

The Relationship between Efficiencies Defenses for Mergers and TFP Growth

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Abstract

This article investigates whether efficiencies defenses in merger control lead to greater economic efficiency, specifically by examining their impact on national total factor productivity (TFP) growth. Efficiencies defenses are provisions in competition law that allow efficiencies from mergers to be weighed against potential harms. While increasingly common—present in 40.4 per cent of countries by 2010—their effectiveness remains underexplored. To address this gap, the study adapts the econometric model from Buccirosi *et al.* (2013), using data from the Penn World Tables version 10.01 and the Comparative Competition Law Dataset (Bradford *et al.*, 2018). The analysis estimates the causal relationship between the introduction of efficiencies defenses and TFP growth. The results yield two key findings. First, introducing efficiencies defenses is generally associated with higher TFP growth, suggesting they may enhance economic performance. However, the effectiveness likely varies by the design and implementation of these provisions—an area for future research. Second, these legal reforms often coincide with increased enforcement resources. While efficiencies defenses appear to contribute to productivity gains, their impact depends heavily on the capacity of enforcement agencies. Without sufficient resources, even well-designed competition laws are unlikely to produce meaningful results.

For over a century, architects of competition law in nations across the globe have grappled with the challenge of reconciling the potential efficiency-enhancing benefits of mergers with the potential harm these transactions can impose on competition within markets. Consolidation of business can lead to greater economies of scale and other synergies, but at the cost of greater market power, resulting in deadweight loss, higher prices, and other consumer and societal harms. Some lawmakers have attempted to reconcile these two seemingly competing outcomes of mergers is by through efficiencies defenses. These provisions articulate how competition law en-

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forcers and adjudicators should consider efficiencies outcomes when evaluating mergers, including how these efficiency benefits should be weighed against harms from a merger and what kinds of efficiencies and harms should be included in their analysis.

Efficiencies defenses for mergers have become increasingly common over time. Given their prevalence, it is worth examining if they actually drive greater efficiency within national economies. However, to date there has been limited, if any, empirical research on the effectiveness of these defenses. More generally, mergers could play an important role in driving total factor productivity growth by reorganizing the ways that labour and capital are combined for production within national economies.

To illustrate, in 2023 the world's Merger and Acquisition (M&E) volume, measured as deal value, was equal to 2.5 per cent of global GDP (IMAA, n.d.; World Bank, n.d.). To be sure, M&A deal value is not a perfect measure of generated economic value, as measured by GDP. Furthermore, deal value is typically a multiple of the income or assets of a business, not the value at a given point in time. However, it does point to the potential magnitude of the impact mergers could have in shaping economic outcomes. Seeking to optimize merger control law to enhance economic well-being and standards of living is a worthwhile task for policy makers. To that end, this study fills an important gap in the literature by investigating whether legislated efficiencies defenses for mergers have an impact on the efficiency and productivity of economies.

Furthermore, Canada in particular has seen some notable reforms to its Competi-

tion Act. These changes include removing its legislated efficiencies defense, outlined in bill C-56, which received royal assent in December 2023. While Canada is not included in this empirical analysis for reasons explained later in the paper, this research could help inform Canadian policy makers as they re-evaluate the role of efficiencies considerations in mergers going forward.

For this analysis, Total Factor Productivity (TFP) is used as the measure of macroeconomic efficiency. Not only does TFP capture the types of efficiencies that could be created through mergers, but it is also an important ingredient of economic growth, particularly in developed economies. Thus, TFP and its growth are highly relevant indicators for economic policy makers.

To test whether efficiencies defenses lead to greater TFP growth, this study builds on the econometric analysis done by Buccrossi *et al.* (2013), which estimates the impact of competition laws on TFP growth for industries in 22 OECD countries. We expand on Buccrossi *et al.* (2013) in two ways. First, a similar model is estimated using global dataset not limited to OECD countries. National- rather than industry-level data from the Penn World Tables version 10.01 (PWT 10) and the Comparative Competition Law Dataset developed by Bradford and Chilton (2018) are used. Second, using these data an in-depth investigation is undertaken into the impact of efficiencies defenses on productivity growth specifically, rather than competition law and merger control more generally.

Importantly, the focus of this study is efficiencies defenses implemented by legislators and included within competition

law legislation. Some jurisdictions, notably the United States, have efficiencies defenses that have been created and implemented by the enforcers of competition law, not lawmakers (US Department of Justice and Federal Trade Commission, 2010). These forms of efficiencies defense are not examined here.

The article is organized as follows. The first section provides more detailed background on efficiencies defenses. It also includes a descriptive analysis about the adoption of defenses by countries around the world and the characteristics of countries that do and do not have them. The second section begins with a brief literature review of whether efficiency defense lead to greater economic efficiency, an overview of the model and data used for the econometric analysis, and regression results. The third section provides an interpretation of the empirical results of the previous section, and the last section concludes.

What are Efficiencies Defenses?

The idea of an efficiencies defense for mergers in the context of competition law was formalized by Oliver Williamson in his 1968 article "Economies as an Anti-Trust Defense: The Welfare Trade-Off". Williamson argued that the American test for assessing mergers, which asks if the merger will "substantially lessen competition, or [will] tend to create a monopoly", may lead to "serious economic loss" (Williamson, 1968:18). His point was that the rule does not consider potential efficiencies arising from mergers, namely economies of scale and scope. He posits that in merger assessment, policy makers

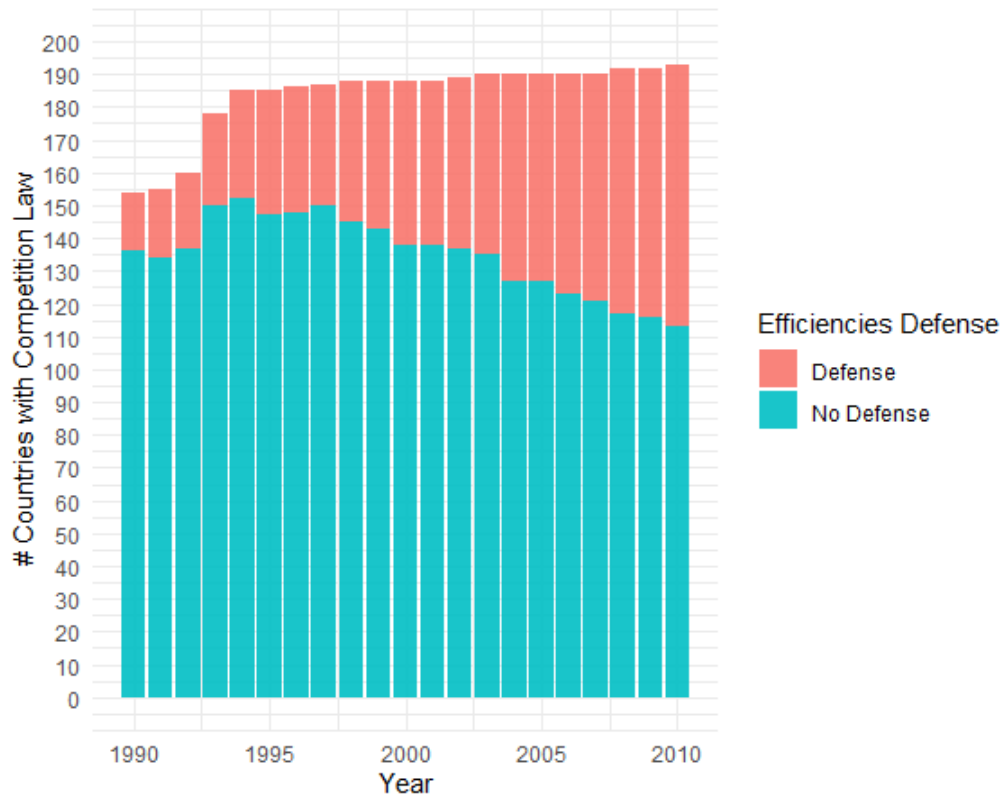
face a tradeoff between increased market power resulting from a merger (allocative inefficiency) against the efficiencies it produces (economies of scale and scope).

Since the publication of Williamson's 1968 article, nations have adopted efficiencies defenses of various forms. These defences are provisions within competition legislation that create some type of exemption for potentially harmful mergers on the basis that they create efficiencies. Some defences more closely mirror Williamson's original model than others. Some defenses, like Canada's section 96 (1) which was recently stricken from the Competition Act, are weighted defences. They require that law enforcers and judges weigh the harms from a merger against the efficiencies it creates. Other defenses, like that articulated in the European Union's Treaty on the Functioning of the European Union, put bounds on the types of efficiencies that can be considered in this weighing exercise. In the case of the EU, efficiencies must be to the benefit of consumers and not undermine the competitive process. Some defences are very broad, providing exemptions to mergers that create efficiencies without specifying the type of magnitude of the efficiency. In some laws, efficiencies are considered as a factor among several others when evaluating mergers (Shaban, 2024).

Efficiencies defenses – a common fixture of merger control

Efficiencies defenses are identified through the Comparative Competition Law dataset (Bradford and Chilton, 2018). The dataset is a census of all competition

Chart 1: Countries with Competition Laws in Force, With and Without Efficiencies Defense, 1990 to 2010.



Source: Comparative Competition Law Dataset (Bradford and Chilton, 2018) and the World Bank table The World by Income and Region.

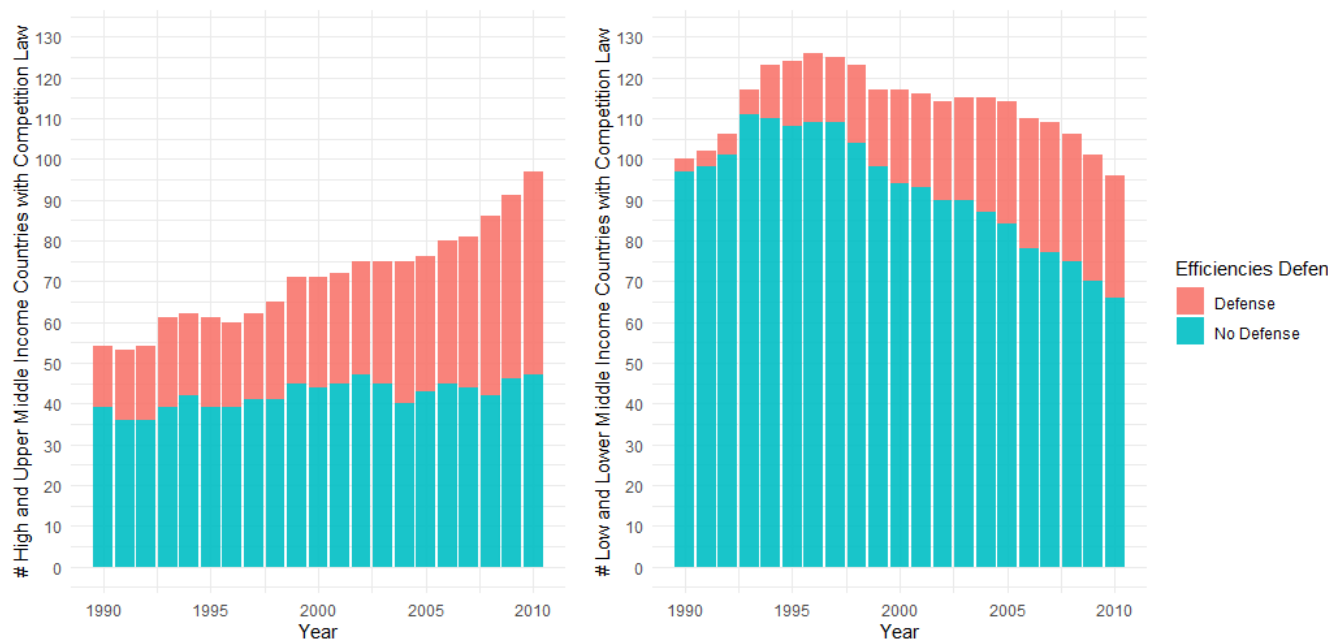
laws in force spanning the 1800s to 2010 and includes variables indicating whether a law contains an efficiencies defense for mergers. Chart 1 shows the number of countries with competition laws in force each year from 1990 to 2010, broken down by whether or not it has an efficiencies defense.

A small number of nations had efficiencies defences in the early 1990s, with defenses became more widespread beginning in late 1990s. By 2010, 41.5 percent of na-

tions with a competition law had an efficiencies defense, based on data from the Comparative Competition Law Dataset.² In that year, nations in Europe and Central Asia were most likely to have a defense (45.0 per cent), followed by Sub-Saharan Africa (17.5 per cent), East Asia and Pacific (13.8 per cent), and Latin America and Caribbean (12.5 per cent). In modern times these defenses have become a common fixture of competition laws across the world.

² Jersey Channel Islands and Faroe Islands have been removed from the data used for this chart. Furthermore the data are limited to those countries and years for which the World Bank as assigned an income category from the table The World by Income and Region. For example, the Comparative Competititon Law Dataset has entries for Kosovo beginning in 2004, but the World Bank assigned Kosovo an income category only in 2010.

Chart 2: Countries With and Without Efficiencies Defense, by Income Group, 1990 to 2010



Source:

Chart 2 gives a further breakdown of countries presented in Chart 1 by income group, based on the World Bank's income classification system. The first panel shows an increasing number of high- and upper middle income countries that have adopted competition laws over time. The number of nations at this income level that do not have an efficiencies defense has been relatively stable over time, ranging from a high 47 in 2002 and 2010 to a low of 36 in 1992. In contrast, the number and proportion of nations in this income category with a defense has increased steadily, from 15 (27.8 per cent) in 1990 to 50 (51.5 per cent) in 2010. The second panel of Chart 2 presents data for low- and lower middle income countries with competition laws. The number of nations at this income level with a competition law declined from a high of 126 in 1996 to a low of 97 in 2010. The

competition laws of low and lower middle income countries are more likely to have an efficiencies defense in more recent years (31.3 per cent in 2010) than in the mid-1990s (12.9 per cent in 1995). Overall, the figures highlight that high- and upper middle income nations with competition laws are more likely to have an efficiencies defense than low- and lower middle income nations. However, nations of both income levels have been increasingly adopting defenses over time.

Table 1 shows that, overall, countries with defenses are more likely to be higher income, although in more recent years a greater proportion of countries with a defense were upper-middle income. Countries that adopted defenses from 1991 to 2000 were more likely to be lower-middle income, while countries across the income categories adopted defenses from 2001 to

Table 1: Count, Incidence, and Percent of Nations by Efficiencies Defense Status and World Bank Income Category, 1997 to 2009

Income Group	Defense in Force for Entire Period	Defense Introduced	Defense Removed	No Defense in Force During Period	Total
Count					
High income	18	14	1	19	52
Upper middle income	4	11	2	23	40
Lower middle income	4	17	0	33	54
Low income	6	7	0	35	48
Total	32	49	3	110	194
Incidence (%)					
High income	34.6	26.9	1.9	36.5	100.0
Upper middle income	10.0	27.5	5.0	57.5	100.0
Lower middle income	7.4	31.5	0.0	61.1	100.0
Low income	12.5	14.6	0.0	72.9	100.0
Total	16.5	25.3	1.5	56.7	100.0
Percentage (distribution)					
High income	56.3	28.6	33.3	17.3	26.8
Upper middle income	12.5	22.4	66.7	20.9	20.6
Lower middle income	12.5	34.7	0.0	30.0	27.8
Low income	18.8	14.3	0.0	31.8	24.7
Total	100.0	100.0	100.0	100.0	100.0

Source: Comparative Competition Law Dataset (Bradford & Chilton, 2018) and the World Bank table *The World by Income and Region*.

Table 2: Percent of Countries by Efficiencies Defense Status and World Bank Region Categories, 1997 to 2009

Geography	Defense in Force for Entire Period	Defense Introduced	Defense Removed	No Defense in Force During Period
East Asia & Pacific	6.3	16.3		17.3
Europe & Central Asia	62.5	36.7	100	10.9
Latin America & Caribbean	6.3	18.4		20.0
Middle East & North Africa	6.3	10.2		12.7
North America	3.1			0.9
South Asia	6.3			6.4
Sub-Saharan Africa	9.4	18.4		31.8
Total	100	100	100	100

Source: Comparative Competition Law Dataset (Bradford & Chilton, 2018) and the World Bank table *The World by Income and Region*.

2010.

The large majority of countries with a defense are in Europe and Central Asia, as Table 2 shows. Countries from Europe and Central Asia also made up the largest segment of countries that adopted a defense during that period. The geographic distribution of countries with no defense remained very similar across the two periods presented in the table. Of countries that adopted a defense in the two periods, a relatively large proportion of them were also in Europe and Central Asia, painting a picture of efficiencies defense diffusion in that region. However, in more recent

years, countries from other regions made up a larger proportion of defense adopters.

Do Efficiencies Defenses Lead to Greater Economic Efficiency?

Total Factor Productivity (TFP) is the measure of efficiency for this analysis because it is a critical driver of economic growth, making it a highly relevant policy indicator. It is also relevant for studying the impact of mergers and merger control law because it reflects the way that labour and capital are used within an econ-

omy (industry, or firm) to produce value added. Mergers can reorganize businesses and the ways they use and combine labour and capital. In this way, mergers influence the determinants of TFP and its growth. By extension, laws that impact merger activity, including efficiencies defenses, have the potential to influence TFP as well. Despite the importance of TFP as a driver of economic growth, to date there is no indication of any empirical research exploring the effectiveness of legislated efficiencies defenses, specifically.³ This study fills an important gap in the literature by providing this empirical research.

Empirical research done by Buccirosset *al.* (2013) provides some insight into the impact competition law can have on TFP growth. The authors examine the degree to which competition policy, including merger control, impacts the productivity of industries in 22 OECD nations from 1995 to 2005. They find that, overall, quality competition policy positively contributes to TFP growth, and this relationship is statistically significant.⁴ The researchers find that the relationship between competition policy quality and TFP growth also holds when they examine competition law and enforcement targeted at mergers specifically.

The Model

The econometric model developed by Buccirosset *al.* (2013) is the basis for the model put forward in this study. Their model is grounded in the theoretical framework put forward by Aghion and Howitt (2006) based in Schumpeterian growth theory. Using a fixed-effects approach following Nicoletti and Scarpetta (2003) and Griffith, Redding, and van Reenen (2004), Buccirosset *et al.* regress TFP growth of national industries (country-industry level) onto their own competition law index that reflects the quality of a nation's competition law.

To capture the endogenous drivers of industry TFP growth of a country, they also include variables that measure the growth of TFP at the technological frontier for a given industry and the distance of a given country-industry from that technological frontier. The authors consider industry-country and country-level factors that also contribute to TFP growth. Industry-country controls include trade openness, R&D intensity, and human capital. National-level controls include product-market regulation and various measures of the quality of a nation's institutions, particularly with respect to

³ To inform the literature search for this section of the paper, a systematic search for “efficiencies defense mergers”, “efficiency defense mergers”, “efficiencies defense competition”, and “efficiency defense competition” was conducted on the American Economic Association, EconLit, Hein Online, and Oxford Academic databases. Of the top 50 most relevant results from each database, papers were selected to inform this section of the paper. A search of relevant studies from the OECD competition policy collection was also undertaken.

⁴ Their evaluation of competition policy quality includes these factors: the degree of independence of a nation's competition authority; separation between the adjudicators and the prosecutors; whether business behaviours that are illegal under competition law align well with behaviours that actually lead to negative impacts on social welfare; the scope of an authority's investigative powers; the level of fines, imprisonment, or other deterrents; the “toughness” of a competition authority, reflected in its level of activity and the size of the sanctions it imposes in the event of a conviction; and the amount and the quality of the financial and human resources of a competition authority.

a nation's legal system. In addition, the authors also include variables to capture industry-country deviations in TFP growth from both linear and quadratic trendlines to account for the effect of business cycles. To address potential endogeneity issues, Buccirossi *et al.* (2013) use lagged versions of the competition policy variable and most other explanatory variables, which in effect implies one-directional causality.

Like Buccirossi *et al.*, the model developed for this study also uses a fixed-effects approach. However, a key difference with this study's model is that it uses country-level, rather than industry-level data. Using country-level data provides a novel contribution to the literature. It also allows for more countries to be included in the study since industry-level productivity data is not available for many countries outside the OECD.

The specification for this analysis is the following:

$$\begin{aligned} \Delta TFP_{i,t} = & \alpha + \beta_1 \text{Efficiency Defense Measure}_{i,t-1} \\ & + \beta_2 \text{Competition Law Intensity}_{i,t-1} \\ & + \delta \left(\frac{\text{Frontier}_t - TFP_{i,t}}{\text{Frontier}_t} \right) + \chi Z_{i,t-1} \\ & + \psi_i + \phi_t + u_{i,t} \end{aligned} \quad (1)$$

Total factor productivity growth of na-

tion i at time t is a function of a measure of the intensity of competition law and its enforcement and the presence of an efficiencies defense within a nation's competition law, both of which are lagged one year to establish causality as in Buccirossi *et al.* (2013).⁵ Therefore, this model does not make use of instrumental variables. As a robustness check, this study presents regressions results estimated with variables lagged over two and three years.

In the model, TFP growth is also a function of nation i 's relative distance from the TFP frontier,⁶ deviations in TFP growth from both linear and quadratic trendlines to account for the effect of business cycles (included in $Z_{i,t-1}$), additional lagged country-specific controls, and country and year fixed effects (ψ_i and ϕ_t , respectively). Country-specific controls include trade openness and human capital. Trade openness facilitates TFP growth by facilitating the transfer of technology between firms across countries (Buccirossi *et al.*, 2013; Miller and Upadhyay, 2000). Following Buccirossi *et al.* (2013), measures of the quality of a country's institutions are included. In addition, based on the findings of Miller and Upadhyay (2000), the nation's deviation of its market exchange rate from purchasing power parity is included, which factors into a nation's trade posi-

⁵ The results in Table 3 illustrate that there may be some relationship between a government's choice to introduce an efficiencies defense and devoting greater resources to competition law enforcement. To explore whether there is any potential endogeneity between the variables capturing the intensity of competition law and the variable denoting whether a nation has an efficiencies defense, regressions presented in this article are estimated with the competitive intensity variable lagged an additional year. The results of these regressions are not materially different from the preferred specifications presented in the article.

⁶ Given the structure of this variable, there is the possibility that for nations that are very far or very close to the frontier, the variable may create extreme values that have an outsized impact on the estimated model. However, summary statistics for the variable that are provided in Table 5, along with further investigation by the author, find that there are no notable outlier observations.

tion and openness. Countries with "[t]rade policies that lower (raise) the real exchange rate toward or below (above) its purchasing power parity value associate with higher total factor productivity [levels]," which may have implications for TFP growth. (Miller & Upadhyay, 2000: 408).⁷

Unlike in Buccirosi *et al.* (2013), variable for the technology frontier is not included in this model (although a variable for distance from the frontier is included) because the technology frontier is global. Since all nations are subject to the same frontier, the variable is effectively removed from the regression under a country-level fixed-effects specification. In a similar vein, a potential problem that arises from this specification is that the key variable of interest – the binary variable for efficiencies defenses – does not vary over the time period of the study for several countries. Many countries that have defenses adopted them prior to 1997, and many countries have never adopted a defense. The lack of variance over time raises specification challenges under a fixed-effects approach. To address this issue, only countries that 1) have introduced an efficiencies defence between 1997 and 2009 or 2) have never introduced a defense, are included in the data sample used to estimate the model. Limiting the sample of countries in this way allows for within- and between- country comparisons of the impact of introducing an efficiencies defense.

Another potential issue with this model, which was flagged by Buccirosi *et al.* (2013), is the risk of omitted variables and resulting bias. Despite the various controls included in the model, there are many other factors that could also impact a nation's TFP growth. The fixed-effects method used in this study will address the impact of any omitted variable that is constant within a country or across time. To address potential heteroskedasticity resulting from other non-constant omitted variables, all fixed-effects specifications are estimated using heteroskedasticity-consistent errors clustered by country following Arellano (1987), using weighting scheme HC4 to improve performance given small sample size and influential observations (Cribari-Neto, 2004).

Data and Variables

To test the impact of efficiencies defenses for mergers on the TFP growth of a nation's economy, data drawn from the Comparative Competition Law dataset (Bradford and Chilton, 2018), the Penn World Tables 10.0, and the World Bank's Worldwide Governance Indicators are used. The data covers years 1997 to 2010 and 69 countries. The sample of countries used for these regressions includes countries that have introduced an efficiencies defense at some point between 1997 and 2010 and countries that have never introduced a de-

⁷ From Miller and Upadhyay (2000: 408): "The local price deviation from purchasing power parity has a significant negative effect at the 5 per cent level. What does this imply? An increase in deviations from purchasing power parity means that the countries' currency becomes less undervalued (more overvalued). Trade policies that lower (raise) the real exchange rate toward or below (above) its purchasing power parity value associate with higher total factor productivity. In sum, real exchange rate changes that stimulate exports (and limit imports) associate with a higher total factor productivity."

fense. More details on these excluded observations are provided in the following sections. The variables used in this study and their summary statistics are provided in Appendix Table 1, and the sections that follow provide details on their source and construction.

Comparative Competition Law Dataset

The Comparative Competition Law Dataset is a census of all legislated competition laws in force up until 2010. It contains a detailed coding of several key aspects of competition laws, including provisions on merger control, abuse of dominance, and anticompetitive agreements. The dataset also contains a module – the enforcement database – that gives detailed enforcement information for several competition authorities around the world, including total enforcement budget in US dollars and total number of mergers reviewed. There are four key variables from this data source: a binary variable denoting whether a nation has an efficiencies defense for mergers in a given year, the Comparative Competition Law Index (CLI), the total budget of all enforcement agencies, and the total number of mergers reviewed by authorities.

The CLI aims to reflect the stringency or intensity of a nation’s entire competition law. As the value of the index increases, the “regulatory risk” faced by firms increases (Bradford and Chilton, 2018). The CLI differs notably from the index developed and used by Buccirossi *et al.* (2013) in two respects. First, the index developed by Buccirossi *et al.* includes information on both

the content of a nation’s competition law and its enforcement, such as the number of staff and budget allocated to the nation’s competition authority and the degree of independence of the competition authority from economic and political interests. In contrast, the CLI reflects only the content of a nation’s competition law. Second, and more broadly, the Buccirossi *et al.* index is designed to reflect the degree to which a nation’s competition policy system aligns with a given ideal following Becker’s (1968) theory of optimal deterrence. In their index, Bradford & Chilton aim to provide a positive, descriptive measure of a nation’s competition law that is not based on a normative standard as in the Buccirossi *et al.* index.

For EU nations, which are subject to both EU and national competition law, the version of the CLI used captures the characteristics of both a nation’s domestic law and EU law. For this study, a new, modified version of the CLI is constructed by the author which removes the efficiencies defense from the CLI. While this change has a minimal impact on the overall value of the CLI index, it addresses potential correlation between the CLI and efficiencies defense variable when included in the same regression.

Data on a nation’s total enforcement spending are also important aspects of the model given the clear relationship between enforcement resources and the presence of an efficiencies defense from the previous descriptive analysis. Enforcement spending is the total budget of competition agencies in 2017 US dollars. For this study, enforcement spending is divided by real GDP at constant 2017 national prices in thousands,

US dollars (variable *rgdpna* in PWT 10.01 to adjust for the size of the nation's economy. Multiplying the CLI with total enforcement spending gives the new variable CLI and enforcement spending used in the regressions. This variable reflects the potential joint effect of competition law stringency and enforcement rigour and controls for other factors that within competition law and its enforcement that could impact TFP growth.

Importantly, the coverage of the enforcement variables is far more limited than the coverage of all other variables used in the regressions. Of the 69 countries included in the dataset, 58 per cent (40 countries) have data on total enforcement spending for 2010. However, enforcement spending does play a key role in making competition law an effective policy intervention, so these variables are included in the estimated regressions. Including these variables means that there are significantly fewer observations included in the regressions.

Penn World Tables

The Penn World Tables version 10.01 provide the majority of the variables used in this analysis given its broad coverage of countries over time. TFP growth, the dependent variable of this analysis, is avail-

able continuously for years 2000 onward. It is calculated using the growth rate of real GDP along with growth rates of real capital labour input data, and labour share (Feenstra *et al.*, 2015). Like the measure of TFP growth used by Buccirosi *et al.* (2013), it is represented as an index. The value of the index is normalized to 1 in 2005 for all countries.⁸

The PWT 10.01 is also the primary source of control variables. Using the level of TFP from the tables, the variable OECD frontier distance is constructed to reflect the relative distance of a nation's TFP from the technological frontier (the OECD average in TFP) for each year. Following Buccirosi *et al.* (2013), two variables are constructed that denote a nation's distance from the quadratic and linear trends in TFP growth: TFP growth trend difference (linear) and TFP growth trend difference (quadratic), respectively.

In addition, variables on the share of merchandise exports at current PPPs (national exports lagged), the price level of the US GDP (output side) normalized such that year 2017 equals 1 (national price level lagged), and the human capital index (human capital lagged) are included. Variables for national imports and national exports are used to reflect trade openness. The human capital index measure human capital per worker and has also been found to

⁸ As in Buccirosi *et al.* (2013), the measure of TFP (and by extension TFP growth) used in the PWT 10.01 relies on the strong assumption of perfect competition. Both Feenstra *et al.* (2015) and Buccirosi *et al.* discuss the implications of this underlying assumption. Feenstra *et al.* point to Burstein and Cravino (2015) who compare productivity measures developed under assumptions of perfect and monopolistic competition and find that these measures are comparable. Thus, Feenstra *et al.* make the assertion that “we expect that the methods used to construct [TFP][...], while derived from perfectly competitive behavior [...] may well apply more generally”(p. 3167). Using data on industry-specific markups, which are not available in the PWT 10.0, Buccirosi *et al.* make modifications to their measure of TFP to allow for imperfectly competitive markets.

be a determinant of TFP and TFP growth (Buccirosi *et al.*, 2013; Miller & Upadhyayb, 2000).⁹

More recent analysis has highlighted that there are several notable outliers in the PWT 10.01 data, particularly with respect to TFP levels. Inklaar and Woltjer (2021) note that a number of low-income countries have TFP levels that are greater than that of the United States, for example Egypt. The authors find that these anomalous results are likely the result of the underlying inputs data. They point to Lagakos *et al.* (2018), who show that human capital measures may understate human capital accumulation in lower-income countries, leading to lower variance in human capital across nations thus overstating TFP variation. Inklaar and Woltjer also refer to Freeman, Inklaar and Diewert (2021), who show that when resource rents are taken into account TFP levels for some outliers are corrected. As Inklaar and Woltjer (2021) point out, determining which observations are outliers is difficult to do with discernment. However, to help address the issue of outlier TFP levels the resource-rich countries examined by Freeman, Inklaar and Diewert are removed from the sample.

World Bank

Variables from the World Bank are R&D expenditure and the national rule of law

index. R&D expenditure is an important driver of TFP growth. The data comes from the World Bank's online data collection. For several countries, there are notable data gaps. To address these gaps, values are interpolated assuming linear growth (or decline) from the years beginning and ending the data gap.¹⁰

The national rule of law index comes from the World Bank's Worldwide Governance Indicators, which provide national-level data on six governance topics based on data from 30 different sources including surveys of enterprises, citizens and experts. Buccirosi *et al.* (2013) use the national rule of law index of the World Bank's Worldwide Governance Indicators to capture "perceptions of the extent to which agents have confidence in and abide by the rules of society". The index is used as a measure of institutional quality and takes values from -2.5 to 2.5, with higher values indicating better outcomes.

Interpretation of Empirical Results

There are three sets of regressions presented in the tables that follow. In Table 3, the sample of countries includes only those that introduced a defense between 1997 and 2009. Table 4 expands the sample to include countries that have never implemented a defense, allowing for a between- and within-country comparison of the im-

9 The index is "based on the average years of schooling, linearly interpolated from Barro and Lee (2013), and an assumed rate of return for primary, secondary, and tertiary education, as in Caselli (2005)" (Feenstra *et al.*, 2015, p. 3172).

10 Countries for which data are interpolated are Australia, Burkina Faso, Switzerland, Costa Rica, Ethiopia, Ecuador, Ghana, Iceland, Morocco, Mozambique, Malaysia, Norway, Philippines, Paraguay, Senegal, Sweden, Thailand, Uruguay, South Africa, and Zambia.

Table 3: Regression Results, Countries that Introduced a Defense between 1997 and 2009

Variable	Dependent variable: <i>rtfpna</i>				
	(1)	(2)	(3)	(4)	(5)
Efficiencies defense lagged	0.017*	0.025*	0.029		
	(0.009)	(0.013)	(0.019)		
Modified CLI lagged	-0.006				
	(0.023)				
CLI and enforcement spending lagged		0.545			
		(1.132)			
CLI and enforcement spending lagged, squared		-1.235			
		(8.331)			
CLI, enforcement spending, and efficiencies defense interaction lagged			-0.522		
			(0.627)		
CLI and enforcement spending quadratic, and efficiencies defense interaction lagged			12.524***		
			(4.829)		
OECD frontier distance lagged	-0.321***	-0.002	-0.022		
	(0.093)	(0.072)	(0.059)		
Efficiencies defense lagged two years			0.032***		
			(0.011)		
CLI and enforcement spending lagged two years			0.195		
			(0.847)		
CLI and enforcement spending lagged two years, squared			0.229		
			(5.542)		
OECD frontier distance lagged two years			-0.021		
			(0.076)		
Efficiencies defense lagged three years				0.031***	
				(0.007)	
CLI and enforcement spending lagged three years				0.213	
				(0.325)	
CLI and enforcement spending lagged three years, squared				-1.693	
				(2.567)	
OECD frontier distance lagged three years				-0.039	
				(0.051)	
TFP growth trend difference (quadratic)	-0.311*	-0.068	0.033	-0.400**	-0.459***
	(0.180)	(0.300)	(0.269)	(0.158)	(0.139)
TFP growth trend difference (linear)	0.896***	0.702*	0.647*	1.228***	1.310***
	(0.236)	(0.420)	(0.386)	(0.126)	(0.140)
Rule of law index lagged	0.066	0.075**	0.077**	0.102***	0.082***
	(0.044)	(0.032)	(0.030)	(0.020)	(0.014)
National exports lagged	-0.064	0.195**	0.162**	0.088	0.005
	(0.150)	(0.079)	(0.064)	(0.073)	(0.071)
National imports lagged	-0.200	0.035	0.006	-0.006	-0.135***
	(0.163)	(0.093)	(0.105)	(0.111)	(0.051)
Human capital lagged	0.319**	0.134	0.161	0.158	0.298***
	(0.125)	(0.108)	(0.111)	(0.192)	(0.112)
National price level lagged	-0.010	0.090	0.157***	0.072	0.070***
	(0.090)	(0.122)	(0.057)	(0.061)	(0.027)
R&D expenditure lagged	1.017	3.736	5.320***	2.729*	2.725**
	(2.486)	(2.331)	(1.881)	(1.613)	(1.363)
Observations	342	172	172	147	131
R²	0.615	0.671	0.714	0.832	0.877
Adjusted R²	0.544	0.550	0.609	0.765	0.821
F-Statistic	41.792***	21.240***	26.019***	43.011***	53.089***
	(df = 11; 288)	(df = 12; 125)	(df = 12; 125)	(df = 12; 104)	(df = 12; 89)

Note: * p < 0.1; ** p < 0.05; *** p < 0.01. Countries included in regression (1) are Bulgaria, Costa Rica, Croatia, Cyprus, Estonia, Finland, Iceland, Jordan, Latvia, Mexico, Morocco, Norway, Panama, Romania, Serbia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Sweden, Thailand, Tunisia, Uruguay.

Table 4: Regression Results: Countries that Introduced a Defense between 1997 and 2009 and Never Had a Defense

Variable	Dependent variable: <i>rtfpna</i>				
	(1)	(2)	(3)	(4)	(5)
Efficiencies defense lagged	0.020*	0.023	0.020		
	(0.010)	(0.018)	(0.027)		
Modified CLI lagged	-0.003				
	(0.019)				
CLI and enforcement spending lagged		0.740			
		(0.494)			
CLI and enforcement spending lagged, squared		-2.785			
		(2.869)			
Enforcement rigour defense interaction lagged			0.024		
			(0.792)		
Enforcement rigour defense interaction lagged, squared			5.549		
			(6.456)		
OECD frontier distance lagged	-0.279***	-0.034	-0.053		
	(0.084)	(0.063)	(0.065)		
Efficiencies defense lagged two years			0.029***		
			(0.010)		
Efficiencies defense lagged three years				0.027***	
				(0.009)	
CLI and enforcement spending lagged two/three years				0.510	0.716**
				(0.486)	(0.346)
CLI and enforcement spending lagged two/three years, squared				-1.037	-2.277
				(2.654)	(1.636)
OECD frontier distance lagged two/three years				-0.061	-0.031
				(0.064)	(0.050)
TFP growth trend difference (quadratic)	-0.418***	-0.221	-0.217	-0.316**	-0.329**
	(0.071)	(0.162)	(0.160)	(0.146)	(0.157)
TFP growth trend difference (linear)	1.009***	0.810***	0.806***	1.022***	1.023***
	(0.088)	(0.210)	(0.196)	(0.139)	(0.148)
Rule of law index lagged	0.031	0.045**	0.046*		
	(0.026)	(0.023)	(0.025)		
National exports lagged	-0.006	0.136	0.093		
	(0.092)	(0.087)	(0.081)		
National imports lagged	-0.133	-0.006	-0.055		
	(0.102)	(0.079)	(0.083)		
Human capital lagged	0.130**	0.037	0.043		
	(0.062)	(0.107)	(0.106)		
National price level lagged	0.036	0.057	0.081*		
	(0.053)	(0.049)	(0.047)		
R&D expenditure lagged	1.399	2.924	3.426*		
	(2.084)	(1.787)	(1.900)		
Rule of law index lagged two/three years				0.043**	0.036*
				(0.021)	(0.019)
National exports lagged two/three years				0.060	-0.010
				(0.080)	(0.076)
National imports lagged two/three years				-0.071	-0.128*
				(0.085)	(0.068)
Human capital lagged two/three years				0.071	0.128
				(0.125)	(0.126)
National price level lagged two/three years				0.026	-0.012
				(0.029)	(0.034)
R&D expenditure lagged two/three years				3.851***	3.452**
				(1.388)	(1.473)
Observations	566	257	257	219	192
R²	0.733	0.650	0.646	0.749	0.756
Adjusted R²	0.689	0.543	0.538	0.666	0.665
F Statistic	121.194***	30.315***	29.829***	40.737***	35.875***
	(df = 11; 486)	(df = 12; 196)	(df = 12; 196)	(df = 12; 164)	(df = 12; 139)

Note: * p < 0.1; ** p < 0.05; *** p < 0.01. Countries included in regression (1) are Argentina, Australia, Bulgaria, Burkina Faso, Chile, Costa Rica, Croatia, Cyprus, Egypt, Estonia, Finland, Iceland, India, Indonesia, Israel, Jamaica, Jordan, Latvia, Mexico, Morocco, Norway, Panama, Peru, Romania, Senega, Serbia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Sweden, Thailand, Tunisia, Turkey, United States, Uruguay.

impact of implementing an efficiencies defense. In Table 5, the sample used for the regressions in Table 4 are limited to only high- and upper-middle income countries, based on the World Bank's income classifications.¹¹

Overall, the results from Table 3 suggest that introducing an efficiencies defense may have a positive impact on TFP growth. In specifications (1) and (2), the coefficient for the one-year lagged efficiencies defense is positive at a 10 per cent level of significance. In regression (3), variables that are made up of combinations of the modified CLI index, enforcement spending, and the efficiencies defense binary variables are included to reflect how enforcement intensity may impact the outcomes of efficiencies defenses. The results from this regression show that higher levels of enforcement intensity lead to positive impacts for efficiencies defenses, with the magnitude of these returns decreasing as intensity increases. Regressions (4) and (5) mirror regression (2) but variables are lagged by 2 and 3 years are lagged 2 and 3 years and find that efficiencies defenses are a positive and statistically significant determinant of national TFP growth. The results of regression (3) do not hold when estimated with lagged variables.

In Table 4 presents the same regressions from Table 3 but includes countries that never had a defense. For regressions (2) and (3), where the data are lagged one year, the coefficient for the efficiencies defense variable fails to be statistically significant

at any relevant level of significance. However, for regressions (4) and (5), the variable of interest is statistically significant at a 1 percent level of significance. The results from regressions (4) and (5) may suggest that the impacts from implementing an efficiencies defense may not be immediately realized but may manifest in the long run.

In Table 5, the sample used in Table 7 is limited to only high and upper-middle income countries, based on the World Bank's income classification. Here, the coefficient for the efficiencies defense variable is statistically significant at a 1 per cent level of significance across nearly all the regressions, including the lagged specifications. The difference between the results of regression (3) in this table and those of Table 7, which does not limit the sample by country income level, may suggest that higher income countries are able to realize the benefits of efficiencies defenses more quickly than lower income countries.

Discussion

The results from the regressions show that implementing an efficiencies defense can have a positive impact on TFP growth, controlling for competition law enforcement intensity via spending and the stringency of a nation's competition laws. Due to data limitations, less can be said about the impacts of implementing efficiencies defenses in lower income countries.

An important factor to consider when interpreting these results is that there are

¹¹ Canada is not included in any of these regressions because in the period examined for this study, Canada has always had a defense. The regressions only include countries that have implemented a defense at some point from 1997 and 2009, or have never implemented a defense.

Table 5: Regression Results: Countries that Introduced a Defense between 1997 and 2009 and Never Had a Defense, High- and Upper-Middle Income Countries

Variable	Dependent variable: <i>rtfpna</i>				
	(1)	(2)	(3)	(4)	(5)
Efficiencies defense lagged	0.016 (0.010)	0.031*** (0.008)	0.056*** (0.014)		
Modified CLI lagged	-0.003 (0.022)				
CLI and enforcement spending lagged		0.810 (0.588)			
CLI and enforcement spending lagged, squared		-3.348 (3.844)			
Enforcement rigour defense interaction lagged			0.013 (0.019)		
Enforcement rigour defense interaction lagged, squared			-0.010 (0.011)		
OECD frontier distance lagged	-0.125** (0.051)	0.029 (0.058)	-0.109 (0.077)		
Efficiencies defense lagged two years			0.021*** (0.007)		
Efficiencies defense lagged three years				0.018** (0.008)	
CLI and enforcement spending lagged two/three years				0.715 (0.619)	0.573* (0.345)
CLI and enforcement spending lagged two/three years, squared				-2.555 (3.234)	-3.213 (2.680)
OECD frontier distance lagged two/three years				0.004 (0.055)	-0.003 (0.044)
TFP growth trend difference (quadratic)	-0.423*** (0.123)	-0.245* (0.145)	-0.413** (0.193)	-0.223* (0.120)	-0.218 (0.163)
TFP growth trend difference (linear)	1.079*** (0.082)	1.001*** (0.139)	1.018*** (0.190)	0.959*** (0.116)	1.002*** (0.163)
Rule of law index lagged	0.032* (0.019)	0.064*** (0.022)	0.072*** (0.021)		
National exports lagged	0.094** (0.044)	0.175*** (0.060)	0.054 (0.083)		
National imports lagged	-0.013 (0.054)	0.085 (0.054)	0.051 (0.053)		
Human capital lagged	0.115** (0.047)	0.103 (0.076)	0.052 (0.082)		
National price level lagged	0.065** (0.026)	0.089** (0.044)	0.135*** (0.049)		
R&D expenditure lagged	2.938* (1.664)	2.996** (1.474)	2.597 (2.113)		
Rule of law index lagged two/three years				0.063*** (0.017)	0.048** (0.021)
National exports lagged two/three years				0.162** (0.063)	0.061 (0.067)
National imports lagged two/three years				0.030 (0.060)	-0.078* (0.041)
Human capital lagged two/three years				0.057 (0.095)	0.164 (0.102)
National price level lagged two/three years				0.055 (0.034)	0.029 (0.038)
R&D expenditure lagged two/three years				3.926*** (1.202)	3.492*** (0.866)
Observations	339	183	119	163	145
R²	0.853	0.735	0.742	0.752	0.818
Adjusted R²	0.824	0.640	0.604	0.653	0.735
F Statistic	148.856*** (df = 11; 283)	30.908*** (df = 12; 134)	18.413*** (df = 12; 77)	29.290*** (df = 12; 116)	37.037*** (df = 12; 99)

Note: * p < 0.1; ** p < 0.05; *** p < 0.01. Countries included in regression (1) are Argentina, Australia, Bulgaria, Chile, Costa Rica, Croatia, Cyprus, Estonia, Finland, Iceland, Israel, Latvia, Mexico, Norway, Panama, Romania, Serbia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Sweden, Turkey, United States of America, Uruguay.

a variety of different types of efficiencies defenses. Since efficiencies defenses were first formalized as a concept (in the North American context) by Williamson in 1968, legislators and policy makers have explored several different ways that competition law, competition law enforcers, and adjudicators can understand efficiencies and the ways they should be considered against merger harms. For instance, Canada's (former) efficiencies defense strongly mirrored the framework put forward by Williamson (1968), which required that adjudicators weigh the efficiencies resulting from a merger against the inefficiencies the merger created, namely through increasing deadweight loss (Ware and Winter, 2016). This approach contrasts with the EU's consumer-focused approach to its efficiencies defense.

Since 1997 about half (52 percent) of all defenses enacted by countries were weighted defenses similar to Canada's former defense. The other half included defenses that mirror that of the EU, and exemption and factor defenses discussed earlier (Shaban, 2024). While efficiencies defenses do enable law enforcement and adjudicators to accept mergers that may otherwise not be permitted on the basis of efficiencies, not all efficiencies defenses are agnostic to the types of efficiencies a merger creates or the impact of those efficiencies.

Furthermore, the relationship between enacting efficiencies defenses and increases in enforcement spending and merger reviews has an important role to play in understanding the impact of new efficiencies defenses. The results suggest that efficiencies defenses on their own could positively impact TFP growth. However, making

changes to competition law without also providing competition law enforcers the resources they need to actually enforce the new law would be unlikely to yield positive results.

Additionally, across nearly all the preferred specifications applied to all the samples, rule of law remains a positive, and statistically significant determinant of TFP growth this finding points to the importance of institutional quality in fostering productivity advancements within a country's economy. Similarly, spending on research and development relative to the size of a nation's economy is also has a positive and statistically significant relationship to TFP growth, although this relationship is less pronounced than that of the rule of law variable.

Conclusion

Since the mid-1980s, efficiencies defenses for mergers have become increasingly more common. Yet, despite their growing prevalence, there has been little research into their effectiveness, particularly from a macroeconomic perspective. Mergers between companies have the capacity to drive substantial changes in how the private sector arranges and uses labour and capital for production. Mergers, and laws that regulate them, could have a meaningful impact on the TFP growth of national economies.

Using data from the Comparative Competition Law Dataset developed by Bradford & Chilton (2018), macroeconomic data from the Penn World Tables version 10.0, and the World Bank, this study undertakes both a descriptive and econometric analyses into the link between efficien-

cies defenses for mergers and TFP growth. The analysis finds a relationship between the introduction of an efficiencies defense and TFP growth. However, importantly, the analysis also points to a relationship between the introduction of an efficiencies defence and enforcement rigour, measured as both total competition law enforcement spending and the number of mergers reviewed by authorities (adjusting for the size of the national economy). While the econometric results find that efficiencies defenses can themselves impact TFP growth, the data also point to the reality that without resources to enforce these laws, they are unlikely to have an impact.

Given recent changes to Canada's Competition Act that saw the removal of its efficiencies defense for mergers, the findings of this study are pertinent. The results provide some evidence that removing the defense could undermine Canada's TFP growth. However, this assertion should be tempered by two considerations. First, this study examines the impact of introducing an efficiencies defense for mergers. It does not consider whether the impact of introducing a defense persists in the long-run and whether, consequently, there is an impact associated with removing these defenses. The study examined defenses introduced between 1997 and 2009, considering one-, two-, and three-year lags specified in the regressions and in many cases these defenses were introduced in the last ten years of the period examined. Second, the study does not differentiate between different types of defenses, whether they be the "weighted" type of defense that Canada used to have or a more consumer-focused type of defense like in EU law.

These different types of defenses have important welfare implications for consumers and could also create different impacts on TFP growth. More research is required to determine the optimal approach for considering efficiencies created by mergers, but this study provides a useful starting point to that research.

There are some important avenues for further research into efficiencies defences for mergers that are worth exploring. First, this area of research would benefit greatly from further data. Expanding the Comparative Competition Law dataset to cover years since 2010, including enforcement spending. This data could enable more sophisticated analysis of the impact of defenses of TFP growth by providing a greater number of observations, both in terms of years of data but also a greater number of countries with enforcement data. With more observations and more countries included in the analysis, more sophisticated econometric techniques can be used to unpack the causal relationship between efficiencies defenses and TFP growth. Another extension that would be possible with more data is exploring how different types of legislated efficiencies may be more or less effective at growing TFP. Including data from after 2010 would also allow studies to capture important technological transformations since that time which would also impact TFP growth. Including more recent years would provide more timely insights for policy makers.

This study highlights the broader economic implications of efficiencies defenses in merger policy, emphasizing both their potential impact on TFP growth and the critical role of enforcement capacity. As

competition laws evolve, ensuring robust enforcement will be essential. Future research with richer datasets and advanced econometric methods can further clarify how efficiencies defenses shape economic performance and market dynamics.

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Table A1: Summary Statistics of Regression Variables

Variable	Obs.	Mean	St. Dev.	Minimum	Maximum	Descriptions
TFP growth	966	0.94	0.17	0.48	1.67	Growth of TFP, (PWT 10.01).
Efficiencies defense lagged	965	0.3	0.46	0	1	Efficiencies defense binary variable, one year lag (Bradford <i>et al.</i> , 2018).
Efficiencies defense lagged two years	964	0.27	0.45	0	1	Efficiencies defense binary variable, two-year lag (Bradford <i>et al.</i> , 2018).
Efficiencies defense lagged three years	963	0.24	0.43	0	1	Efficiencies defense binary variable, three-year lag (Bradford <i>et al.</i> , 2018).
Modified CLI lagged	965	0.43	0.32	0	0.99	Comparative Competition Law Index (CLI), one year lag, efficiencies defense removed (adjusted for EU law), (Bradford <i>et al.</i> , 2018).
CLI and enforcement spending lagged	309	0.02	0.03	0	0.17	CLI multiplied by budget of national enforcement agencies, one year lag (Bradford <i>et al.</i> , 2018).
CLI and enforcement spending lagged two years	266	0.02	0.03	0	0.17	CLI multiplied by budget of national enforcement agencies, two-year lag (Bradford <i>et al.</i> , 2018).
CLI and enforcement spending lagged three years	227	0.02	0.03	0	0.17	CLI multiplied by budget of national enforcement agencies, three-year lag (Bradford <i>et al.</i> , 2018).
CLI and enforcement spending lagged, squared	309	0	0	0	0.03	CLI multiplied by budget of national enforcement agencies squared, one year lag (Bradford <i>et al.</i> , 2018).
CLI and enforcement spending lagged two years, squared	266	0	0	0	0.03	CLI multiplied by budget of national enforcement agencies squared, two-year lag (Bradford <i>et al.</i> , 2018).
CLI and enforcement spending lagged three years, squared	227	0	0	0	0.03	CLI multiplied by budget of national enforcement agencies squared, three-year lag (Bradford <i>et al.</i> , 2018).
OECD frontier distance lagged two years	964	0.31	0.27	-0.97	0.87	Relative distance from technological frontier, two-year lag (Bradford <i>et al.</i> , 2018).
CLI, enforcement spending, and efficiencies defense interaction lagged	257	0.01	0.02	0	0.11	CLI, enforcement spending, and efficiencies defense interaction term lagged, (Bradford <i>et al.</i> , 2018).
CLI and enforcement spending quadratic, and efficiencies defense interaction lagged	257	0	0	0	0.01	CLI and enforcement spending quadratic, and efficiencies defense interaction term lagged, (Bradford <i>et al.</i> , 2018).
OECD frontier distance lagged one year	965	0.31	0.27	-0.97	0.87	Relative distance from technological frontier, one year lag, (Average OECD TFP level less national TFP Relative distance from technological frontier, two-year lag (PWT 10.0)).
OECD frontier distance lagged three years	963	0.31	0.28	-0.97	0.87	Relative distance from technological frontier, three-year lag, (PWT 10.0).
TFP growth trend difference (quadratic)	966	0	0.07	-0.33	0.32	Distance from TFP growth trend, (quadratic).
TFP growth trend difference (linear)	966	0	0.09	-0.42	0.44	Distance from TFP growth trend, (linear).
Rule of law index lagged	964	0.01	0.96	-1.85	2	National rule of law index, one year lag, (World Bank Worldwide Governance Indicators).

Variable	Obs.	Mean	St. Dev.	Minimum	Maximum	Descriptions
Rule of law index lagged two years	895	0.01	0.96	-1.82	2	National rule of law index, two-year lag, (World Bank Worldwide Governance Indicators)
Rule of law index lagged three years	826	0.01	0.96	-1.82	2	National rule of law index, three-year lag, (World Bank Worldwide Governance Indicators)
National exports lagged	965	0.26	0.3	0	2.46	Share of merchandise exports at current PPPs, one year lag, (PWT 10.0).
National exports lagged two years	964	0.26	0.3	0	2.82	Share of merchandise exports at current PPPs, two-year lag, (PWT 10.0).
National exports lagged three years	963	0.25	0.3	0	2.82	Share of merchandise exports at current PPPs, three-year lag, (PWT 10.0).
National imports lagged	965	-0.32	0.29	-2.83	-0.02	Share of merchandise imports at current PPPs, one year lag, (PWT 10.0).
National imports lagged two years	964	-0.31	0.3	-3.39	-0.02	Share of merchandise imports at current PPPs, two-year lag, (PWT 10.0).
National imports lagged three years	963	-0.3	0.31	-3.39	-0.02	Share of merchandise imports at current PPPs, three-year lag, (PWT 10.0).
Human capital lagged	965	2.35	0.67	1.05	3.69	Human capital index, one year lag, (PWT 10.0).
Human capital lagged two years	964	2.34	0.66	1.05	3.67	Human capital index, two-year lag, (PWT 10.0).
Human capital lagged three years	963	2.31	0.66	1.05	3.66	Human capital index, three-year lag, (PWT 10.0).
National price level lagged	965	0.44	0.22	0.12	1.64	Price level of CGDP, one year lag, (PWT 10.0).
National price level lagged two years	964	0.43	0.22	0.12	1.64	Price level of CGDP, two-year lag, (PWT 10.0).
National price level lagged three years	963	0.42	0.21	0.12	1.64	Price level of CGDP, three-year lag, (PWT 10.0).
R&D expenditure lagged	566	0.01	0.01	0	0.04	R&D expenditure (% of GDP), one-year lag, (World Bank).
R&D expenditure lagged two years	519	0.01	0.01	0	0.04	R&D expenditure (% of GDP), two-year lag, (World Bank).
R&D expenditure lagged three years	473	0.01	0.01	0	0.04	R&D expenditure (% of GDP), three-year lag, (World Bank).

Sources: PWT 10.0, Bradford *et al.* (2019), World Bank Worldwide Governance Indicators.