competition policy related to its institutional set up and antitrust activities (rather than merger control). The effect is strengthened by good legal systems, suggesting complementarities between competition policy and the efficiency of law enforcement institutions.

Keywords: Competition Policy, Productivity Growth, TFP, Institutions, Deterrence, OECD

JEL classification: L4, K21, O4, C23

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A. Introduction

The aim of this paper is to assess the effectiveness of competition policy in providing higher welfare to society thanks to improved efficiency and productivity.[1] While most economists, starting from Adam Smith, agree that *competition* works in the general interest, there is no such consensus on the ability of *competition policy* to be socially beneficial. Some economists, dating back to the "Austrian School" (e.g. Von Mises, 1940), argue that any state intervention that interferes with free markets will make society worse off. According to them, competition policy is not an exception, even though its aim is to safeguard effective competition.

More recently, Crandall and Winston (2003) claimed that, at least in the US, antitrust law has been ineffective. They maintain that its poor performance is mostly due to the difficulty of distinguishing genuine and healthy competition from anti-competitive behaviors (in all areas of competition law) and to the undervalued power of the markets to curb anti-competitive abuses. They do not ask for a repeal of antitrust law, but urge applying it only for blatant price-fixing and merger to monopoly. Baker (2003) and Werden (2003) disagreed with Crandall and Winston's point of view. They argue that the net effect of competition policy on social welfare is positive. In their opinion, competition policy improves social welfare by also (or mostly) inducing firms to forgo anti-competitive behaviors without an explicit intervention of any competition authority, i.e. by deterring them. The debate appears to be still unsettled. As noted by Whinston (2006), even in the most established area of competition policy, cartel deterrence, 'strong' empirical evidence of the actual effects of the practices forbidden by antitrust law (e.g. competitors communicating on prices), and of active antitrust law enforcement on social welfare, is still missing.

This paper is an attempt to provide 'strong' empirical evidence, at least with respect to the effectiveness of the application of competition law in general. In order to do so,

[1] By competition policy we mean the set of prohibitions and obligations that forms the substantive rules of competition (or antitrust) law together with the array of tools available to competition authorities for policing and punishing any violation of the same rules.

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we estimate the impact of competition policy and some of its components on total factor productivity (TFP) growth on a sample of 22 industries in 12 OECD countries over the period 1995-2005. To measure competition policy, we identify a set of its institutional and enforcement features that we consider to be key in deterring anti-competitive behavior. We then aggregate these variables to form a set of summary indicators, the Competition Policy Indicators (CPIs). We generate an Aggregate CPI that summarizes all the key features of the competition policy of a country, as well as more disaggregated ones that refer only to the features of competition policy relative to specific behaviors (i.e. cartels, other competitive agreements and abuses of dominance – collectively referred to as 'antitrust' – and mergers), or only to the 'institutional' or the 'enforcement' features of a competition policy.

As a measure of efficiency we use TFP growth, which measures the increase in the amount of output that can be produced with a given increase in the amount of inputs. The theoretical and empirical literature has shown the existence of a positive relationship between competition and productivity. For this and related reasons, as we will argue in more detail in section 2, we believe that there should be a positive link between good competition policy and productivity. Since there is no consensus on the proper way to measure the extent of product-market competition and even the most widespread measure used to this end, the price-cost margin, has been strongly criticized (e.g. Boone, 2008), we think that to study the direct impact of competition policy on productivity growth, a crucial determinant of economic growth, is a proper way to measure the *gross* contribution of competition policy to social welfare.

In all specifications of our model, we control for country-industry and time fixed-effects, product market regulation, trade liberalization, and other likely determinants of productivity growth, and we find that the Aggregate CPI has a positive and highly significant effect on TFP growth. This impact is larger for industries far away from the technological frontier, suggesting that effective competition in such laggard sectors is even more important to foster productivity and increase efficiency. When we use the more

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disaggregated CPIs, separating the effects of the institutional and enforcement features, and distinguishing between mergers and antitrust, we find positive and significant coefficients estimates for all these indicators, though institutions and antitrust appear to have the strongest and a more significant impact on productivity growth. For the Aggregate CPI we find the same result both when we estimate the model by OLS, as well as in alternative IV specifications, which use either some political variables or the competition policy in other countries as instruments for the policy. In addition to the IV estimation, we exploit the possible non-linearities in the effectiveness of competition policy on TFP growth to improve our identification strategy. Competition policy is expected to be more effective in countries with better legal institutions as well as in industries where no other sector-specific authorities are in charge of regulating the competitive processes. This is what we find.

The interaction between competition policy and institutions is not only part of our identification strategy. Indeed, competition policy does not work in isolation. Our CPIs describe some *internal* features of competition policy. However, the effectiveness of competition policy is also likely to depend on *external* factors: the quality of a country's institutions in general, and of its judicial system, in particular. These external factors may matter for two main reasons. First, the general quality of the institutions of a country creates an environment that affects the effectiveness of all public policies. In a context where public bodies in general are effective and efficient the bodies that preside over the enforcement of competition law also tend to be effective and efficient. Hence, if we do not control for institutions, the CPIs might capture some features that, instead, are a reflection of these more general factors. Second, inherent complementarities between competition policy and the judicial system might exist, as the enforcement of the policy is often done by the courts, directly or in appeal. For these reasons the courts, and the legal system in general, may play an important role in determining the deterrence properties of a competition policy regime. When we add the dimension of the quality of the institutions to our estimate, we observe that there are both direct effects of institutions on TFP growth

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and complementarities between them and our measures of competition policy. Indeed, we find that the effects of competition policy are strengthened in countries where the cost of enforcing contracts are low and the quality of the legal system is high, which points to sizable institutional complementarities between competition policy and the efficiency of legal institutions. These results suggest that competition policy grossly contributes to social welfare, especially in those countries where it is coupled with efficient and effective institutions.

The remainder of the paper is organized as follows. In Section 2 we briefly provide the theoretical background of our empirical research and relate our paper to the relevant literature. Section 3 presents and discusses our empirical model and the identification strategy. Section 4 presents the data we use, the CPIs and how they have been built, and the political variables we use as instruments in the policy equation. Section 5 discusses our results and performs some robustness checks. Section 6 briefly concludes.

B. Theoretical Background and Literature Review

The objective of competition policy is to deter behaviors that reduce competition. Therefore, the causal link between competition policy and efficiency goes through the impact of the former on market competition. Aghion and Schankerman (2004) provide a theoretical framework for explaining this link. They point out that competition-enhancing policies may improve productivity by facilitating the weeding out of less efficient firms;[2] by promoting cost reduction investments by incumbent firms;[3] and by encouraging entry of new, more efficient firms. Nickell (1996), Blundell et al. (1999) and Aghion et al. (2004, 2009), using firm-level data, show that product market competition has indeed a

[2]More generally, competition acts as a selection process that reallocates market shares in favor of the most productive firms. Haskel (2000) provides empirical evidence of this process. Disney et al. (2003) and Syverson (2004) show that competition reduces productivity dispersion suggesting that inefficient firms are forced to either catch-up or to exit.

[3]Competition also presses managers to reduce x-inefficiency (Hicks, 1935, Leibstein, 1966). This point is made theoretically by Nalebuff and Stiglitz (1983), while Vickers (1995), Nickell et al. (1997), Griffith (2001) and Bloom and Van Reenen (2007) provide empirical evidence of a positive relationship between competition and x-efficiency.

 DOI: 10.2870/31694

positive impact on productivity. However, some disagreement exists on the impact of competition – and of competition enhancing policies – on innovation. Whinston and Segal (2007) study a dynamic Schumpeterian model in which incumbents and innovating entrants compete for the market. They find that pro-competitive policies that facilitate entry tend to increase entrants' incentives to innovate by front-loading the returns from their R&D investments. Contrastingly, Acemoglu and Cao (2010) propose a model where both the incumbents' and entrants' innovation rates are endogenous, finding that subsidies to entrants may reduce productivity growth by curbing incumbents' innovation.[4]

The disagreement on the effect of competition – and hence competition enhancing polices – and innovation is also reflected in the extensive macroeconomic literature on Schumpeterian growth. At first sight, the intuitive Schumpeterian argument that firms invest and innovate to capture future monopoly rents suggests a negative relationship between competition and innovation. However, this intuition, which is reflected in early Schumpeterian growth models like Aghion and Howitt (1992) and Caballero and Jaffe (1993), has been overturned by several recent contributions. In particular, Aghion et al. (2001) study a model of step-by-step innovation where both leaders and laggards produce and innovate. Laggards must first reach the leader's technological level before being able to challenge its leadership and replace it. Aghion et al. (2001) find that in most cases an increase in competition spurs innovation, as the standard negative effect linked to lower rents is dominated by a positive 'escape-competition-effect'. Aghion et al. (2005), which can be considered to be the benchmark in the literature on competition and innovation, further develop this approach taking into account the probability that an industry is in a neck-and-neck situation. They predict an inverted U shape for the relationship between competition and innovation, and find this prediction to be confirmed by firm-level

[4]Bartelsman and Doms (2000) empirically show that a large fraction of productivity growth is indeed due to incumbents' incremental innovation. Aghion et al. (2009) study the effect of the threat of technologically advanced entry on incumbents' innovation. They find that such a threat increases innovation in sectors close to the technology frontier, where an innovating incumbent can survive the entry of technologically advanced firms. Yet, it reduces innovation in laggard sectors where the threat of technologically advanced entry decreases the incumbent's expected rent from innovating.

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data. A different link between competition and productivity is studied in Acemoglu et al. (2006), who examine the process of selection of more efficient firms and managers induced by competition. They show that this selection is beneficial for countries close to the technological frontier where its effect on cutting-edge innovation is more important. Yet, selection may be harmful for countries far away from the frontier, where the intensity of investment to adopt existing technologies is more important and is reduced by stronger competition.[5]

In light of the previous discussion, in principle we cannot rule out that competition policy, if too strict, may also have some adverse effects on efficiency. This identifies an issue that we will empirically address in section 3. However, it seems important to point out some reasons why the ambiguity of the impact of competition on innovation may not extend to competition policy. First, even if the relationship between *competition* and innovation has an inverted-U shape, *competition policy* is less likely to have a strong impact in those markets where competition is already intense. Indeed, in most areas of competition law (i.e. vertical agreements, abuses of dominance and mergers) the pertinent prohibition applies only if the relevant market *significantly* departs from perfect competition (e.g. high concentration, high barriers to entry, large switching costs, etc.).[6] As for cartels, even if the prohibition applies irrespective of the competitive conditions of the market, they generally represent the most serious restriction of competition. Moreover, the idea that cartels foster innovation has been generally dismissed (Nocke, 2007). Second, in most jurisdictions, all the relevant antitrust prohibitions (again with the exception of cartels) admit an 'efficiency defense'. This defense is meant to allow conducts that, al-

[5]Denicolò and Zanchettin (2009) also analyze the role of competitive selection on growth in a model where competition is less extreme and innovations are not 'drastic'. More efficient and less efficient firms coexist for several periods and the market share of more efficient firms gradually grows at the expense of the less efficient ones. They show that an increase in competition has conflicting effects on incentives to innovate: equilibrium prices go down, reducing profits from innovating, but the faster reallocation of market shares increases the innovators' profits. The net effect on innovation, when competition is tough, is however positive.

[6]In many of these areas antitrust law defines 'safe harbors' in terms of market shares or concentration indexes which establish a presumption of legality. For instance, in the European Union the legal and absolute presumptions are that some vertical restraints are compatible with competition law if none of the parties of the agreement has more than 30% of the relevant market.

 DOI: 10.2870/31694

though reducing competition, improve efficiency and benefit consumers. Therefore, the 'efficiency defense' provides a protection for the investments firms make to innovate.[7]

Our CPIs reflect the extent to which the various competition policy regimes allow this defense, and therefore incorporate the protection of investments in the interpretation of the antitrust rules. Hence, our measure of competition policy takes a higher value (ceteris paribus) where the protection of investments is a goal that shapes the interpretation of the applicable rules. Combining these two considerations, we should expect a positive relationship between *good* competition policy and innovation, both because competition policy increases competition only (or mostly) when the relevant market is in the first part of the inverted-U curve, and because competition policy refrains from increasing competition if this is likely to result in inefficiencies and/or less innovation.[8]

Competition policy is embedded in a wider and interconnected system of institutions and policies that might present inherent complementarities (Aghion and Howitt, 2006). In our context, legal institutions stand out as particularly relevant, since the enforcement of competition law is intimately linked to the functioning of the judiciary system for several reasons. First, competition law is enforced by public bodies and by private firms and individuals who can bring suits in courts for alleged anti-competitive conducts. Second, in some jurisdictions the competition authority can only challenge a conduct or a merger before a court. Finally, even in those jurisdictions where the competition authority acts as an 'adjudicator', its decisions are subject to judicial review, so that courts have the last

[7]Baker (2007) argues that the application of modern economic theory has helped antitrust agencies to identify the types of firm's conduct and industry settings where antitrust interventions are most likely to foster innovation. Similarly, Gilbert (2008) maintains that antitrust policy has recognized the importance of finding a right balance between providing incentives to innovate and limiting practices that may harm competition.

[8]Of course, we are not claiming that our argument applies to any aspect of competition policy and to any antitrust decision. There may be specific interventions that may have a less positive effect on innovation and productivity growth. This may occur if a competition authority wrongfully believes that a high level of concentration is a sign of weak competition, while in fact it is the result of the selection process that characterizes intense competition. We believe that this type of error is less likely nowadays than it used to be 20 or 30 years ago. Indeed, the idea that the degree of concentration is a poor indicator of (the lack of) competition is now widespread in the daily work of many antitrust agencies around the world. Hence, our view is that these cases are likely to represent exceptions and therefore should not alter the positive relationship between competition policy and innovation.

 DOI: 10.2870/31694

say on all competition policy interventions.

The interaction between a country's legal rules and economic activities has recently attracted a large interest following the path-breaking work by La Porta et al. (1997, 1998) who argue that legal traditions spread around through conquests and colonization and shaped the subsequent evolution of legal and regulatory institutions. It has been shown that legal origins affect many other dimensions including bank ownership (La Porta et al. 2002), entry regulations (Djankov et al. 2002), labor market regulation (Botero et al. 2004), and government ownership of the media (Djankov et al. 2003a). Some studies also looked at how the characteristics of the judiciary and other government institutions affect the security of property rights and contract enforcement (Djankov et al., 2003b; La Porta et al., 2008). On the basis of the results by Djankov et al. (2003a) and La Porta et al. (2004) we expect that a lower level of formalism of the judicial procedures and greater judicial independence should improve the quality of the judicial review of the decisions made by competition authorities. Hence, we expect positive complementarities between several indicators of the quality of the judiciary system and competition policy.[9] In doing this, we are close to the recent work of Aghion and Howitt (2006), and more generally to the literature on institutions and long-term economic performance as surveyed in Acemoglu et al. (2005), Glaeser et al. (2004), and Beck and Levine (2005).

More importantly, our paper contributes to the still very limited empirical literature that evaluates the effectiveness of competition policy. Dutz and Hairy (1999) and Dutz and Vagliasindi (2000) use a cross-section of 52 countries and a small sample of transition economies respectively and find a positive effect of antitrust effectiveness on GDP growth. However, they use 'subjective' measures of competition policy that are based on the perceptions of market participants which, as a consequence, may not correctly represent the objective features of a competition policy regime. Konings et al. (2001)

[9]Recently, Malmendier (2009) critically discusses the literature on the nexus between law, finance, and growth. Analyzing the role of the Roman shareholder company, she provides empirical support for the view that political institutions can dominate the role of legal institutions in shaping economic performance. She concludes by suggesting a cautious use of the legal origin approach to measure the transaction costs of institutional environment. The debate is still unsettled and it is not the aim of this paper to enter it.

 DOI: 10.2870/31694

and Kee and Hoekmann (2007) look at the impact of the introduction of competition policy on industrial mark-ups in two very different samples (the first one includes Belgium and the Netherlands and the second includes a large panel of industries in developed and developing countries). Neither paper finds direct evidence of a positive effect of the introduction of competition policy or competition law on mark-ups.[10] However, the interpretation of the results might be misleading as the employed measure of competition policy appears inadequate to capture those features that are likely to impact on its effectiveness.

Finally, especially for the empirical approach, our work is closely related to the literature that examines the impact of regulation and other competition enhancing policies on productivity growth. Nicoletti and Scarpetta (2003) focus on the direct effect of privatization and liberalization on TFP growth. They show that market-oriented regulatory reforms significantly contributed to improving productivity in OECD countries during the Nineties, especially by reducing the gap to the technological frontier.[11] Pavcnik (2002) finds a direct impact of trade liberalization on productivity improvements that works through the reallocation of resources to more efficient producers. Several other papers, instead, look at the effect of competition and entry on productivity growth (e.g. Griffith and Harrison, 2004, and Aghion et al., 2009). They use policy variables, such as the introduction of the EU single market program or the UK privatization program, as instruments for competition, which is proxied by the price-cost margin, and entry. They show that the policies have a positive impact on competition and entry and these, in turn, increase productivity. Unlike these latter studies, we do not attempt to measure the channel through which competition policy affects productivity. First, this is not essential to our exercise as we want to assess the policy effectiveness. Second, in this way we avoid specifying any

[10]See also Sproul (1993), who finds that prices increase in industries after a cartel has been discovered and convicted; Clarke and Evenett (2003), who find that the vitamin cartel reduces cartel prices in jurisdictions where antitrust conviction is more likely and costly; and Voigt (2009), who finds a positive effect of a set of indicators of the quality of competition policy on total factor productivity, that however disappears when controlling for institutional quality.

[11]This results are partially critically challenged by Bourlès et al. (2010) and Amable et al. (2009).

 DOI: 10.2870/31694

notion of competition which might be problematic both theoretically and empirically.[12]

C. Econometric Specification

To make robust causal inference on the effectiveness of competition policy, we analyze the direct link between the policy and TFP growth.[13] Our empirical implementation builds on a general quality-laggard framework typical of endogenous growth models (e.g. Aghion and Howitt, 2006). The basic idea is that laggard industries/countries can catch up with the technological frontier by innovating or adopting the leading technologies. Therefore, the technological and organizational transfer from technology-frontier's firms influences the productivity of laggard industries and, hence, their productivity is co-integrated with that of the leader. Under the assumption of long-run homogeneity, this process has an Error Correction Model (ECM) representation where the industry-level TFP growth ($\Delta TFP_{i,j,t}$) in country i and time t depends on the technology transfer from the country on the technological frontier ($TFP_{L,j,t}$), and the productivity gap or distance to the technological frontier ($TFP_{L,j,t}/TFP_{i,j,t}$) (e.g. Griffith et al., 2004, pg. 886). These dimensions constitute sources of observed heterogeneity that should explain productivity growth and, hence, should be empirically controlled for.

Clearly, the rates of TFP growths are affected by other country-industry characteristics. From our previous discussion, competitive pressure is one of these important drivers. In particular, following the theoretical framework proposed by Aghion and Schankerman (2004) and Acemoglu et al (2006), and the empirical approach suggested by Nicoletti and Scarpetta (2003), Griffith and Harrison (2004), and Aghion et al. (2009), we assume that competition-enhancing policies – such as competition policy (CPI), product

[12]For instance, from a theoretical point of view, the price cost margin (PCM) is a poor indicator as it (imperfectly) captures only a short-run notion of competition. Even in this case, the relationship can be non linear and an increase in competition may result in a higher PCM (Boone, 2000).

[13]While under strict neoclassical assumptions, TFP disembodis technical change or dynamic efficiency, in practice it integrates a range of other efficiency effects including those from organizational and institutional change, changes in returns to scale, and unmeasured inputs such as research and development and other intangible investments (e.g. Inklaar et al., 2008). Moreover, industry-level TFP also captures the effects of reallocation of market shares across firms.

 DOI: 10.2870/31694

market regulations (PMR), as well as trade liberalization – are some of the main drivers of this residual heterogeneity which is not captured in the quality-ladder framework.

Moreover, following Griffith et al. (2004), we also assume that other observable industry-country-specific factors connected to innovation – such as R&D intensity ($R\&D$) and human capital – directly affect the rate of TFP growth.[14] Finally, following the existing literature (e.g. Nicoletti and Scarpetta, 2003 and Griffith et al., 2004) we model the remaining unobserved heterogeneity by means of an error term, which takes the form $\varepsilon_{i,j,t} = \psi_{i,j} + \phi_t + u_{i,j,t}$. The country-industry-specific fixed-effects $\psi_{i,j}$ account for the time-invariant unobserved heterogeneity and the full set of time dummies (ϕ_t) controls for common macroeconomic shocks that may affect TFP growth in all countries at the same time.[15] The basic equation that we estimate is thus the following:

$$\Delta TFP_{i,j,t} = \alpha + \beta CPI_{i,t-1} + \delta \Delta TFP_{L,j,t} - \sigma \frac{TFP_{L,j,t}}{TFP_{i,j,t}} + \gamma X_{i,j,t-1} + \chi Z_{i,t-1} + \varepsilon_{i,j,t}, \qquad \text{(C.1)}$$

where $CPI_{i,t}$ is one of our indicators of competition policy in country i at time t, $X_{i,j,t-1}$ are country-industry-specific control variables (human capital, trade openness, R&D, and a country-industry-specific trend), $Z_{i,t}$ are country-specific controls (product market regulation and the quality of institutions).[16]

As we mentioned in section 2, some recent papers (e.g Aghion et al., 2005, and Acemoglu et al. 2006) suggested that competition-enhancing policies may also influence TFP growth through an indirect channel, by interacting with the distance to the technologi-

[14] Differently from them, however, we do not analyze how R&D might indirectly affect TFP growth by shaping the catch-up process.

[15] We run a large amount of alternative specifications to analyze how these assumptions on the error terms affect our results. This discussion is reported in more details in appendix C. Neither the choice of different individual effects, nor the accounting of potential serial correlation in the residuals affects our main results.

[16] Potentially, competition policy might have a non-linear effect on productivity growth akin to the non-linear effect of competition on innovation found in the literature (Aghion et al., 2005). In section 2 we theoretically motivate why we do not think that such a non-linear effect should be observed. To empirically validate our claim, we tried two alternative specifications. First, we used a quadratic, rather than a linear, term for the Aggregate CPI. Second, we used a step function for low, medium, and high levels of the Aggregate CPI. In both cases we do not find evidence of such non-linear effect, which make us confident of the chosen specification (C.1).

 DOI: 10.2870/31694

cal frontier.[17] Indeed, competition policy, by increasing competition and reducing entry barriers, may increase the opportunities and incentives for the adoption of leading technologies. However, the returns from increasing productivity and improving efficiency in order to escape competitive pressure might be higher for firms competing neck-and-neck with rivals that are close to the technological frontier. Hence, the effect of competition policy might differ, depending on the level of technological development of a country-industry. We therefore look at an additional specification where the effect of competition policy on TFP is interacted with the technology gap.

Identification

The identification of a causal link between competition policy and productivity growth crucially relies on the ability to account for the potential endogeneity of our key policy variables. Especially when looking at country-level aggregates, endogeneity might arise from omitted variable bias as well as from two-way causality and measurement errors. In this paper we adopt a multi-steps approach, using several alternative strategies to pursue the ultimate goal of establishing a robust causal relationship between competition policy and TFP growth.

First, we believe that two-way causality is not a major concern in our case. In principle, the application of competition policy might be focused on less competitive and productive markets, which in turn might lead to a negative correlation between the CPIs and the error term. However, our CPIs aggregate several institutional characteristics, which are unlikely to respond swiftly to changes in TFP growth rates. Institutions face inertia and slowly evolve over time quite independently of specific and short-run changes in market outcomes.[18] Even those variables that represent some relevant enforcement

[17]Similarly, some empirical studies recently analyzed the differential effect of product market regulation on productivity and innovation depending on the distance to the frontier (Nicoletti and Scarpetta, 2003, Amable et al., 2009, Bourlès et al., 2010).

[18]For instance, the introduction of leniency programs or the adoption of the EU competition law model in Eastern European countries are likely to be the consequence of the diffusion of some institutional innovations, rather than a response to inadequate short-run market performances.

 DOI: 10.2870/31694

features, such as the human and financial resources, depend on political decisions that generally take time to be put in practice. In any case, in order to reduce the potential bias resulting from two-way causality, we use lagged values of the policy variables with respect to our dependent variable. This is a standard approach that relies on the assumption that the lagged values of the policy are uncorrelated with the error terms of the estimated equation (e.g. Griffith et al., 2004 use this exclusion restriction to identify the causal effect of R&D on industry TFP growth).

The main identification issue in the context of our model is related to the existence of an omitted variable bias. The panel structure of our data-set allows us to control for time-invariant unobserved individual heterogeneity at the industry-country level through fixed-effects as well as for time fixed-effects. However, there still might be time-varying unobserved heterogeneity. In particular, this might derive from the existence of several other competition-enhancing policies or, in general, other policies correlated with competition policy that might affect TFP growth rates. In our basic specifications, we control for those we believe to be the most prominent policies affecting competition (product market regulation, liberalization, and privatization) and for trade openness. While we are confident that these controls should help mitigate the endogeneity problem, we nonetheless propose a twofold approach to provide further evidence on the causal nature of the link between competition policy and productivity growth.

First, we propose an instrumental variable estimation, which allows us to explicitly test whether endogeneity matters and to control for another source of potential inconsistency of OLS estimates: the existence of measurement errors. We use two very different sets of instruments. Following some recent contributions which find political variables to determine policy outcomes (e.g. Besley and Case, 2000; Duso and Roller, 2003; Duso and Seldeslachts, 2010), we use the government type and its ideological position on regulatory issues as a first set of instruments. An alternative set of instruments derives from a well-established practice in industrial organization (e.g. Hausman, 1997). This consists of using different aggregations of the potentially endogenous variables in other markets

 DOI: 10.2870/31694

as an instrument for the same variables in the market of interest. While the formulation of competition policy in a given country is likely to be affected by the evolution of competition policy in neighboring countries, the latter should not correlate with the rate of TFP growth in the country of interest. This provides the exclusion restriction necessary for identification. The existence of a correlation among policies in different countries is supported by the observable common trends in the evolution of competition policy during the last decades. These trends are possibly due to the leading policy-setting role taken by jurisdictions such as the US or the EU, after which the other jurisdictions' policies are modeled. Moreover, a vigorous international academic and policy debate established a general consensus about the most efficient policies to adopt in the field of competition laws, which surely also generate common trends in its evolution over time.[19]

Second, in addition to the IV estimation, we adopt a less formal approach to improve our identification strategy by looking at potential non-linear effects of competition policy on TFP growth. We search for situations where we expect competition policy to have a differential effect on productivity as compared to other omitted factors or policies. If we were to observe this kind of behavior in the data, this would enhance our confidence that the estimated nexus between the quality of a competition policy regime and TFP growth can be interpreted in a causal way. Although one can never fully rule out the possibility that some complex interactions of omitted shocks would drive the results, this would then seem unlikely. There are two dimensions of heterogeneity that we think are important in this respect. The first is related to country-specific characteristics. As discussed in section 2, we expect competition policy to be more effective in those countries where the quality of legal institutions is higher. In fact, national courts are strongly involved in the enforcement of competition policy, as they often retain the power to adjudicate an-

[19]The role of multinational cooperation for the discussion and adoption of best practices around the world increased over the years covered in our sample. Such cooperation, which took place within the OECD and other international organizations, was fostered by the creation of the International Competition Network (ICN). This informal forum was initiated by the US in 1995 with the aim of providing a platform for competition authorities from around the world to discuss the whole range of practical competition policy enforcement and policy issues. The main objective of the ICN is exactly to spread best practice and promote convergence.

 DOI: 10.2870/31694

titrust cases either directly or in appeal. Yet, crucially for our argument, courts are not involved in the adoption of other productivity-enhancing policies (for instance, regulation, R&D subsidies or fiscal policy) or, at least, they are involved only indirectly. The second dimension of heterogeneity we look at is related to industry-specific characteristics. Our data encompass industries belonging both to the manufacturing and service sectors. We expect the former to be significantly more affected by competition policy. The reason is that services are in general subject to strong sector-specific product market regulations – such as price control, entry regulations, and state ownership – which, in these industries, play a more significant role in shaping the competitive environment and, hence, productivity outcomes than competition policy. This intuition is empirically supported by Nicoletti and Scarpetta (2003) who find that deregulation plays a significantly greater role in fostering productivity in services than in manufacturing sectors. This kind of regulation clashes with competition policy, and for this reason we expect ex-ante that competition policy will be less effective in those industries where the tightness of product market regulation is greater.[20]

D. Data Sample and Descriptive Statistics

We estimate our model (C.1) on a sample of 22 industries in 12 countries over the period 1995-2005. The countries included in the study are: Canada, the Czech-Republic, France, Germany, Hungary, Italy, Japan, the Netherlands, Spain, Sweden, the UK, and the US.[21] We use data both at the national level and at the industry level. National level data are used to measure the policy variables (competition policy, product market regulation) and the quality of institutions. The remaining variables are measured at the industry

[20]Clearly, other forms of regulation – e.g. health and safety regulations – might have an additional effect on productivity growth also in manufacturing industries. However, these regulations are inherently different from those policies that directly control the competitive process and, hence, should not affect our identification argument.

[21]These countries have been selected to be representative of different legal systems (common law and civil law), to include both EU and non-EU countries and, among the EU countries, both founding members and countries that have recently entered the Union, namely Hungary and the Czech Republic.

 DOI: 10.2870/31694

level, which belong both to the manufacturing and to the service sectors.[22]

In the following sections we introduce the main variables that we use in our regressions. We begin by discussing our main explanatory variables, the competition policy indexes. We then move to the discussion of the TFP growth measure and the other explanatory variables. We conclude by introducing our instruments.

Measuring the Quality of Competition Policy: The CPIs

The ultimate aim of competition policy is to maximize social welfare. Hence, the quality of a competition policy regime should be evaluated on the basis of the ability of this policy to deter firms that operate within its jurisdiction from undertaking those behaviors that, by impairing competition, reduce social welfare. In this section, we therefore provide a self-contained discussion on how we measure the quality of a competition policy regime. We shortly report on the theoretical background behind our data collection exercise, the measurement issues, as well as the steps of the aggregation process we undertook to generate a set of summary indicators of the quality of competition policy, the CPIs. An exhaustive discussion of all the issues touched upon in this section can be found in the companion paper (Buccirossi et al., 2010). Moreover, in appendix A we give a more in-depth overview of the properties of some of our indicators and their distributions.

Following Becker's (1968) theory of optimal deterrence, we consider that the level of deterrence is determined by three fundamental elements: the size of the sanctions, the probability of detection and conviction, and the probability of errors. Several institutional and enforcement features of a competition policy regime might affect these three factors (see Buccirossi et al., 2009). The features which we believe have the strongest impact on the level of deterrence of anti-competitive behaviors are: the degree of independence of

[22]The 22 industries (ISIC rev.3 codes) included in the study are the following: agriculture, forestry and fishing; mining and quarrying; food products; textile, clothing and leather; wood products; paper, printing and publishing; petroleum and coal products; chemical products; rubber and plastics; non-metallic mineral products; metal products; machinery; electrical and optical equipment; transport equipment; furniture and miscellaneous manufacturing; electricity, gas and water; constructions; hotels and restaurants; transport & storage; communication; financial intermediation; business services.

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the competition authority (or CA) with respect to political or economic interests (formal independence); the separation between the adjudicator and the prosecutor in a competition case (separation of powers); how close the rules that make the partition between legal and illegal conducts are to their effect on social welfare (the quality of the law on the books); the scope of the investigative powers the CA holds (powers during investigation); the level of the overall loss that can be imposed on firms and their employees if these are convicted (sanctions and damages); the toughness of a CA, which is given by its level of activity and the size of the sanctions that are imposed on firms and their employees in the event of a conviction, and the amount and the quality of the financial and human resources the CA can rely on when performing its tasks.

We collected information on each of these features, by asking several specific questions.[23] We gathered these data separately for the three possible infringements of the antitrust legislation (hard-core cartels, other anti-competitive agreements, and abuses of dominance) and for the merger control policy in each country and for each of the years in the sample. Most of this information was directly obtained from the CAs of the 13 jurisdictions included in our sample through a tailored questionnaire.[24] The data obtained from this survey were integrated with information derived from the country studies carried out by the OECD in the context of its reviews of regulatory reforms, from the chapters

[23]For instance, to measure the quality of the law, we collected information on the standard of proof that is required when deciding on a specific type of violation as well as the nature of the goals that inform the decision-making process. To measure the CA's powers during investigations we collected information on the power to impose, or request, interim measures; the powers to gather information by inspecting the premises of the firms under investigation or the private premises of the firms' employees; the powers to gather information by wiretapping the conversations of the firms' employees. Buccirossi et al (2010) describes all these issues in depth.

[24]Our sample includes 12 countries and 13 jurisdictions, as it includes the European Union. We only surveyed the CAs which are either independent public bodies or ministerial agencies/departments, while we did not survey the courts (but we have collected data on their powers and activities). The bodies surveyed are: Competition Bureau (Canada); Urad pro ochranu hospodarske souteze (Czech Republic); Directorate General for Competition Affairs (European Union); Conseil de la Concurrence (France); Direction Gènèrale de la Concurrence (France); Bundeskartellaamt (Germany); Gazdasági Versenyhivatal (Hungary); Autorità Garante della Concorrenza e del Mercato (Italy); Japan Fair Trade Commission (Japan); Nederlandse Mededingingsautoriteit (Netherlands); Servicio de Defensa de la Competencia (Spain); Tribunal de Defensa de la Competencia (Spain); Konkurrensverket (Sweden); Office of Fair trading (UK); Competition Commission (UK); Federal Trade Commission (US); Antitrust Division - Department of Justice (US).

 DOI: 10.2870/31694

on competition and economic performance in the OECD Economic Surveys and from the CAs' own websites and publications.[25] Despite this extensive data gathering exercise, we encountered some difficulties in obtaining data on the toughness of the CAs and we could include in our database only details on the maximum jail term imposed on managers of firms involved in hard-core cartels (for those jurisdiction that have this type of sanction) and the number of hard-core cartels and mergers investigated every year.[26]

The CPIs have a pyramidal structure.[27] We collected data for each of the seven key feature of competition policy mentioned above. Each piece of information is then assigned a score, on a scale of 0-1, against a benchmark of generally agreed best practice (from worst to best).[28] The best practice is determined by relying on scientific papers and books, on documents prepared by international organizations such as the International Competition Network and the OECD, and on our judgement. All the information on a specific policy feature is summarized in a separate low-level index using a set of weights

[25]Despite the active collaboration of most CAs, it was not possible to collect all data on the enforcement characteristics of the competition policy necessary to build the CPIs for the period considered. Hence, our database has some missing observations. We tried to fill the gaps by asking the CAs to provide us with an imputation of the missing observations based either on other data at their disposal or on their historical knowledge of the trends. When this was not possible, whenever this was allowed by the characteristics of the other available data on that specific feature, we performed some limited imputation of the missing data. Nevertheless, the database still has some gaps. This means that in some cases we do not have all the information necessary to calculate a specific index. To avoid calculating indexes whose value could be altered by the lack of information, we do not calculate an index (at any level of aggregation) if 50%, or more, of the relevant information content was missing.

[26]It is therefore clear that our measure of enforcement is less accurate than our measure of institutions. However, our CPIs capture most of the features that have a likely impact on the deterrence properties of the analyzed competition policy regimes as they fully describe their institutional features and proxy the level of enforcement by important variables such as the budget dedicated to the implementation of this policy, the amount of human resources devoted to the same aim and their quality. Furthermore, we believe that the institutional features of a competition policy regime play the greatest role in determining its effectiveness. As Kovacic (2009, 145) recently pointed out "Good policy runs on an infrastructure of institutions, and broadband-quality policy cannot be delivered on dial-up-quality institutions." Hence, one can see good institutions as a necessary, yet possibly not sufficient, condition for a good enforcement.

[27]Our methodology is akin to the one developed by the OECD for the indicators of product market regulations (PMR) and the competition law and policy indexes (CPL). See Boylaud, Nicoletti, and Scarpetta (2000), Conway and Nicoletti, (2005) Conway and Nicoletti (2006) for the former and Høj (2007) for the latter.

[28]When a data entry is quantitative it is normalized by dividing it by the highest corresponding value held by any CAs in the sample, so that even quantitative information assumes a value between 0-1.

DOI: 10.2870/31694

to linearly aggregate it.[29] We calculated separate indexes for each of the three possible competition law infringements and for mergers, to take into account the differences in the legal framework and, where possible, in the enforcement.[30]

The low-level indicators are subsequently aggregated into two medium-level indexes for each of three types of possible competition law infringements and for mergers: one which summarizes the institutional features of the competition policy regime and one which summarizes its enforcement features. The medium-level indexes are then aggregated to form a number of different summary indexes. More specifically, we calculate (for each country and each year in the sample): i) one index that measures the deterrence properties of the competition policy regime with regard to all antitrust infringements (the Antitrust CPI) and one that measures its deterrence properties in the merger control process (the Mergers CPI); ii) one index that assesses the institutional features (the Institutional CPI) and one that assesses the enforcement features (the Enforcement CPI); iii) a single index that incorporates all the information on the competition policy regime in a jurisdiction (the Aggregate CPI).

The weights employed in this aggregation process are based on the relevance that each item, in our view, deserves.[31] However, in order to check whether our choice of weights has a decisive influence on the results, we also use three alternative weighting schemes. The first uses an agnostic approach and weights each piece of information equally. The second, aggregates the features of competition policy using factor analy-

[29] We are aware that there might be complementarities among different aspect of competition policy that we may miss by using this linearly additive specification. However, we believe that it would be difficult to choose a more precise approximation of the relationship that could exist between these variables. Hence, we have selected this aggregation form that has the advantage of being simple and at the same time rather complete.

[30] This was not always easy. For example, the CAs rarely have separate divisions that deal with the different types of infringements, hence we could not obtain separate data on the resources employed for each of them. Hence, the resource index takes the same value for all the three possible antitrust infringements, as well as for merger control.

[31] We have been very conservative in the choice of the weights and we departed from equal weights only for situations for which there were robust theoretical reasons to do so. Moreover, we tried to be as transparent and explicit as possible in explaining why we chose each particular weight. The in-depth description of these issues can be found in Buccirossi et al. (2010).

 DOI: 10.2870/31694

sis.[32] The correlation coefficients between the values of the Aggregate CPIs built with our weights and these two alternative CPIs built with equal weights and the weights obtained from the factor analysis take very high values (0.97 and 0.96 respectively) and they are significantly different from zero at the 1% level. In the robustness section we run our basic regression using the CPIs calculated by means of these alternative weighting schemes and show that the results are robust. The third alterative weighting scheme is based on random weights. We randomly generate, from a uniform distribution (0,1), 1,000 sets of weights, which are then normalized to sum to one. For each of these sets, we build one Aggregate CPI. In the results section, we report the distribution of the coefficients estimates for these 1,000 Aggregate CPIs and we show that our main findings are not affected.

Main Variables

In this section we describe the main variables that we employ in our regressions. We start by presenting TFP growth and then we move on to the control variables. All monetary measures are in real terms, using 2000 as the base year.

TFP growth. The dependent variable in our empirical model comes from the EU-KLEMS database.[33] TFP growth is measured by the Solow residual within the growth accounting framework as developed by Jorgenson et. al. (2005). Within this framework, TFP is measured under certain restrictive assumptions, among which that of prices equal to marginal costs. Following Griffith et al. (2006), we relax this assumption by multiplying the labor and capital shares by the industry-level mark-up, which is estimated as the ratio between industry-level value added and labor and capital costs (see Paquet and

[32] A complete description of this alternative methodology and the results can be found in Buccirossi et al. (2010).

[33] The EU-KLEMS project is funded by the European Commission, Research Directorate General as part of the 6th Framework Programme, Priority 8, 'Policy Support and Anticipating Scientific and Technological Needs'. The aim of the project is to create a database on measures of economic growth, productivity, employment creation, capital formation and technological change at the industry level for all European Union member states plus selected non-European countries from 1970 onwards. For a short overview of the methodology and results of the EU KLEMS database, see Timmer et al. (2007).

 DOI: 10.2870/31694

Roubidoux, 2001).[34] In our sample, the average TFP growth at the industry level ranges between -1.7% for the business services sector and 3.7% for the communications sector. The average TFP growth in the entire sample is 0.0096%. A more in-depth description of this and other TFP-based variables can be found in appendix B.

Technology Gap. We use TFP levels to determine the technology frontier at the country-industry level and the technology gap between each country-industry and the frontier. Following the existing literature (Griffith et al., 2004; Nicoletti and Scarpetta, 2003), we obtain the technology gap using a two-step procedure. First, we calculate the ratio between the level of TFP in each country-industry and the geometric mean of the TFP levels in all the countries included in the sample for that industry. The frontier is defined as the country-industry with the highest ratio. Second, we obtain the technology gap by subtracting all the observed country-industry ratios from the frontier ratio.[35]

R&D. The variable we use in our regressions is the ratio between R&D expenditure and the industry-level value added, both in nominal values. We gathered detailed data on the level of expenditure in R&D in different industries from the OECD Analytical Business Enterprise Research and Development (ANBERD) database, which covers 19 OECD countries, from 1987 to 2004. We took data on value added from the EU-KLEMS database. Unfortunately, data on R&D for the 'Agriculture, forestry and fishing' sector and the 'Mining and quarrying' sectors for all countries involved in the study as well as data for Hungary are not available in ANBERD.

Human Capital. We measure human capital as the share of high-skilled labor employed in each country-industry in a given year. We took data on human capital from the KLEMS database, which holds information on the level of educational attainment of workers by industry for all the EU member countries, the US and Japan from 1970 to 2004.

[34]The concerns that we expressed on the ability of the mark-up to measure the intensity of competition in a market are not necessarily relevant for the correction implemented in the calculation of the Solow residual. Indeed, this correction cleans the TFP measure of the error due to the existence of a divergence between price and marginal cost (the mark-up).

[35]Given the potential measurement errors in the construction of the Technology Gap (see appendix B), we test the robustness of our results using Labor Productivity (value added per worker) as a proxy for the distance from the technology frontier.

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Unfortunately, data on Human Capital are not available for Canada.

Trade openness. We measure the degree of openness to trade by the ratio of industry import over value added in each specific industry. The data come from the OECD STAN database, which contains data on total exports and imports for 19 OECD countries, plus the EU, from 1987 to 2004, disaggregated by industry.

Product Market Regulation. We measure the tightness of product market regulation by the aggregate PMR index, taken from the OECD PMR database. The aggregate PMR index covers formal regulations in the following areas: state control of business enterprizes, legal and administrative barriers to entrepreneurship, and barriers to international trade and investment. The tightness of regulation is measured at the national level on a scale between 0 and 6, where lower values indicate less tight regulation. Data on PMR are available for two years: 1998 and 2003.[36]

Quality of Institutions. The quality of the institutions of a country enters in our regressions both as a control variable and as an interaction with the competition policy indexes in order to explore non-linearities in the effectiveness of competition policy. We use variables from four different sources to proxy the quality of the national institutions.

The first source of data is the World Bank Worldwide Governance Indicators (WGI) database, which collects aggregate and individual indicators for six dimensions of governance: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, control of corruption.[37] The data cover 212 countries and territories over the period 1996-2006 and are based on the views of a large number of enterprisers, citizens, and experts. We use the index that measures the national rule of law, as the most proper indicator of a country's legal system. The index takes values from -2.5 to 2.5, with higher values indicating better governance outcomes.

The second source of data is the Fraser Institute Database, which is used to construct the 'Economic Freedom of the World' indexes. From this database, we use an aggregate

[36] We assume regulation before 1998 to be as tight as in 1998, and regulation after 2003 to be as tight as in 2003. For the period between 1998 and 2003 we impute an average between the two available observations.

[37] Note that all these indexes are highly correlated and contain, therefore, very similar information.

 DOI: 10.2870/31694

index (index_2) called 'legal system', which aggregates information on variables measuring judiciary independence, impartiality of the courts, protection of intellectual property, law and order, and legal enforcement of contracts. These indexes, as the WGIs, are based on the perceptions of enterprisers, citizens and experts. The indexes take values between 0 and 10, with higher values indicating better governance outcomes.

The third source of data is the Doing Business database of the World Bank and the International Finance Corporation, which collects data representing 'objective measures' of the overall quality of the regulatory and institutional environment on 181 countries. The data we use in our empirical model relate to the time and cost of enforcing debt contracts through the national courts system.[38] Finally, we use the legal origins dummies from La Porta et al. (1997).

Industry-level deviations from the trend. We use country-industry deviations from a linear and a quadratic trend to account for the effect of business cycles on TFP. When capacity is constrained, TFP growth may in fact reflect short-run demand fluctuations. We measure a different deviation from the trend for each country-industry using value added taken from the EU-KLEMS database.

Instruments for Policy

In our IV regressions we use two different sets of instruments for the policies (competition policy and PMR). First, we use political variables which are derived from the dataset developed by Cusack and Fuchs (2002) which uses two main sources:[39] the first is a database on political parties' programmatic position developed in the Manifesto dataset by Klingemann et al. (2006), while the second is the database developed by Woldendorp,

[38]The time of enforcing debt contracts represents the estimated duration, in calendar days, between the moment of issuance of judgment and the moment the landlord repossesses the property (for the eviction case) or the creditor obtains payment (for the check collection case). The cost of enforcing contracts represents the estimated cost as a percentage of the debt involved in the contract. For a full description, see Djankov et. al (2003b). Both variables have been measured within the Doing Business Project from 2004 on. In our specifications, we use the end of sample (2005) values, and assume it represents the quality of contracts enforcing for the entire sample period.

[39]We are very grateful to Tom Cusack for providing us with the original data and the updates for the last years in our sample.

 DOI: 10.2870/31694

Keman, and Budge (2000) on government compositions for 48 countries from 1948 onwards. For each country and year in our sample, we create measures of a government location along the Manifestos political dimensions by taking a weighted average of the programmatic positions of each of the parties belonging to government coalition. As weights, we used the number of each party's votes. We used the following programmatic positions:

Market regulation (per403). This variable measures favorable mentions in the parties' programs of the need for regulations to make private enterprizes work better, actions against monopoly and trusts, in defence of consumer, and encouraging economic competition.

Economic planning (per404). This variable measures favorable mentions in the parties' programs of long-standing economic planning of a consultative or indicative nature.

Welfare state limitations planning (per505). This variable measures negative mentions in the parties' programs of the need to introduce, maintain or expand any social service or social security scheme.

European Community (per108): This variable measures favorable mentions in the parties' programs of the European Community in general, and on the desirability of expanding its competency.

Second, as we mentioned in the previous section, as additional instruments for the CPI and for regulation for a given country we use different aggregations of the level of these variables in other countries as possible instruments. In particular, we build different set of instruments based on country grouping (EU countries vs. non-EU countries). We then use as instruments for the policies (CPI and PMR) in one country the average value of these variables in all other countries from the same group, as well as the average value of these variables in all countries from other groups.[40]

Table 3.1 reports the preliminary statistics for the main variables discussed in these

[40]Moreover, we also try using alternative instruments, such as the US policies as instruments for EU countries, the mean policies of EU member states (including the EC) as instruments for the US policies, and the mean between the EU and US policies for the policies in non-European countries such as Canada and Japan.

 DOI: 10.2870/31694

sections.

Descriptive Analysis

As a first motivating step, we look at simple moments. We start by looking at the correlation between TFP growth and the CPI at the country-aggregate level. We compute a weighted average for TFP growth using the industry value added as a weight. The correlation coefficient is large and positive (0.29) and significantly different from zero at the 1% level. Figure 3.1 gives a graphical representation of this relationship at the country level. The positive correlation between the average TFP growth and the CPI is clear for most of the countries. In particular, we calculate a positive and significant correlation coefficient for the Czech Republic (0.83), France (0.32), Germany (0.43), Hungary (0.13), Japan (0.21), Netherlands (0.39), and UK (0.51).

Figure 3.1 also shows that there is substantial variation in TFP growth measures among the several industries within a country. In this study we also exploit this heterogeneity dimension, as competition policy might affect various industries in a different way. We make use of this argument as an additional step in our identification strategy. We therefore look at the pairwise correlation between the CPI and TFP growth at the industry-country level. Again, this correlation is positive (0.08) and significantly different from zero at the 1% level. Our empirical model starts from this simple correlation to identify the causal effect of the policy.

E. The Results

We start by considering the average effect of competition policy on total factor productivity growth by using the various CPI indexes discussed above. All regressions in the following tables include year dummies and industry-country fixed-effects. We further control for other competition-enhancing policies as measured by the OECD PMR index, trade liberalization, a country-industry-specific deviation from the trend to account for potentially different business cycles at the country-industry level, as well as for the

 DOI: 10.2870/31694

other determinants of productivity growth, which we previously discussed. Most of the explanatory variables are lagged by one year to reduce possible endogeneity issues. Standard errors are clustered at the country level to allow for correlation among industries in the same country. We estimate the model by OLS. Our sample, after discarding some extreme outliers, consists of 1,847 country-industry-time observations.[41]

The Basic Model

In column 1 of table 3.2 we report the results of the basic specification. The key result is that the coefficient estimate for the Aggregate CPI is positive (0.0924) and statistically significant at the 1% level: good competition policy is strongly positively correlated to productivity growth in a statistically significant way.[42] This estimates also points to an economically significant effect. A coefficient estimate of 0.09 for the aggregate CPI implies an average elasticity of TFP growth with respect to the aggregate CPI of around 4.66.[43] Estimates for all other control variables conform to our expectations and to previous results reported in the literature and hence give us confidence about the quality of our specification. In particular, the TFP level of the leader, the technology gap, and import penetration have a positive and significant impact on TFP growth; while product market regulation, in the form of barriers to competition, has a negative effect on productivity growth, though this is not significant mimicking the findings by Nicoletti and Scarpetta (2003). Finally, the country-industry-specific trend that we inserted to account for short-run cyclical fluctuations in demand also has a positive and significant impact.

As we mentioned in section 4.2, there are two other important control variables –

[41] We dropped the observations corresponding to the first and the last percentiles of the TFP growth distribution.

[42] This value is quite close to the value of the simple correlation coefficient that is equal to 0.08.

[43] To give a more concrete idea of the economic meaning of this, we can look at one example such as the 'food products' industry in the UK. Over the period 2001-2004, the average productivity growth rate in this industry was 2.23%. Our model implies that part of this growth rate is due to the effect of the improvement of competition policy. In the same period, the average growth rate of the aggregate CPI was 3.75%. Using our average coefficient would imply that, had competition policy not improved, the average TFP growth rate would have been 1.92%.

DOI: 10.2870/31694

R&D and human capital – for which we unfortunately have many missing values.[44] Yet, we still want to analyze whether their introduction substantially affects our results, especially in light of potential omitted variable bias. In column 2 we therefore add R&D to our basic specification, which reduces the number of observations to 1,463. In line with Griffith et al. (2003), R&D intensity has a positive and significant impact on TFP growth. All other results, and especially the size and significance of the coefficient estimate for the Aggregate CPI, are not affected. In column 3, we report the results for our basic specification using the sub-sample where R&D is not missing. Again, our results are almost not affected. In column 4 we add to our basic specification human capital as a further control, which reduces the observation to 1,783. Again, this variable has a positive effect on TFP growth which, however, is not statistically significant. The other results are not substantially changed. We finally introduce both R&D intensity and human capital (column 5) and run our basic regression without these controls in the sub-sample where both variables are non-missing (column 6). Again, our main results are not affected, yet now the two controls are significant. This can be due to the sample selection effect, given that we run this specification on a much smaller sub-sample (1,408 observations). From this point on, we therefore decide to use our basic specification, so that we can use the maximum possible number of observations.[45]

The last column (7) reports the results from the specification where we assume that competition policy might affect TFP growth differently depending on the country-industry's distance from the frontier. We therefore define three categories for the technology gap (low, medium, high) and allow the coefficient for the CPI to differ among them.[46] The estimated effect of competition policy is much larger and more significant (0.124) for country-industries far away from the frontier than for country-industries close to the

[44]In particular, R&D data are missing for Hungary and for several industries-years in other countries, while Human Capital is missing for Canada.

[45]We do however run all regressions and robustness checks also adding R&D intensity and human capital as additional controls. These results can be obtained from the authors upon request.

[46]We define the three dummies according to the distribution of the gap variable: low level (up to the 33rd percentile of the distribution), medium level (from the 33rd to the 66th percentile), and high level (from the 66th percentile).

DOI: 10.2870/31694

frontier (0.053). This result is in line with the empirical findings of Nicoletti and Scarpetta (2003) who show that liberalization is mostly beneficial for productivity in manufacturing industries the further a given country is from the technology leader. Hence, increasing competition through an effective competition policy (or reducing entry-limiting regulations) may facilitate the adoption and development of advanced technologies, which increase productivity. The benefits of increasing competition in country-industries close to the technological frontier seem, instead, to be more modest, yet still positive and significant.[47]

We then move to analyze the impact of the various dimensions of competition policy as measured by our disaggregated indexes. In table 3.3, we focus on the difference between institutions and enforcement in columns 1 and 2 and between mergers and antitrust in columns 3 and 4. Again, we obtain similar results to our basic model: the various dimensions of competition policy have a positive and significant effect on productivity growth. With the exception of the Antitrust CPI, the size of the effect is, however, always smaller than the one measured by the Aggregate CPI and, in some cases, it is also less significant. In particular, the results for the Enforcement CPI are the weakest, as the coefficient estimate drops to 0.04 and loses significance. Our interpretation for this result lies in the quality of the information summarized in this index. As we mentioned, we do not have complete measures of antitrust enforcement in terms of actions taken by the authorities but rather measures of the monetary and human capital resources.

The established positive and significant relationship between the quality of competition policy, and in particular of its institutional design in the area of antitrust, and produc-

[47]These empirical findings might, at first glance, appear at odds with the theoretical framework proposed by Acemoglu et al. (2006), who show that a limited level of competition might be beneficial for sectors far away from the frontier, as we discussed in section 2. These are adopters and find it optimal to pursue an investment-based strategy rather than selecting high-skill managers and firms through a highly competitive process, which is necessary for innovation. Yet, our results do not necessarily refute this theoretical argument, as they might rather be driven by the fact that the country-industries in our sample are not, on average, so far from the technological frontier to switch to the investment-based strategy. This seems plausible in our context, as all countries in our sample are quite homogenous, being part of the OECD. Indeed, the empirical evidence put forward by Acemoglu et al. (2006) is based on data for non-OECD countries so as to approximate real technology 'followers', which are significantly behind the world frontier.

 DOI: 10.2870/31694

tivity growth is the key finding of this study. As we discussed thoroughly in section 3.1, one major concern for the causal interpretation of this effect is the potential endogeneity of the policy. In this section we started tackling this issue by lagging the policy variables and controlling for most of the determinants of TFP growth discussed in the literature. The next sections aim at providing further evidence to get more confidence in the causal interpretation of the established link between competition policy and TFP growth.

Instrumental Variables

The next step that we propose in terms of identification strategy is to use an instrumental variables (IV) approach. The results of these IV estimations are reported in table 3.4. In the first three specifications (columns 1, 2, and 3), we use the political variables discussed in section 4.3 as instruments for the policy. Independent of whether we instrument only for the Aggregate CPI (column 1), for both the Aggregate CPI and PMR (column 3), or if we control for R&D while instrumenting both policies (column 2), we always find a positive and significant coefficient estimate for the Aggregate CPI, which is even larger than those reported in our basic OLS specifications. This result is reassuring, as IV estimates are consistent in the presence of endogeneity. The instruments used seem to work properly: they are correlated to the instrumented variables as shown by the high values taken by the F-statistic for the excluded instruments in the first-stage regressions. Furthermore, they are not correlated with the error term as shown by the Sargan statistic.[48] Although being always consistent, IV estimates are not efficient in the absence of endogeneity. We therefore run a Wu-Hausman test of endogeneity and cannot reject the null hypothesis that the policies are exogenous at the 1% level, hence OLS estimates should be preferred because they are more efficient.

[48]In table 3.5 (columns 1 to 3), we report the first-stage regressions for the IV specifications 1 and 3 of table 3.4. As expected, a pro-regulation attitude of the government (**per403**) and a pro-welfare limitation programmatic position (**per404**) are, respectively, negatively and positively correlated to the CPI and positively and negatively correlated to PMR. A pro EU attitude (**per104**) correlates positively with the CPI and negatively with the PMR index, which is consistent with the tendency of the European Commission to support the development of more competitive markets.

DOI: 10.2870/31694

Even though, as we motivated, the proposed instruments seem to be a reasonable choice, one could still be concerned that they might be potentially correlated with other omitted factors. We therefore present a second set of results, based on a very different set of instruments. Following an established literature in industrial organization, we use the policies in neighboring jurisdictions as instruments for the policies in a given country. We instrument for the Aggregate CPI alone (column 4), for both the Aggregate CPI and PMR (column 6) and also control for R&D while instrumenting for both policies (column 5). Again, we consistently estimate a positive and mostly significant coefficient for competition policy. Similarly to the previous specifications, the instruments seem to be good in terms of correlation to the potentially endogenous variables (F-statistic for the excluded instruments), while they are uncorrelated to the error terms (Sargan test).[49] Moreover, also in this case the Wu-Hausman test cannot reject the null hypothesis of exogeneity, which might also partially explain the reduction in the significance level, as the IV estimates are less efficient than OLS estimates.

These sets of results confirm our claim that the established positive link between competition policy and productivity growth can be interpreted in a causal way, as we can reject the hypothesis that the policies are endogenous. Therefore, from now on we will focus on the OLS estimates which, in the absence of endogeneity, are more efficient.

Non-Linearities

The final, informal, step of our identification strategy is based on the exploitation of non-linearities. The idea is that competition policy is more effective in some countries than in others, due to their better institutional environment, and in those sectors which are less subject to industry-specific regulations. This should not be the case for other

[49] In table 3.5 (columns 3 to 6) we report the first-stage regressions for the IV specifications 4 and 6 of table 3.4. The instruments are the mean of the policies in other countries from the same group (CPI_G and PMR_G) and a different group (CPI_NG and PMR_NG). While we could potentially expect a positive correlation if *all* policies move in the same direction, it is not a priori clear whether this should be expected for the mean policies over the entire sample period. Indeed, we report negative and significant average correlations.

DOI: 10.2870/31694

(omitted) policies. Moreover, the analysis of such non-linearities with respect to institutional details is an important contribution on a more theoretical basis, as it allows us to identify the existence of complementarities between competition policy and the efficiency of (legal) institutions and therefore to provide a novel contribution to a recently expanding literature (Aghion et Howitt, 2006). These results are reported in table 3.6.[50]

In the first column, we present our basic specification where we simultaneously control for several institutional dimensions. Institutions seem to have a significant direct impact on productivity growth. Yet, unlike previous studies (e.g. Voigt, 2009), the positive and significant effect of competition policy is not affected by these additional controls. This reinforces the view that our indicators are able to capture the specific features of a competition policy regime, which we aimed to measure, and not the general quality of a country institutional environment.

In column 2 we then interact the Aggregate CPI with the dummies for legal origins. While the effectiveness of competition policy is significantly higher in countries with German and Nordic legal origins, it is clearly less so in countries with French legal origins, which in our sample are France, Italy, and Spain. These results seem to be in line with findings reviewed by La Porta et al. (2008) who report that countries with civil law are associated with a heavier-hand regulation, which has an adverse impact on markets and economic performance.

We then explore what specific characteristics of a legal system are important drivers of competition policy effectiveness. To exploit in the best possible way the limited variation in our institutional data and, at the same time, to allow for non-linear effects through a step function, we have transformed our continuous institutional variables into categorical variables based on their distribution. Thus, for each institutional variable we defined three dummies: low level '*l*' (up to the 33rd percentile of the distribution), medium level '*m*' (from the 33rd to the 66th percentile), and high level '*h*' (from the 66th percentile) of institutional quality. Finally, we interact these dummies with the Aggregate CPI.

[50]Notice that, for lack of space, we do not report the coefficient estimates for all control variables as they are anyway very similar to those reported in our previous regressions.

 DOI: 10.2870/31694

In column 3 we report results for the specification where we interact the Aggregate CPI with dummies measuring the cost of enforcing contract (EC).[51] Although competition policy seems to have a positive and significant effect independently of the levels of contract enforcement, the effect is substantially larger – indeed more than double (0.240) – for those countries with low enforcement costs (CPI_lEC). Hence, our results support the view that competition policy effectiveness might be reinforced in countries where law enforcement is more efficient. In columns 4 and 5 we report the results of the specifications where we interact the Aggregate CPI with the Fraser 'Rule of Law' (RL) index and the WGI's 'Legal System' (LS) index.[52] In both cases, we observe competition policy to be less effective in countries with less efficient legal institutions, such as a low rule of law or a poor legal system.

The reported results point out to complementarities between competition policy and some dimensions of legal institutions. This does not mean that policies in countries with a worse legal system or higher costs of enforcing contracts must be ineffective, but rather that their (partial) ineffectiveness can be better explained by the bad functioning of the more general legal institutions. Therefore, policy changes in this country must be adequately designed to account for the additional constraints imposed by the legal system.

The second dimension of heterogeneity of the degree of competition policy's effectiveness is industry-specific. As we pointed out, most of the service industries in our sample (e.g. electricity, gas, water, communication, financial intermediation) are subject to more or less heavy-handed sector-specific regulations and the organization of competition matters in these industries is delegated to sectoral authorities. Our claim is therefore that competition policy should have less of a bite in such industries, but this should not necessarily be true for other productivity-enhancing policies (e.g. fiscal policy and labor regulations). We report the results of the specification where we estimate separate coefficients for the Aggregate CPI as well as for PMR in service and manufacturing sectors in

[51] Very similar results are obtained by using the general index for contract enforcement. However, in that case we lose Italy since there is no information on the time needed to enforce the contracts for this country.

[52] We also try specifications where we use sub-components of the legal system index, specifically 'Independence of the Judiciary' and 'Impartiality of the Courts' and find similar results.

DOI: 10.2870/31694

column 6 of table 3.6. For the Aggregate CPI, we find a large (0.143) and statistically significant coefficient estimate in manufacturing, while the coefficient is much smaller and not significant in the service industries. Moreover, similarly to Nicoletti and Scarpetta (2003), we also find that the coefficient of product market regulation is negative and significant in services but not in manufacturing industries.[53] These results perfectly conform with our expectations.

All results reported in this section point to the existence of significant and sizable non-linear effects of competition policy on productivity growth. The estimated differential effects should not be expected for other kinds of policies, which might constitute our problematic omitted factors and generate endogeneity issues that would invalidate our causal inference. Hence, these further results might be seen as an additional step, which makes us more confident of the causal nature of the link we identify.

Extensions and Robustness Checks

We finally perform several robustness checks by using different CPIs and different measures for productivity growth, as well as different sample sizes.

First, to show that our results are not driven by the subjective weights we have chosen to build the CPIs, we use the three alternative weighting schemes, which were discussed in brief in section 4.1. In column 1 and 2 of table 3.7, we report the results obtained when using the Aggregate CPI constructed using equal weights or the weights generated by factor analysis, respectively. Our qualitative results are unchanged and competition policy still has a positive and significant impact on TFP growth at the 1% and 5% level, with a point estimates for the policy effect of 0.0925 and 0.0726, respectively. As an additional robustness check, we run 1,000 regressions, each using a different Aggregate CPI generated with a different set of weights randomly drawn from a uniform distribution (0,1). We therefore obtain estimates for 1,000 β coefficients and their relative t-statistics, whose

[53] We also tried to disaggregate this result even more and estimate industry-specific coefficients for the Aggregate CPI and the PMR indicators. The Aggregate CPI has a significant impact exclusively in manufacturing industries while the PMR indicator mostly in service industries.

DOI: 10.2870/31694

distributions are represented in figure 3.2. The distribution of the coefficients, which is represented in the first panel, ranges between 0.052 and 0.11, with a mean value of 0.084, which is close to our estimate in the basic specification. As shown by the second panel of the figure, all of the 1,000 coefficient estimates are statistically significantly different from zero (the lowest t-value is 2.98).

A second concern with the CPIs relates to the role of the EU competition policy in the EU member states. To correctly evaluate the effectiveness of each EU member state's competition policy, it is necessary to account for the fact the EU competition policy works alongside the national one. Therefore, for these countries, we have built a set of CPIs which are an average of each member states individual index and the EU index.[54] The coefficient estimate for the Aggregate CPI is still positive, highly significant and larger in size (0.115) with respect to our basic specification. This means that EU competition policy improves, on average, the effectiveness of national competition policies.

Third, we need to consider the limitations of the TFP measure we use. Until now, following Griffith et al. (2004), we have used a measure for TFP growth corrected for the mark-ups (as measured by the PCM) to account for imperfect competition. However, one may have some concerns about the quality of an industry-level aggregated PCM measure. Hence, we propose an alternative specification where we use TFP measures (i.e. the growth rate, TFP of the leader, and the technology gap) which are not corrected for the mark-ups. The coefficient estimate reported in column 3 is still positive and significant at the 10% level.

Fourth, while TFP growth is constructed using detailed information on labor and capital input (see appendix B) provided by the KLEMS, the Technology Gap uses OECD data, which are provided at a less detailed level of aggregation.[55] For this reason, we employed

[54]Unfortunately, DG Competition did not provide us with information on enforcement features (such as the budget and the composition of the staff), at the EU level. Hence, we can only use information about EU institutional features. The precise definition of the variable is thus as follows: $AggregateCPI_EU_{it} = \frac{2}{3}(0.5 * Institutions_CPI_{it} + 0.5 * Institutions_CPI_{EU,t}) + \frac{1}{3}Enforcement_CPI_{it}$

[55]Unfortunately, we could not employ the KLEMS data to construct the technology gap, since the KLEMS does not publish the series on capital stock and labor for all countries with the necessary level of detail.

 DOI: 10.2870/31694

as an alternative a much simpler measure of productivity to measure the technology gap: labor productivity, as measured by value added per worker. In this specification, we kept TFP growth as our dependent variable and used TFP growth on the frontier as an independent variable (though the frontier is defined in terms of labor productivity). The coefficient estimate reported in column 4 is still positive and significant at the 1% level.

Fifth, one might be concerned with the frequency of the data. TFP measures change quickly over time as a response to demand shocks, while our policy measures, although showing some significant time variation, present much more inertia. We therefore change the frequency of the data and look at long-run effects. We propose three different specifications along this dimension. In the first one, whose results are reported in column 5, we take longer three-year lags for all explanatory variables. Still, the coefficient of interest is similar in size to that of our basic specification, though it loses a bit of significance, as expected given the long lag used. In the second robustness check (column 6), we define TFP growth over a time span of three years, and sum up the figures from year t to year $t + 2$. We then 'lag' all explanatory variables by taking their value at the initial year, i.e. we look at how the value of competition policy in year t affects TFP growth between year t and t+2. In doing so, the number of observations is obviously reduced. We still find a positive and significant coefficient estimate (0.332) for the Aggregate CPI. As expected the coefficient is much larger, as it represents the effect of the policy on the three-year TFP growth rate. In the final specification, we use three-year averages for all variables (column 7). Also in this case, the coefficient estimate for the Aggregate CPIs is positive (0.0903) and significant.[56]

Sixth, one might be concerned that the right level of aggregation of our data should be the country rather than the industry, as the main interest of our study is in the impact of a national policy. In Section 4.4 we reported a significant simple positive correlation between country-level TFP growth and competition policy. In this robustness check, we

[56]Similar, though a bit less significant, results are obtained using a five-year interval. The loss of significance is due to the imprecision of the point estimation deriving from the reduction of the data variability via the aggregation process.

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re-estimate our model by taking weighted averages of all our industry-specific variables using the value added of the industry as a weight (column 8). Also in this case, the coefficient estimate for the Aggregate CPIs is positive (0.0417) and significantly different from zero at the 10% level.

Finally, given the heterogeneity of competition policy's effectiveness across countries and industries, one might be concerned that our average results do not hold to the exclusions of particular countries and/or industries. We therefore run our basic regression on several sub-samples, sequentially excluding one or two countries (156 sub-samples) or one or two industries (506 sub-samples). For each sub-sample, we run our basic regression. The distribution of the β coefficients and their t-statistics are represented in figures 3.3 and 3.4. In all sub-samples, our estimates for the CPI are positive and, in the very large majority of the cases (99.4%), they are statistically significant at the 10% confidence level at least. While none of the estimates are insignificant when we exclude one or two industries, only in 4 out of the 156 sub-samples where we *simultaneously exclude two countries* are the coefficients significantly positive (one-tailed test) yet not significantly different from zero (two-tailed test).[57]

Where does Identification comes from?

In appendix A we show that there is significant and quite continuous within-country variation in the Aggregate CPI in almost all countries, which identifies our policy effect. Nevertheless, in this section we try to spot which specific policy changes in the Aggregate CPI might be the major identifier of the average increase in TFP growth estimated in our regressions.

In figure 3.5 we plot the evolution of the average *residual* TFP growth and its 95% confidence interval across the 22 industries of each country as well as the competition policy

[57] The only specification for which the t-value is further apart from a critical level (p-value of 0.21) is when we *simultaneously* exclude the UK and the Czech Republic. The reason is that the coefficient estimates drops to 0.04, while the standard error increases a bit with respect to our basic specification. Notice, however that, even in this unique case, we still cannot reject the null hypothesis of the coefficient being positive at the 10% significance level with a one-tailed test.

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indexes over the period 1995-2005. To mimic our estimation and control for sources of observable heterogeneity, we use the *residual* component of TFP growth which is not explained by the fixed-effects and the other variables included in our model (C.1) – excluding, of course, the Aggregate CPI. Again, we observe clear correlation patterns between the evolution of the Aggregate CPIs and of the residual average TFP growth. Our attention focuses on the evolution in the subset of countries and time periods for which the changes in policy are more noticeable and, therefore, which are most likely to influence the average effect identified in our estimation.

The first country that appears to drive the estimated relationship is the Netherlands: the residual TFP growth rises toward the end of our sample period, and then decreases between 2004 and 2005. The same evolution is associated to the aggregate competition policy index, which rises in 2003 following an upward trend in the investment in human and financial resources and then goes slightly down, again because of a contraction in the resources allocated to the competition authorities. In the UK, over the 2000-2003 period, we also observe a strong correlation between the rise of residual TFP growth and the evolution of the aggregate CPI index. Such evolution is due to a steady growth in the financial and human resources available to the two CAs after the introduction of the Competition Act in 2000. In the USA, the period between 1999 and 2003 seems to be the one that identifies a positive link between residual TFP growth and the CPIs, as the two series follow a much correlated pattern. The residual productivity growth performance is accompanied by an increase in the budget/gdp ratio in the US competition authorities, as well by an increase in the human resources.

In Hungary, we observe a common upward trend in residual productivity growth and competition policy. The major institutional changes that mark the evolution of the Hungarian competition policy are the attribution of more investigative powers to the competition authority and the modification of the criteria to sanction firms. The latter are no longer based on discretionary decisions of the competition authority, but are based on firms' turnover. These new tools were introduced starting from 2000. Moreover, a budget

 DOI: 10.2870/31694

increase took place in 2002. A similar common upward trend can be observed in the Czech Republic. Indeed, while the residual productivity growth is constantly increasing, the competition policy experiences a slight increase due to the larger amount of resources available to the competition authority. From the institutional side, an important change that happened around 1998 is the attribution to the competition authority of the power to investigate business' premises.

F. Conclusions

The aim of competition policy is to ensure that firms undertake the least possible number of behaviors that reduce social welfare by impairing competition. Hence, an effective competition policy is one that deters most anti-competitive practices. Since by deterring anti-competitive practices competition policy should make markets work effectively and foster efficiency, in this paper we evaluate the direct impact of competition policy on efficiency. Hence, we estimate the effect of the key institutional and enforcement features of a competition policy, summarized in a set of indicators, the CPIs, on total factor productivity growth in 22 industries of 12 OECD countries between 1995 and 2005.

Our results imply that good competition policy has a strong impact on TFP growth. The coefficient for the Aggregate CPIs is positive and statistically significant in a variety of specifications of our model. The Aggregate CPI also remains highly significant when we control for R&D, human capital, and the quality of a country's institutions. All these variables have a direct impact on TFP growth but do not alter the fact that competition policy is effective in increasing productivity. We obtain similar results when we look at a more disaggregated picture and separately consider the effects of a competition policy's institutional and enforcement characteristics and when we differentiate between the policing of antitrust infringements and the merger control discipline. Yet, the institutional and the antitrust elements of the competition policy appear to have the strongest impact on TFP growth. We adopt a multi-steps approach to identification based on instrumental variable regressions and the exploitation of non-linearities. We therefore provide careful

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support to the causal nature of the established link between competition policy and TFP growth. Furthermore, we observe complementarities between competition policy and the quality of legal institutions. The effect of the former is indeed larger in those countries where the enforcement costs are low and with a better legal system. Finally, our main findings prove to be robust to several checks, such as various measures of productivity, different aggregation techniques for the CPIs, and several sub-samples.

Our results provide support for the argument that competition policy creates gross benefits to the long-term performance of a country's economy. Nevertheless, these benefits should be compared to the costs of introducing competition laws and enforcing competition policy to perform a clear welfare assessment. Unfortunately, we did not have access to sufficiently precise and encompassing cost estimates to allow us to undertake such an analysis, which could, however, be undertaken in future work subject to further data collection. There is also scope for further refinements. Currently, we have used data on 22 industries in 12 OECD countries over ten years, but it would be interesting to expand the database so as to include more countries over a longer time period and, particularly, to analyze the impact of the policy in less developed economies, which are further apart from the technological frontier. Moreover, the CPIs could be improved by including more detailed information on the enforcement features, in particular on the sanctions that are effectively imposed on convicted firms and individuals and on the resources employed and the number of cases investigated by the EU Commission. However, such a refinement of the CPIs is difficult because of the lack of available data. Indeed, if competition authorities were to increase their accountability by collecting and keeping reliable data on the enforcement of competition policy in an easily accessible format, studying the effectiveness of competition policy would become much easier.

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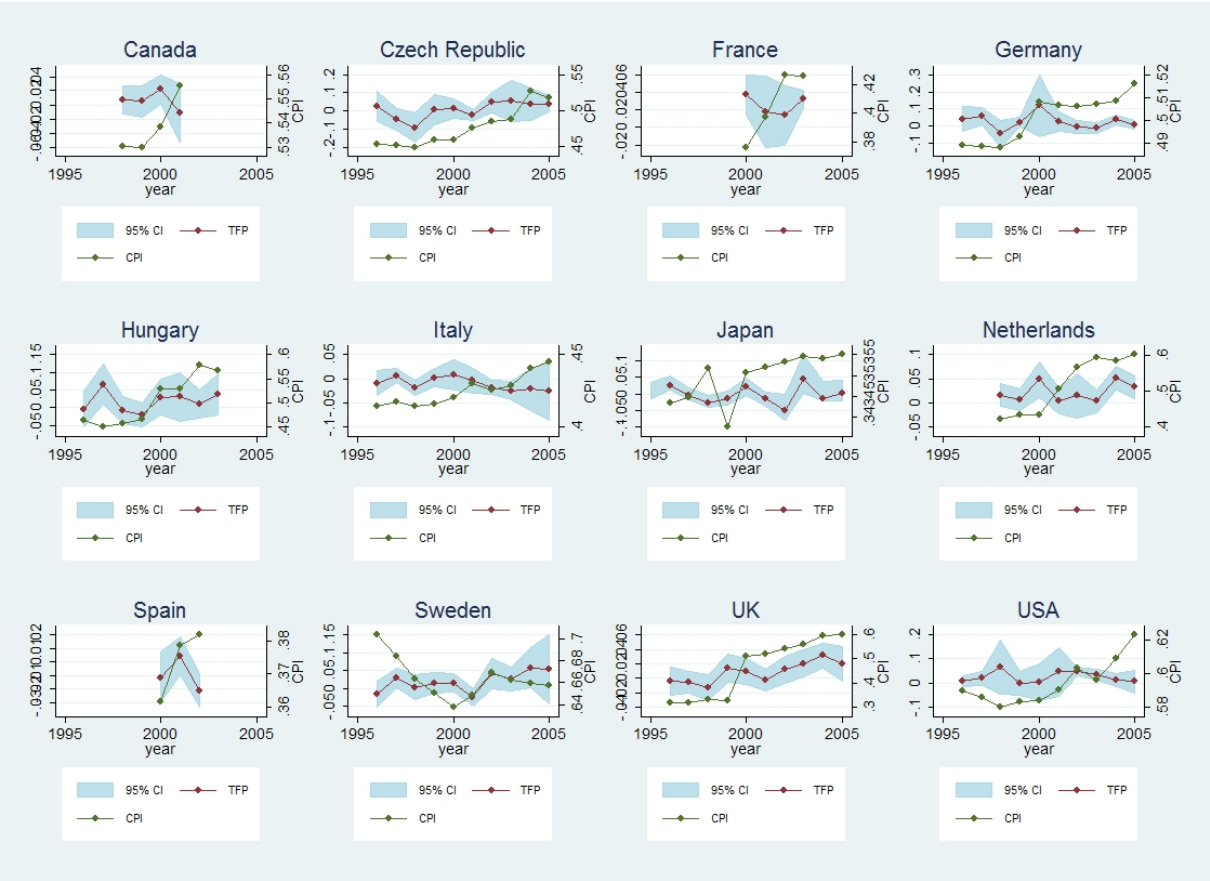
G. Figures and Tables

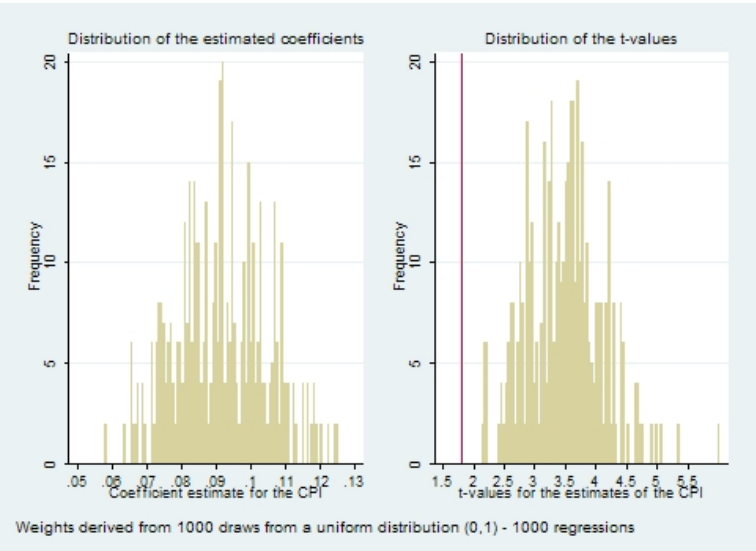
Figure 3.1: TFP Growth and the CPIs



TFP growth is corrected for mark-ups. For each country, we report the weighted average of TFP growth across the 22 industries in the sample. The shaded area represents the 95% confidence interval around the mean.

DOI: 10.2870/31694

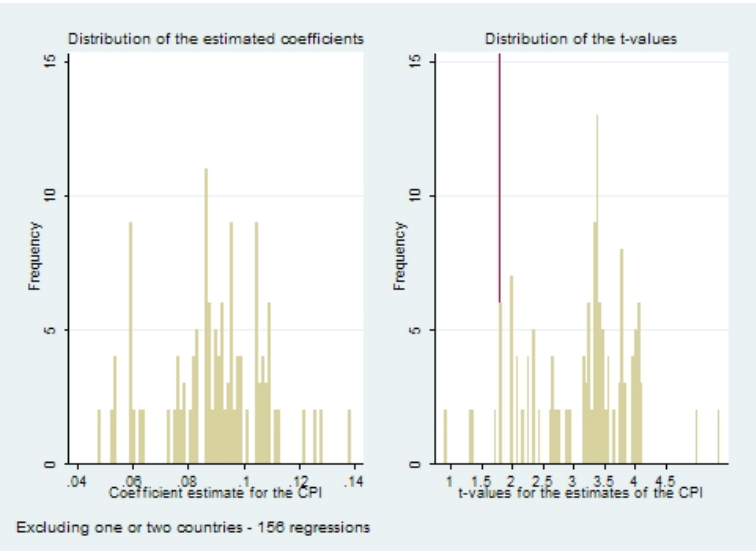
Figure 3.2: Distribution of the β Coefficients and t-statistics obtained by Random Weights



In the first panel, we represent the distribution of the estimated β coefficients from 1,000 regressions. In each of these regressions, the CPI index is built using random weights derived from a uniform distribution (0,1) and normalized to sum to 1. In the second panel, we represent the distribution of the t-statistics for the estimated coefficients. The red line represents the critical value for significance at the 10% level.

DOI: 10.2870/31694

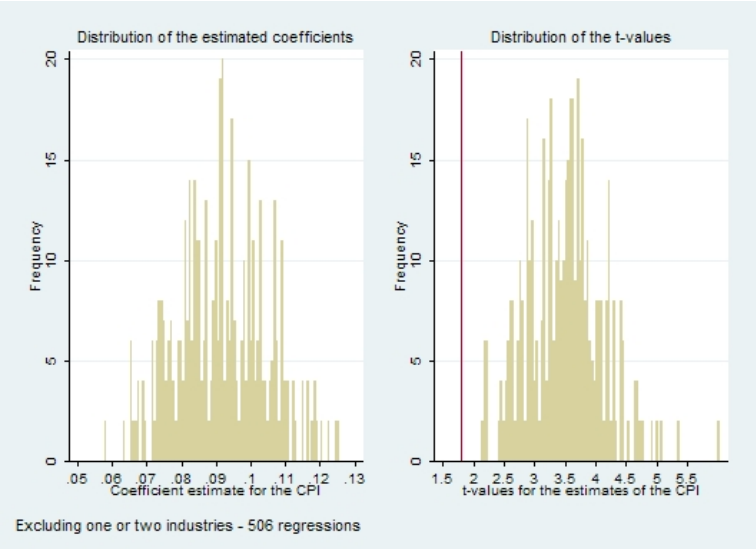
Figure 3.3: Distribution of the β Coefficients and t-statistics obtained by Excluding Countries



In the first panel, we represent the distribution of the estimated β coefficients from 156 regressions. In each of these regressions, we exclude one or two countries from our sample. In the second panel, we represent the distribution of the t-statistics for the estimated coefficients. The red line represents the critical value for significance at the 10% level.

DOI: 10.2870/31694

Figure 3.4: Distribution of the β Coefficients and t-statistics obtained by Excluding Industries



In the first panel, we represent the distribution of the estimated β coefficients from 506 regressions. In each of these regressions, we exclude one or two industries from our sample. In the second panel, we represent the distribution of the t-statistics for the estimated coefficients. The red line represents the critical value for significance at the 10% level.

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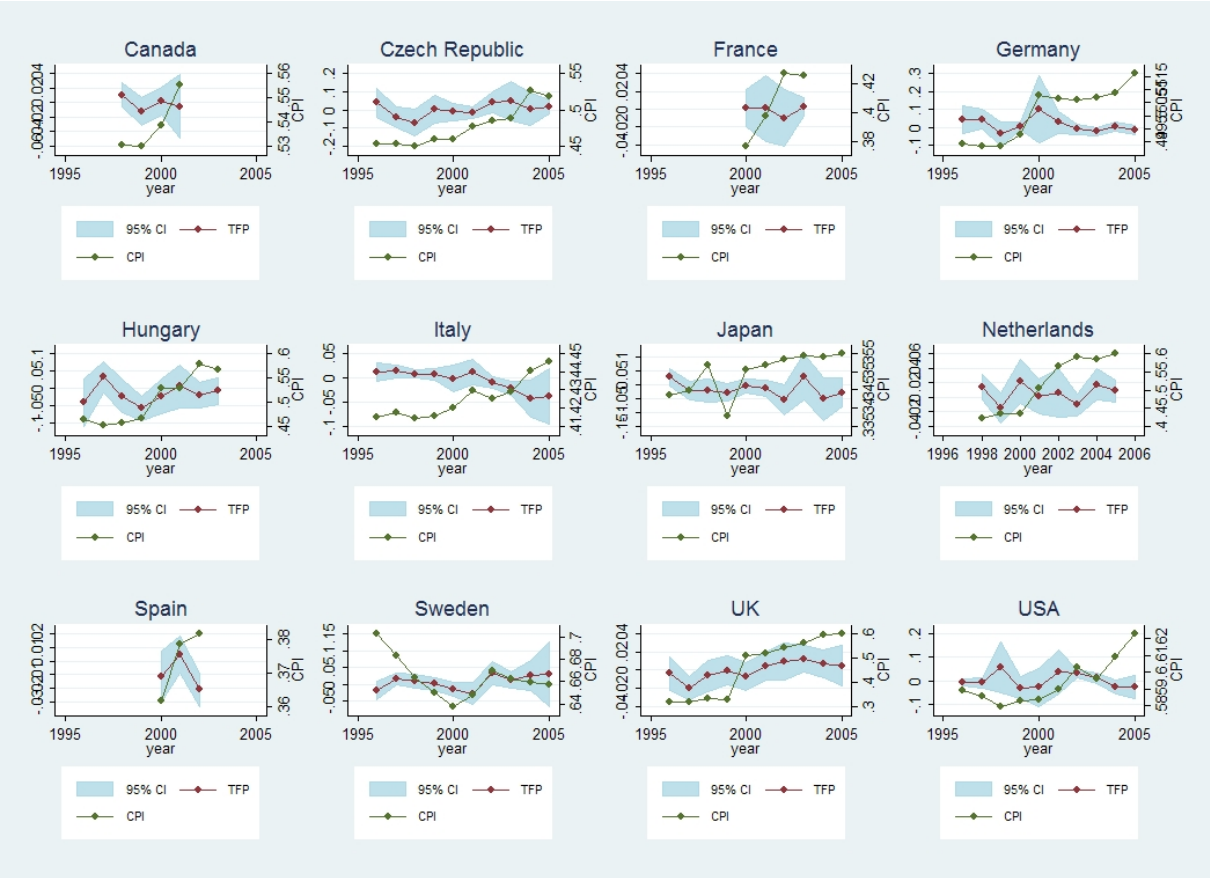
Figure 3.5: Residual TFP Growth and the CPIs



TFP growth is measured as the residual from equation (C.1], where we exclude the CPI from the regressors. The shaded area represents the 95% confidence interval around the mean TFP growth among the 22 industries for each country.

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Table 3.1: Preliminary Statistics

	Obs.	Mean	St. Dev.	Min.	Max
TFP Growth	1847	0.0096	0.0686	-0.2818	0.2727
TFP Leader	1847	0.0154	0.0931	-0.7863	0.6246
Technology Gap	1847	0.6891	0.6697	0	5.6063
R&D	1463	0.0253	0.0574	0	0.4041
Human Capital	1783	0.1171	0.0977	0.0058	0.5588
Trade openness	1847	1.0096	1.8350	0	17.2785
PMR	1847	1.6721	0.5227	0.9234	3.0336
CPI	1847	0.4976	0.1019	0.3167	0.7035
CPI_institution	1847	0.6048	0.1114	0.3513	0.7735
CPI_enforcement	1847	0.2802	0.1587	0.0499	0.7513
CPI_antitrust	1847	0.5023	0.1032	0.3292	0.7047
CPI_mergers	1847	0.4834	0.1137	0.1372	0.6999
Enforcement Costs	1847	22.1471	8.2423	9.4000	33.5000
Rule of Law	1847	1.4263	0.4141	0.5251	1.8801
Legal System	1847	8.1494	1.0655	5.5667	9.6246
Market regulation (per403)	1847	1.3767	1.2564	0	5.5007
Economic planning (per404)	1847	0.3348	0.6229	0	2.6971
Welfare state limitation (per505)	1847	0.5264	0.5679	0	1.9637

We present preliminary statistics for all used variables in the selected estimation sample.

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Table 3.2: Basic OLS Regressions - Aggregated Index

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS
TFP leader	0.0653**	0.0885***	0.0870***	0.0599**	0.0811***	0.0863***	0.0651**
	(0.0233)	(0.0251)	(0.0257)	(0.0232)	(0.0254)	(0.0259)	(0.0228)
L.Techno Gap	0.0075*	0.0162**	0.0168**	0.0085*	0.0181**	0.0178**	-0.00169
	(0.0041)	(0.00706)	(0.00724)	(0.0042)	(0.0069)	(0.0072)	(0.00566)
Industry trend	0.0445***	0.127***	0.127***	0.0369***	0.131***	0.127***	0.0405***
	(0.0052)	(0.0103)	(0.0100)	(0.0052)	(0.0106)	(0.0100)	(0.00595)
L.Import penetration	0.0144***	0.0171**	0.0174**	0.0147***	0.0170**	0.0171**	0.0134***
	(0.0040)	(0.0056)	(0.0056)	(0.00415)	(0.0055)	(0.0056)	(0.00400)
L.PMR	-0.0312	-0.0380**	-0.0379**	-0.0390*	-0.0506**	-0.0410**	-0.0251
	(0.0196)	(0.0172)	(0.0163)	(0.0205)	(0.0175)	(0.0168)	(0.0212)
L.CPI	0.0924***	0.0827***	0.1064***	0.0945***	0.0800***	0.111***	
	(0.0243)	(0.0263)	(0.0290)	(0.0221)	(0.0231)	(0.0291)	
L.CPI-low gap							0.0548*
							(0.0304)
L.CPI-medium gap							0.0821***
							(0.0264)
L.CPI-high gap							0.1223***
							(0.0312)
L.R&D		0.6750***			0.6633**		
		(0.1880)			(0.2131)		
L.Human Capital				0.286	0.460*		
				(0.172)	(0.218)		
Constant	-0.137**	-0.433***	-0.439***	-0.00989	0.0147	0.0205	-0.134**
	(0.0536)	(0.0543)	(0.0516)	(0.0240)	(0.0292)	(0.0308)	(0.0525)
R^2	0.269	0.294	0.290	0.273	0.299	0.292	0.275
Observations	1847	1463	1463	1783	1408	1408	1847

The dependent variable is TFP growth corrected for mark-ups. Standard errors in parentheses are robust and allow for correlation among industries in the same country. In all regressions we insert country-industry dummies and time dummies. The symbols ***, **, and * represent significance at the 1%, 5%, and 10% significance respectively.

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Table 3.3: OLS Regressions - Dissagregated Indexes

	(1) OLS	(2) OLS	(3) OLS	(4) OLS
TFP leader	0.0656**	0.0659**	0.0654**	0.0653**
	(0.0233)	(0.0232)	(0.0233)	(0.0234)
Industry trend	0.0428***	0.0438***	0.0444***	0.0443***
	(0.0051)	(0.0053)	(0.0051)	(0.0054)
L.Techno Gap	0.0075*	0.0076*	0.0075*	0.0075*
	(0.0042)	(0.0042)	(0.0041)	(0.0042)
L.Import penetration	0.0142***	0.0144***	0.0144***	0.0144***
	(0.0040)	(0.0040)	(0.0040)	(0.0040)
L.PMR	-0.0304	-0.0266	-0.0336	-0.0249
	(0.0196)	(0.0250)	(0.0197)	(0.0206)
L.CPI_institution	0.0705***			
	(0.0227)			
L.CPI_enforcement		0.0400*		
		(0.0195)		
L.CPI_antirust			0.0957***	
			(0.0255)	
L.CPI_mergers				0.0744***
				(0.0221)
Constant	-0.133**	-0.117*	-0.132**	-0.143**
	(0.0551)	(0.0594)	(0.0526)	(0.0587)
R^2	0.268	0.267	0.269	0.268
Observations	1847	1847	1847	1847

The dependent variable is TFP growth corrected for mark-ups. Standard errors in parentheses are robust and allow for correlation among industries in the same country. In all regressions we insert country-industry dummies and time dummies. The symbols ***, **, and * represent significance at the 1%, 5%, and 10% significance respectively.

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Table 3.4: IV Regressions - Aggregated Index

	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV
TFP leader	0.0638***	0.0852***	0.0640***	0.0636***	0.0870***	0.0649***
	(0.0186)	(0.0211)	(0.0186)	(0.0186)	(0.0210)	(0.0185)
Industry trend	0.0487**	0.125***	0.0486**	0.0491**	0.126***	0.0459*
	(0.0237)	(0.0398)	(0.0237)	(0.0238)	(0.0395)	(0.0236)
L.Techno Gap	0.0074*	0.0155***	0.0072*	0.0074*	0.0159***	0.0074*
	(0.0040)	(0.0055)	(0.0040)	(0.0040)	(0.0055)	(0.0040)
L.Import penetration	0.0146***	0.0175***	0.0146***	0.0147***	0.0173***	0.0145***
	(0.0036)	(0.0041)	(0.00361)	(0.00361)	(0.0041)	(0.0036)
L.R&D		0.481*			0.587**	
		(0.262)			(0.260)	
L.PMR	-0.0402***	-0.0543***	-0.0493**	-0.0410***	-0.0454**	-0.0388***
	(0.0137)	(0.0179)	(0.0195)	(0.0142)	(0.0177)	(0.0133)
L.CPI	0.2220**	0.2890**	0.218**	0.233**	0.277**	0.136
	(0.1020)	(0.1460)	(0.102)	(0.115)	(0.143)	(0.0832)
Constant	-0.276***	-0.324***	-0.258***	-0.212**	-0.0118	0.222***
	(0.0699)	(0.0780)	(0.0750)	(0.105)	(0.0749)	(0.0799)
First-stage F-test (CPI)	51.00	29.75	47.23	77.33	61.53	60.29
First-stage F-test (PMR)			194.49			147.84
Sargan test	2.616 (3)	4.212 (3)	2.450 (2)	0.781 (1)	0.899 (1)	1.230 (2)
Wu-Hausman test	0.2105	0.2219	0.4037	0.2366	0.5278	0.5067
Observations	1847	1463	1847	1847	1463	1847

The dependent variable is TFP growth corrected for mark-ups. Standard errors in parentheses are robust and allow for correlation among industries in the same country. The instruments in the IV regressions reported in columns 1, 2, and 3 are: coal, per108, per403, per404, per505. In column 1 only the CPI is instrumented, wile in columns 2 and 3 both CPI and PMR are instrumented. The instruments in the IV regressions reported in columns 4, 5, and 6 are the average values of CPI and PMR among the other countries in the same group (European and non-European countries) and among the other countries in a different group. In columns 1, 2, 4, and 5 only the CPI is instrumented, while in columns 3 and 6 both CPI and PMR are instrumented. The value of the F-statistic for the test of excluded instruments in the first-stage regressions is reported. The Sargan statistic is distributed as a χ^2 and the degrees of freedom parameters are in parentheses. We report the p-value for the Wu-Hausman F-Statistic. In all regressions we insert country-industry dummies and time dummies. The symbols ***, **, and * represent significance at the 1%, 5%, and 10% significance respectively.

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Table 3.5: First-Stage Regressions

	(1)	(2)	(3)	(4)	(5)	(6)
Specification	(1)	(3)	(3)	(4)	(6)	(6)
Dep. Var.	CPI	CPI	PMR	CPI	CPI	PMR
L.per108	0.1292***	0.0124***	-0.0071**			
	(0.0013)	(0.0013)	(0.0030)			
L.per403	-0.0083***	-0.0126***	0.0578***			
	(0.0015)	(0.0014)	(0.0033)			
L.per404	0.0060**	0.0034	-0.0353***			
	(0.0030)	(0.0054)	(0.0072)			
L.per505	0.0011	0.0191***	-0.2404***			
	(0.0039)	(0.0031)	(0.0075)			
L.CPI_NG				-1.8651***	-1.3312***	1.7896***
				(0.1569)	(0.1512)	(0.2265)
L.CPI_G				-0.2728***	-0.2172***	0.0995**
				(0.0335)	(0.0328)	(0.0492)
L.PMR_NG					0.0899	-8.0118***
					(0.0787)	(0.1179)
L.PMR_G					-0.2287***	-1.9799***
					(0.0230)	(0.0345)
Partial R^2	0.1148	0.1229	0.4056	0.0894	0.1641	0.7748
Test of excluded instrum.: F(4,1574)	51.00***	55.16***	286.56***	77.33***	77.23***	1354.06***
Observations	1847	1847	1847	1847	1847	1847

The dependent variable is CPI in columns 1, 2, 4, and 5 and PMR in columns 3 and 6. In column 1 and 4 only the CPI is instrumented, wile in columns 2-3 and 5-6 both CPI and PMR are simultaneously instrumented. The Partial R-squared of excluded instruments and the value of the F-statistic for the test of excluded instruments in the first-stage regressions is reported. In all regressions we insert country-industry dummies and time dummies, as well as all the other exogenous variables from the main regression. The symbols ***, **, and * represent significance at the 1%, 5%, and 10% significance respectively.

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Table 3.6: Interactions Regressions

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS
Enforcement Cost	-0.0100***		-0.0063**			
	(0.0007)		(0.0027)			
Rule of law	0.0211			0.0471		
	(0.0298)			(0.0391)		
Legal system	0.0115*				0.0137*	
	(0.0059)				0.0069	
L.CPI	0.0830***					
	(0.0204)					
L.CPI_LOe		0.0881***				
		(0.0143)				
L.CPI_LOg		0.182***				
		(0.0324)				
L.CPI_LOf		0.0206				
		(0.0406)				
L.CPI_LOn		0.263**				
		(0.117)				
L.CPI_lEC			0.240*			
			(0.122)			
L.CPI_mEC			0.110***			
			(0.0256)			
L.CPI_hEC			0.0938**			
			(0.0368)			
L.CPI_lRL				0.0837**		
				(0.0310)		
L.CPI_mRL				0.0945***		
				(0.0197)		
L.CPI_hRL				0.117**		
				(0.0532)		
L.CPI_lLS					0.0553	
					(0.0406)	
L.CPI_mLS					0.0722***	
					(0.0253)	
L.CPI_hLS					0.0830***	
					(0.0255)	
L.CPI_service						0.0091
						(0.0501)
L.CPI_manifacturing						0.143***
						(0.0420)
L.PMR_service						-0.0485**
						(0.0189)
L.PMR_manifacturing						-0.0235
						(0.0188)
heightR^2	0.273	0.270	0.271	0.270	0.270	0.272
Observations	1847	1847	1847	1847	1847	1847

The dependent variable is TFP growth corrected for mark-ups. Standard errors in parentheses are robust and allow for correlation among industries in the same country. In all regressions we insert country-industry dummies and time dummies. We control for the following variables 'TFP leader', 'Techno Gap', 'Industry trend', 'PMR', 'Import penetration' and a constant term but we do not report the coefficient estimates for space limitation and as they are comparable with those reported in Table 3.2. The symbols ***, **, and * represent significance at the 1%, 5%, and 10% significance respectively.

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Table 3.7: Robustness Checks

	(1) (OLS) Equal Weights	(2) (OLS) FA	(3) (OLS) EU	(4) (OLS) Non correct	(5) (OLS) LP	(6) (OLS) Long run I	(7) (OLS) Long run II	(8) (OLS) Long run III	(9) (OLS) Aggregated
TFP/LP leader	0.0651**	0.0657**	0.0655**	0.0372	0.0402	0.0734**	0.0842	0.0185	0.2174**
	(0.0233)	(0.0232)	(0.0234)	(0.0340)	(0.0394)	(0.0248)	(0.272)	(0.139)	(0.0990)
L.Techno Gap	0.0075*	0.0075*	0.0075*	0.0564***	0.0084***	-0.0027	0.0672**	-0.0070	0.0013
	(0.0042)	(0.0041)	(0.0042)	(0.0177)	(0.0017)	(0.0056)	(0.0286)	(0.0152)	(0.0063)
Industry trend	0.0464***	0.0426***	0.0450***	0.0533***	0.0536***	0.0548***	0.0078	0.0051**	0.2531**
	(0.0054)	(0.0050)	(0.0055)	(0.0057)	(0.0071)	(0.0043)	(0.0265)	(0.0020)	(0.1025)
L.PMR	-0.0264	-0.0315	-0.0277	-0.0141	-0.0289	0.00642	-0.171	-0.0406	-0.0125**
	(0.0203)	(0.0200)	(0.0204)	(0.0213)	(0.0237)	(0.0353)	(0.0969)	(0.0377)	(0.0058)
L.Import penetration	0.0141***	0.0143***	0.0143***	0.0183***	0.0172***	0.00792	0.0812	0.0050*	0.0044
	(0.0039)	(0.0040)	(0.0039)	(0.0052)	(0.0040)	(0.0051)	(0.0506)	(0.0027)	(0.0041)
L.CPI	0.0925***	0.0726**	0.115***	0.0662*	0.102***	0.0792*	0.332*	0.0903*	0.0417*
	(0.0209)	(0.0235)	(0.0369)	(0.0304)	(0.0298)	(0.0397)	(0.156)	(0.0480)	(0.0236)
Constant	-0.161***	-0.126**	-0.152**	-0.233***	-0.644***	-0.230***	0.0359	0.0403	-0.0024
	(0.0429)	(0.0546)	(0.0601)	(0.0430)	(0.0929)	(0.0628)	(0.182)	(0.0679)	(0.0135)
R^2	0.269	0.268	0.268	0.274	0.302	0.301	0.414	0.394	0.272
Observations	1847	1847	1847	1850	1651	1275	1479	802	93

In all specifications we control for country-industry and time fixed-effects. In columns 1, 2, 3, 5, 6, 7, 8, and 9 the dependent variable is TFP growth corrected for mark-ups. In column 4 the dependent variable is TFP growth non-corrected for mark-ups. Column 1 and 2 report results for the model where the Aggregate CPI is constructed on the base of equal weights and the weights obtained by factor analysis (FA), respectively. Column 3 reports results for the model where the Aggregate CPI for EU member states incorporates information about EU competition policy. Column 4 reports results where all productivity measures are based on TFP non-corrected for mark-ups. Column 5 reports results where the technology gap and the productivity level of the country at the frontier are based on labor productivity. Column 6 reports results where all explanatory variables are lagged three years instead of one. Column 7 reports results based on a three-year time horizon; the explanatory variables are measured at the beginning of the period. Column 8 reports results based on a three-year time horizon; all variables are three-years averages. In this last specification, given the lack of degree of freedom, we use 12 country and 22 industry fixed effects, instead of 264 country-industry fixed-effects. Column 9 reports results based on country level observations; all industry variable are averaged using the industry value added as a weight. The symbols ***, **, and * represent significance at the 1%, 5%, and 10% significance respectively.

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APPENDICES

A. The Indexes

The Competition Policy Indexes, CPIs, incorporate data on how the key features of a competition policy regime score against a benchmark of generally-agreed best practices and summarizes them. The CPIs have a pyramidal structure which encompasses a large number of sub-indicators that are progressively linearly combined using a set of weights at each level of aggregation. This structure is described in Tables A1, A2 and A3.

Table A1 shows the content of low-level indexes. The weights used to sum the information contained in each index are indicated in brackets.

Table A2 shows the eight medium-level indexes, which are given by the weighted average of the relevant low-level indexes. The weights are indicated in brackets.

Table A3 shows the different CPIs we built and the weights (in brackets) used in the aggregation process.

We now turn to the values of the Aggregate CPIs for the countries in our sample over the period 1995-2005. Figures 3.6 to 3.8 give a general idea of the measure of the deterrence properties of the competition policy in those countries and of the relevant changes occurred over time. It is evident from them that there is substantial cross-sectional and cross-time variation. It should be stressed that the institutional component of the aggregate index takes a greater weight (2/3), hence the evolution of the Aggregate CPIs is mostly explained by the institutional features of the competition policy which is relatively stable.[58]

[58]The enforcement features undergo more frequent changes and so do the Enforcement CPIs. For the sake of space we have only shown the values of Aggregate CPIs. For more details on the values of the other CPIs refer to Buccirossi et al. (2009a).

Ciari, Lorenzo (2011), Essays in Economic Policy
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Table A1. The Low-level Indexes

Abuses	Hard-core Cartels	Other agreements	Mergers
Independence: *Nature of prosecutor (1/2)* *Nature of adjudicator and role of government (1/2)*	Independence: *Nature of prosecutor (1/2)* *Nature of adjudicator and role of government (1/2)*	Independence: *Nature of prosecutor (1/2)* *Nature of adjudicator and role of government (1/2)*	Independence: *Nature of bodies involved in Phase 1 and 2 (1/2)* *Role of government in decision (1/2)*
Separation of powers: *Separation between adjudicator and prosecutor (2/3)* *Nature of appeal court (1/3)*	Separation of powers: *Separation between adjudicator and prosecutor (2/3)* *Nature of appeal court (1/3)*	Separation of powers: *Separation between adjudicator and prosecutor (2/3)* *Nature of appeal court (1/3)*	Separation of powers: *Separation between adjudicator and prosecutor (1/3)* *Separation between Phase 1 and 2 (1/3)* *Nature of appeal court (1/3)*
Quality of the law: *Standard of proof for predation and goals that inform decision (1/2)* *Standard of proof for refusal to deal and goals that inform decision (1/2)*	Quality of the law: *Standard of proof and goals that inform decision (1/2)* *Leniency program (1/2)*	Quality of the law: *Standard of proof for exclusive contracts and goals that inform decision*	Quality of the law: *Obligation to notify (1/2)* *Efficiency clause (1/2)*
Powers during investigation: *Combination of powers (3/4)* *Availability of interim measures (1/4)*	Powers during investigation: *Combination of powers*	Powers during investigation: *Combination of powers (3/4)* *Availability of interim measures (1/4)*	
Sanction policy and damages: *Sanctions to firms (1/3)* *Sanctions to individuals (1/3)* *Private actions (1/3)*	Sanction policy and damages: *Sanctions to firms (1/3)* *Sanctions to individuals (1/3)* *Private actions (1/3)*	Sanction policy and damages: *Sanctions to firms (1/3)* *Sanctions to individuals (1/3)* *Private actions (1/3)*	
Resources: *Budget (1/2)* *Staff (1/4)* *Staff skills (1/4)*	Resources: *Budget (1/2)* *Staff (1/4)* *Staff skills (1/4)*	Resources: *Budget (1/2)* *Staff (1/4)* *Staff skills (1/4)*	Resources: *Budget (1/2)* *Staff (1/4)* *Staff skills (1/4)*
	Sanctions and cases: *Number of cases opened (1/3)* *Max jail term imposed (2/3)*		Cases: *Number of mergers examined*

To allow a clearer interpretation of the results we include only a limited number of countries in each figure. Yet, to allow readers to easily perform comparisons among them, we report the sample average in each figure. Figure 3.6 shows the Institutional CPIs for the three OECD countries in our sample that are not part of the EU: Canada, Japan, and the US.

As a starting point, the sample average of the aggregate CPIs shows an upwards trend during the sample period, which is common to almost all the 12 countries. Moreover, the time variation of the average index is significant with an average increase of almost 2%

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Table A2. The medium-level Indexes

	Abuses	Hard-core Cartels	Other agreements	Mergers
Institutional features	*Independence (1/6)* *Separation of powers (1/6)* *Quality of the law (1/6)* *Powers during investigation (1/6)* *Sanctions and damages (1/3)*	*Independence (1/6)* *Separation of powers (1/6)* *Quality of the law (1/6)* *Powers during investigation (1/6)* *Sanctions and damages (1/3)*	*Independence (1/6)* *Separation of powers (1/6)* *Quality of the law (1/6)* *Powers during investigation (1/6)* *Sanctions and damages (1/3)*	*Independence (1/6)* *Separation of powers (1/3)* *Quality of the law (1/3)*
Enforcement features	*Resources*	*Resources (2/3)* *Cases (1/3)*	*Resources*	*Resources (2/3)* *Cases (1/3)*

Table A3. The CPIs

The Aggregate CPI				
	The Antitrust CPI (3/4)			The Merger CPI (1/4)
	Hard-core Cartels (1/3)	Abuses (1/3)	Other agreements (1/3)	
Institutional CPI (2/3)	*Institutional features of hard core cartels*	*Institutional features of abuses*	*Institutional features of other agreements*	*Institutional features of hard core cartels*
Enforcement CPI (1/3)	*Enforcement features of hard core cartels*	*Enforcement features of abuses*	*Enforcement features of other agreements*	*Enforcement features of hard core cartels*

points per year (18% over the sample period). The Aggregate CPIs of the non-EU countries changed more or less markedly over the period under exam, and their levels differ considerably among each other. The aggregate CPI for the US takes very high values which are constantly among the highest in the sample ranging between 0.58 and 0.62, showing therefore a significant time variation. The values for Canada are also quite high (between 0.53 and 0.56) and above the sample average. The range of variation is however limited to some percentage points per year. Japan's values are very low and among the lowest in the sample for the entire period (between 0.34 and 0.35). Differently from most other countries, also the changes in the Aggregate CPI are lower than an average of 1%

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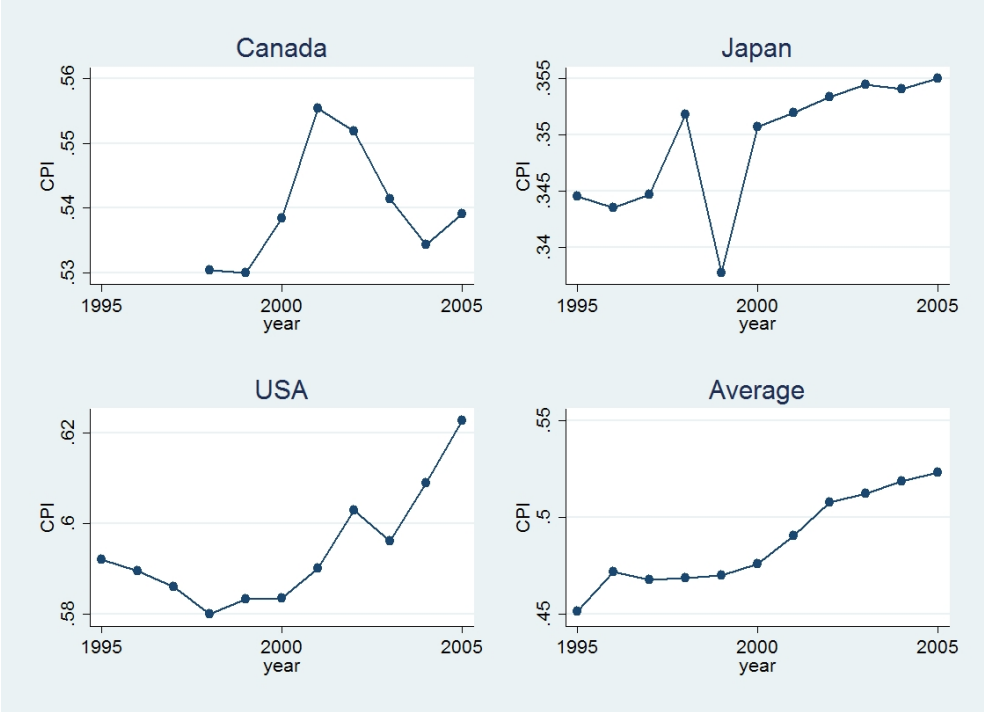
Figure 3.6: Aggregated CPI for the Non-EU Countries



per year. The reason behind Japan's low performance is manifold. First, Japan suffers from the lack of a leniency program for cartel whistleblowers. Second, in Japan there is no separation between the body that prosecutes violators of the antitrust law and the body that adjudicates such cases. Third, the Japanese CA has limited human and financial resources. Further elements are the absence of the possibility to start a class action and the fact that the Japanese competition legislation envisages the consideration of non strictly-economic goals when assessing the effects of abuses of dominance.

Figure 3.7 depicts the Aggregate CPIs for the large EU member states in our sample: France, Germany, Italy, Spain, and the UK.

The first noticeable element in this figure is that the data for the first five years in the sample are missing for Spain and France. This lack of information does not allow one to have a clear picture of the trend for these two jurisdictions. Anyhow, the Aggregate CPIs for these two countries, as well as for Italy, are very low and consistently below the sample

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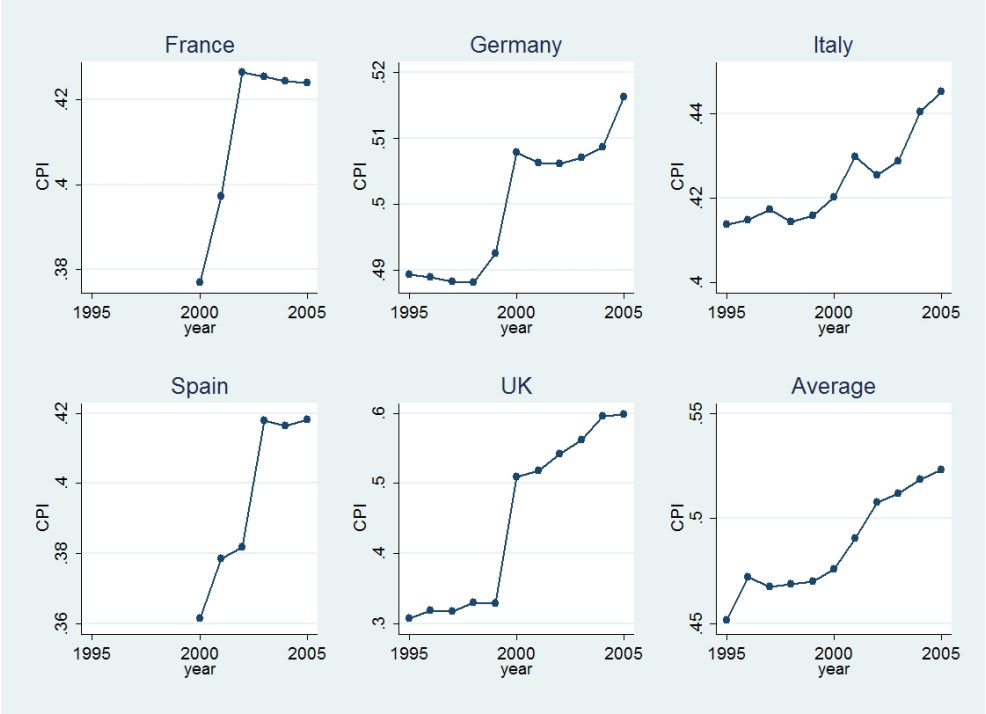
Figure 3.7: Aggregated CPI for the Large EU Countries

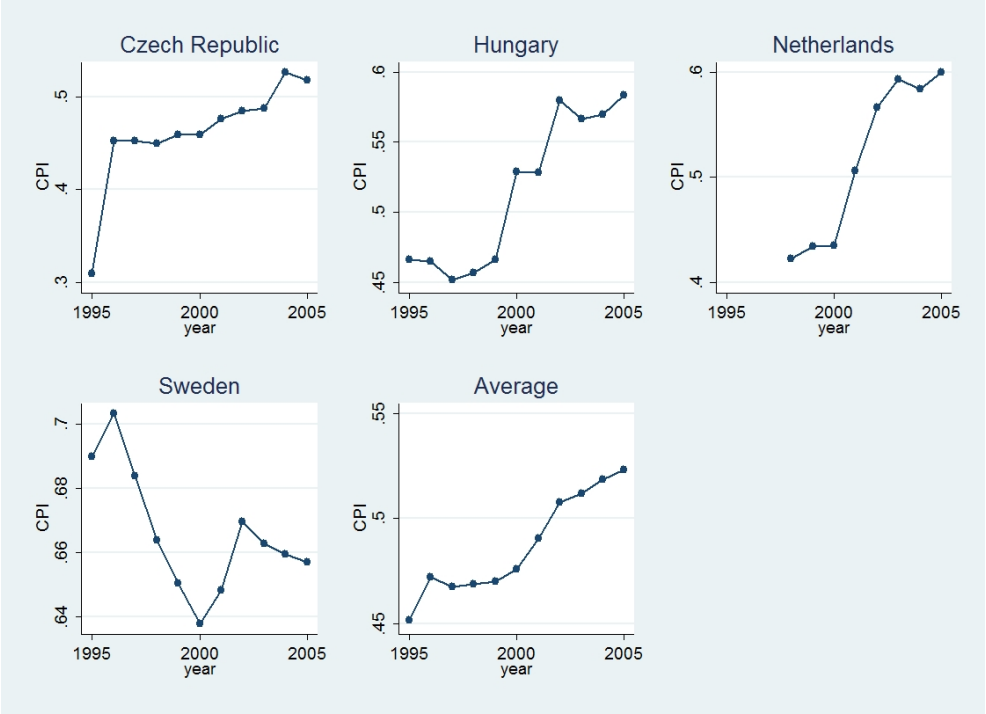


average (0.38-0.42 for France, 0.36-0.42 for Spain, and 0.41-0.44 for Italy). Both Spain and France experience a substantial improvement between 2000 and 2003. The former benefited from the introduction of class action in 2001 and of the powers to investigate business premises in 2003. In the latter, the quality of the institutional CPI improved because of the introduction of a leniency program for cartels whistleblowers and of the obligation to notify mergers. Germany shows a good and constant performance ranging between 0.49 and 0.52. Notably, the CPIs for the UK start well below all the values of the CPIs of the other countries (0.3), but over time they become the highest in the group (0.6). This is due to the dramatic institutional changes that accompanied the introduction of the Competition Act in 2000, coupled with a steady increase in the financial and human resources of the two CAs.

Figure 3.8 depicts the Aggregate CPIs for the small EU member states in our sample: the Czech Republic, Hungary, the Netherlands, and Sweden.

DOI: 10.2870/31694

Figure 3.8: Aggregated CPI for the Small EU Countries



Sweden is consistently the country with the highest CPI value, not just in this group but in the whole sample, yet this slowly declines over time (from 0.7 to 0.66) because of a reduction, in real terms, of the financial and human resources available to its CA. Instead, the CPIs for the other jurisdictions start below the sample average, but they all improve over time. The Czech Republic experiences a first, considerable shift in 1996, due to the CA acquiring independence from the government – previously all decisions were taken by a ministerial department. A further improvement takes place in 2004, when the power to investigate business premises is introduced. In the sample period, the CPI increases by 70% from a low of 0.3 to a high of 0.51. In Hungary the major changes happen in 2000, when there is an increase in the investigative powers of the CA and a shift in the criterion used to set the sanctions for antitrust infringements, which changed from a discretionary decision left to the adjudicator to an approach based on the firm's turnover. Moreover, in 2002 there was a substantial increase in the budget of the CA. These changes are captured

DOI: 10.2870/31694

by an increase in the CPI by over 30% from a low of 0.45 to a high of 0.59. The Netherlands did not have a CA before 1998. Hence, it was not possible to calculate a CPI until that year. In subsequent years, the index steadily rises by almost 50% over the sample period from a low of 0.4 to a high of 0.6 as a consequence of a regular increase in the amount and in the quality of its CA's resources.

These three figures give a general idea of the factors that affect the ability of a competition policy regime to deter anti-competitive behavior in the jurisdictions included in our sample and of how these have changed over time. It is evident from them that there is substantial cross-sectional and cross-time variation.

Table A4 instead shows the ranking of the 12 countries in our sample based on the average value of their Aggregate CPIs over the years 1995 to 2005 and on its value in 2005. Sweden and the US are the best-scoring countries and this is true for each year in the sample, similarly France, Spain, and Japan constantly have the lowest scores. The UK and Canada are the countries that experience the most marked change.

Table A4 : The Ranking of the Countries on the Basis of the Aggregate CPIs

Country	Ranking based on average score	Ranking based on 2005 score
Sweden	1	1
US	2	2
Canada	3	6
Netherlands	4	3
Hungary	5	5
Germany	6	8
Czech Republic	7	7
UK	8	4
Spain	9	11
Italy	10	9
France	11	10
Japan	12	12

B. The TFP Measures

In this appendix we describe in more detail the TFP growth and Technology Gap variables employed in our regressions.

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TFP growth. The measure of TFP growth employed in our regressions is taken from the EU-KLEMS database.[59] The database improves substantially on the existing industry level databases, among which the OECD STAN database and its predecessor the ISDB database. The main limitation of previously existing databases is that they provide industry-level series on output, aggregate hours worked and aggregate capital stock, ignoring changes in the composition of factor inputs. As a result, TFP measures based on these aggregate quantities might be biased. On the contrary, the KLEMS database takes into account changes in the composition of the labor force over time. Furthermore, it discriminates among different types of capital input measures.

The TFP measure reported by the KLEMS database and employed in our regressions is based on the growth accounting methodology, which essentially consists of decomposing output growth into the contribution of input growth (labor and capital) and TFP growth.[60] TFP measures within the growth accounting framework are based on several assumptions: in particular, it is assumed that markets are perfectly competitive and that inputs are fully utilized. Under these assumptions, TFP growth can be written as follows:

$$\Delta TFP_{ijt} = ln(\frac{Y_{ijt}}{Y_{ijt-1}}) - \frac{1}{2}(\alpha_{ijt} + \alpha_{ijt-1})ln(\frac{L_{ijt}}{L_{ijt-1}}) - (1 - \frac{1}{2}(\alpha_{ijt} + \alpha_{ijt-1}))ln(\frac{K_{ijt}}{K_{ijt-1}}) \quad \text{(B.2)}$$

where Y_{ijt} is real value added, L_{ijt} measures the labor input and the K_{ijt} capital input. Within the EU-KLEMS database, accurate measures of labor and capital input are based on a breakdown of aggregate hours worked and aggregate capital stock into various components. Hours worked are cross-classified by various categories to account for differences in the productivity of various labor types, such as high- versus low-skilled labor. Similarly, capital stock measures are broken down into stocks of different asset

[59]The EU-KLEMS database is the result of a research project funded by the European Commission that involves major national level economic and statistical research centers. Details about the EU-KLEMS project can be found at the website: www.euklems.net. An overview of the methodology employed to collect data and build the measures of productivity can be found in Timmer et al. (2007).

[60]The growth accounting methodology for computing productivity has a long standing history. For a full description of the methodology see Jorgenson et al. (1967, 2005) and Caves (1982a).

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types.[61] The term α_{ijt} measures the labor share in value added. For our study, given that we measure the effectiveness of competition policy in promoting competition and ultimately efficiency, the main concern related to the TFP measure reported in the EU-KLEMS database is the assumption of perfect competition in the product markets. In order to take the existence of imperfectly competitive product markets into account, we modify the expression in equation (B.2) and multiply the labor share by industry-specific mark-ups.[62]

We estimate industry level mark-ups as in Griffith and Harrison (2004), using the following equation:

$$Markup_{ijt} = \frac{ValueAdded_{ijt}}{LaborCosts_{ijt} + CapitalCosts_{ijt}} \tag{B.3}$$

where $ValueAdded_{ijt}$ is nominal value added, Labor Costs is labor compensation and Capital Costs is capital compensation.[63] The main source of data for computing mark-ups is still the EU-KLEMS database.[64] An important aspect to notice is that the measure of capital input necessary to compute capital costs is a somewhat cruder measure than the one employed in the construction of the TFP measure. In particular, we use an aggregate measure of capital stock, not accounting for different types of capital assets.[65] This capital stock measure is computed starting from the real gross fixed-capital formation series available in the EU-KLEMS database, using the perpetual inventory method.

[61] The EU-KLEMS database covers all the countries involved in our study except for Canada. For measuring TFP growth for Canada, we use data from the Groningen Growth and Development Centre (GGDC). The GGDC methodology is totally analogous to the one adopted by the EU-KLEMS consortium, of which the GGDC is member. The correlation between the EU-KLEMS TFP and the GGDC TFP is high (0.7) and strongly significant. However, we run specifications excluding Canada and results remain qualitatively and quantitatively unchanged.

[62] In this, we follow the existing literature that explores the determinants of TFP growth. See, for example, Griffith et al. (2004), Aghion et al. (2009) and Nicoletti and Scarpetta (2003).

[63] The Capital Costs measure is obtained by multiplying the capital stock for the user cost of capital, which takes into account the real interest rate and the extent of capital depreciation. For details see Griffith et al. (2006).

[64] For the computation of capital costs, we needed data on the inflation rate as well as on the yield on 10-years Federal Reserve Bonds. These come from the OECD MEI (Main Economic Indicators) database.

[65] The reason why we use an aggregate measure of the capital stock is that the series on gross fixed-capital formation disaggregated for different types of assets are publicly available in the EU-KLEMS database only for a limited number of countries.

DOI: 10.2870/31694

Technology gap. One of the main regressors in our specifications is the technology gap between a country-industry in a given year and the technological frontier. There are several ways which can potentially be used to measure the technology gap. In our study, we follow the existing literature and use the TFP level to compute the distance to the technological frontier.[66] The computation of the technology gap is made in two steps. The first step consists of evaluating the level of TFP in each country-industry relative to a common reference point – the geometric mean of the TFPs of all other countries in the same industry. This measure of the TFP level with respect to the average is given by:

$$TFP_{ijt} = ln(\frac{Y_{ijt}}{\overline{Y}_{jt}}) - \widetilde{\sigma}_{ijt} ln(\frac{L_{ijt}}{\overline{L}_{jt}}) - (1 - \widetilde{\sigma}_{ijt}) ln(\frac{K_{ijt}}{\overline{K}_{jt}})$$

where the output and input measures are the same employed in the measurement of TFP growth, and the bar denotes a geometric mean.[67] The variable $\widetilde{\sigma}_{ijt} = \frac{1}{2}(\alpha_{ijt} + \overline{\alpha}_{jt})$ is the average of the labor share in country i and the geometric mean labor share. The technology leader is defined as the country-industry with the highest value for the TFP level relative to the common reference point. The second step for computing the technology gap consists of subtracting TFP_{ijt} from TFP_{Ljt}, where the latter is the TFP level in the identified country-industry leader. The technology gap variable used in our regressions is thus: $TechnoGap_{ijt} = TFP_{Ljt} - TFP_{ijt}$

C. The Assumptions on the Error Terms

Following the existing literature (e.g. Nicoletti and Scarpetta, 2003, Grifith et al., 2004, and Bourlès et al., 2010) we specified a particular structure for the individual effects and the error term in equation C.1. In this appendix, we present and discuss a large amount

[66] In the effort to verify the robustness of our results, we also employ a different measures of technology gap, based on labor productivity (value added per worker) differences among country-industries. The results remain basically unchanged, suggesting a stronger role for the technology gap in explaining TFP performance and weaker one for TFP growth on the technological frontier.

[67] Data are aggregated using national level purchasing power parities (PPPs). For the base year we use for measuring real variables (2000), neither industry level PPPs for value added nor capital specific PPPs are available.

 DOI: 10.2870/31694

of specifications, which are aimed at testing the robustness of our assumptions along two lines. First, since our data have a nested structure, as an industry is 'naturally' nested within a country, we follow Baltagi et al. (2001) and estimate several mixed-models to fit two-way, multilevel effects by maximum likelihood. Second, we more carefully analyze the autocorrelation structure of the residuals, to check and, eventually, correct for serial correlation in the residuals. Table A5 reports the results of our robustness checks.

We start by estimating a model with 12 country, 22 industry, and 9 time fixed-effect and cluster the standard error at the country level, which we use as a first benchmark (column 1). Then, we replicate our main specification with 264 country-industry and 9 time fixed-effects and standard error clustered at the country level (column 2). We then try a specification with country and time-industry fixed-effects (column 3). We then use three different specifications that make use of the nested structure we talked above and which are estimated by maximum likelihood with xtmixed in Stata. First, we specify country fixed-effects by the means of country dummies and use industry-within-country random effects. We allow for a complex, unspecified covariance structure and distinctly estimate all variances-covariances (column 4). We then assume country and industry-within-country random effects. Our model now has two random-effects equations. The first is a random intercept (constant-only) at the country level, the second a random intercept at the industry-within-country level (this, by the way, is exactly the model estimated by Baltagi et al. (2001) to investigate the productivity of public capital in private production). As before, we distinctly estimate all variances-covariances (column 5). While the size of the coefficient estimates is slightly affected, its sign and significance are not. In all specifications, we do find a strong and significant impact of the Aggregate CPI on TFP growth. Notice that, if we estimate a simple random effect model with country-industry random effects and time fixed-effects, i.e. a simplified version of specification (5), we also find a coefficient estimate for the Aggregate CPI equal to 0.0550 and significant at the 1% level. However, when we run a Hausman test to verify whether the fixed or the random-effects specification should be preferred, we reject the appropriateness of

 DOI: 10.2870/31694

the random-effects estimator.

The second robustness check concerns another aspect of the correlation structure of the residuals and, in particular, the potential existence of serial correlation. We start from our preferred fixed-effects specifications (1)-(3) with clustered standard errors at the country level. We run the Arellano and Bond (2001) test of autocorrelation of the first order.[68] The Arellano-Bond test rejects the null hypothesis in model (1) but not in model (2) and (3). We therefore re-estimate the basic models (1)-(3) by assuming a AR(1) structure for the error term. Results are reported in columns (6)-(8). Again, in all specifications we estimate a positive and significant coefficient for the CPI.[69] This is very similar in size to the coefficient estimated in our reference model. Eventually, the coefficients estimates are a bit larger in the models with AR(1) disturbances if compared to the basic specifications.

To conclude, while the structure for the error term that we adopted might appear to be subjective, we believe that it does not significantly affect our conclusions.

[68]The test was originally proposed for a particular linear Generalized Method of Moments dynamic panel data estimator (Arellano and Bond, 1991), but is quite general in its applicability (more general than the xtserial test in Stata). It can be applied to linear GMM regressions in general, and thus to the special cases of ordinary least squares (OLS) and two-stage least-squares (2SLS). To run this test we therefore estimate the LSDV version of models (1)-(3).

[69]Notice that the TFP level of the leader was dropped from specification (8) because of collinearity.

DOI: 10.2870/31694

Table 3.8: Table A5 - Different Specifications with Various Individual Effects and Correlation Structures

	(1) OLS	(2) OLS	(3) OLS	(4) MLE	(5) MLE	(6) OLS	(7) OLS	(8) OLS
TFP leader	0.0738***	0.0653**	0.133***	0.0869***	0.0990***	0.0728***	0.0657***	dropped
	(0.0236)	(0.0233)	(0.0370)	(0.0192)	(0.0184)	(0.0173)	(0.0219)	
L.Techno Gap	0.0072	0.0075*	0.0149	0.0050*	0.0031	0.0073**	0.0063	0.0054
	(0.0060)	(0.0041)	(0.0107)	(0.0030)	(0.0027)	(0.0030)	(0.0051)	(0.0040)
L.Import penetration	0.0047**	0.0144***	0.0048*	0.0045***	0.0046***	0.0050***	0.0172***	0.0049***
	(0.0019)	(0.0040)	(0.0022)	(0.0011)	(0.0010)	(0.0009)	(0.0050)	(0.0011)
L.PMR	-0.0328*	-0.0312	-0.0331*	-0.0334**	-0.0079*	-0.0323***	-0.0529***	-0.00419
	(0.0162)	(0.0196)	(0.0167)	(0.0132)	(0.0047)	(0.0115)	(0.0156)	(0.00352)
L.CPI	0.0868***	0.0924***	0.0832**	0.0875**	0.0540**	0.0849**	0.115**	0.0563***
	(0.0243)	(0.0243)	(0.0278)	(0.0380)	(0.0223)	(0.0410)	(0.0476)	(0.0132)
Constant	0.0472	-0.152***	0.0272	-0.0045	-0.0091	-0.0021	-0.0125	-0.0077
	(0.0328)	(0.0440)	(0.0463)	(0.0256)	(0.0161)	(0.0329)	(0.0265)	(0.0058)
Correlation Structure	Clustered	Clustered	Clustered	Unstructured	Unstructured	AR(1)	AR(1)	AR(1)
Country Effects	Fixed (12)		Fixed (11)	Fixed (12)	Random (12)	Fixed (12)		Fixed (12)
Industry Effects	Fixed (22)					Fixed (22)		
Industry-within-country Effects		Fixed (264)		Random (256)	Random (256)		Fixed (264)	
Time Effects	Fixed (9)	Fixed (9)	Fixed (9)	Fixed (9)	Fixed (9)	Fixed (9)	Fixed (9)	Fixed (9)
Industry-Time Effects			Fixed (242)					Fixed (242)
Arellano-Bond test	0.258	0.054	0.077					
LR test vs. linear regression				21.16***	18.5***			
Observations	1847	1847	1847	1847	1847	1591	1591	1628
R^2	0.121	0.269	0.255					

The dependent variable is TFP growth corrected for mark-ups. Columns 1-3 report results of the fixed-effects specifications (column 1: country, industry, time fixed-effects; column 2 country- industry and time fixed-effects; column 3 country, industry-time fixed-effects) where the error terms are robust and clustered at the country level. Column 4 reports result for a the mixed-model with country fixed-effects and industry-within-country random effects and column 5 report the results for the mixed model with country and industry-within-country random effects. In columns 4 and 5 the covariance structure is unspecified and all variances-covariances are distinctly estimated. Column 6-8 reproduce the fixed-effects specifications with clustered standard errors reported in 1-3, which are augmented to allow for an AR(1) structure in the error term. The symbols ***, **, and * represent significance at the 1%, 5%, and 10% significance respectively. The p-value of the Arellano-Bond (1991) test for AR(1) is reported.

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